NNSN

Aeronautical Engineering A Continuing Bibliography with Indexes NASA SP-7037(240) June 1989

National Aeronautics and Space Administration

Aeronautical Engineering Aero ronautica n 8 M nauti Ca a to to a t **1a** (6/27) Aeronautical Engineeri n ronautical En gin onautical Eng utical au

NASA SP-7037(240)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 240)

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 May 1989 in

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



National Aeronautics and Space Administration Scientific and Technical Information Division Washington, DC 1989

INTRODUCTION

This issue of Aeronautical Engineering -- A Continuing Bibliography (NASA SP-7037) lists 629 reports, journal articles and other documents originally announced in May 1989 in Scientific and Technical Aerospace Reports (STAR) or in International Aerospace Abstracts (IAA).

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category

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

An annual cummulative index will be published.

Information on the availability of cited publications including addresses of organizations and NTIS price schedules is located at the back of this bibliography.

TABLE OF CONTENTS

) i

ł

	Page
Category 01 Aeronautics (General)	269
Category 02 Aerodynamics Includes aerodynamics of bodies, combinations, wings, rotor faces; and internal flow in ducts and turbomachinery.	rs, and control sur-
Category 03 Air Transportation and Safety Includes passenger and cargo air transport operations; and ai	302 rcraft accidents.
Category 04 Aircraft Communications and Navigation Includes digital and voice communication with aircraft; air na (satellite and ground based); and air traffic control.	307 avigation systems
Category 05 Aircraft Design, Testing and Performance Includes aircraft simulation technology.	309
Category 06 Aircraft Instrumentation Includes cockpit and cabin display devices; and flight instrur	318 nents.
Category 07 Aircraft Propulsion and Power Includes prime propulsion systems and systems components engines and compressors; and onboard auxiliary power plar	322 a, e.g., gas turbine ats for aircraft.
Category 08 Aircraft Stability and Control Includes aircraft handling qualities; piloting; flight controls; a	331 nd autopilots.
Category 09 Research and Support Facilities (Air) Includes airports, hangars and runways; aircraft repair and wind tunnels; shock tubes; and aircraft engine test stands.	334 overhaul facilities;
Category 10 Astronautics Includes astronautics (general); astrodynamics; ground sup facilities (space); launch vehicles and space vehicles; spa space communications, spacecraft communications, comm spacecraft design, testing and performance; spacecraft ins spacecraft propulsion and power.	339 poort systems and ice transportation; and and tracking; strumentation; and
Category 11 Chemistry and Materials Includes chemistry and materials (general); composite mater physical chemistry; metallic materials; nonmetallic materials fuels; and materials processing.	340 ials; inorganic and s; propellants and

Category 12 Engineering

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

343

Category 13 Geosciences Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.	352
Category 14 Life Sciences Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.	N.A.
Category 15 Mathematical and Computer Sciences Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.	353
Category 16 Physics Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and ther- modynamics and statistical physics.	356
Category 17 Social Sciences Includes social sciences (general); administration and management; documen- tation and information science; economics and cost analysis; law, political sci- ence, and space policy; and urban technology and transportation.	357
Category 18 Space Sciences Includes space sciences (general); astronomy; astrophysics; lunar and planet- ary exploration; solar physics; and space radiation.	N.A.
Category 19 General	N.A.

TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 240)

JUNE 1989

01

AERONAUTICS (GENERAL)

A89-25199*# National Aeronautics and Space Administration, Washington, DC.

RECENT RESULTS IN THE NASA RESEARCH BALLOON PROGRAM

W. VERNON JONES (NASA, Washington, DC) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs (AIAA PAPER 89-0233)

The NASA Balloon Program has progressed from a total hiatus in the fall of 1985 to an unprecedented flight success rate in the fall of 1988. Using heavy-lift balloons being regularly supplied by two manufacturers, the program has provided a timely response for investigations of Supernova 1987A from Australia, low energy cosmic ray investigations from Canada during periods of near-solar-minimum, and routine domestic turnaround flights for a variety of investigations. Recent re-evaluation of balloon flight-safety have resulted in severe constraints on flights launched from the Palestine, Texas facility. The future program must rely heavily on the use of remote launch sites to meet the growing requirements for more frequent and longer duration flights being planned for the next 3 - 5 years. Author

A89-25428#

THE INTELLIGENT WING - AERODYNAMIC DEVELOPMENTS FOR FUTURE TRANSPORT AIRCRAFT

R. HILBIG and J. SZODRUCH (Messerschmitt-Boelkow-Blohm GmbH, Bremen, Federal Republic of Germany) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. Research supported by BMFT. refs (AIAA PAPER 89-0534)

The development of several aerodynamic technologies related to the speed range of subsonic aircraft are reviewed. The potential benefits of various technologies are analyzed. It is suggested that the variable camber control concept for transonic wings may lead to an L/D improvement of up to 9 pct and a buffet boundary increase of up to 12 pct. It is found that the integration of passive shock boundary layer interaction control in wing designs may reduce total aircraft drag by two to three pct. In addition, it is suggested that the natural laminar flow concept may make drag reductions of 15-20 pct possible. R.B.

A89-26673#

AMBER FOR LONG ENDURANCE

RONALD D. MURPHY (DARPA, Arlington, VA) Aerospace America (ISSN 0740-722X), vol. 27, Feb. 1989, p. 32-34.

In 1984, DARPA awarded a development contract for a long-endurance unmanned air vehicle (UAV), designated Amber, whose fully-integrated gasoline-fueled four-cylinder powerplant module could accommodate either a naturally aspirated air induction system for operation to 30,000 ft, or a turbocharged system for higher altitudes. A pusher-prop configuration is used to facilitate sensor placement near the fuselage nose, as well as to maximize optics' field-of-view. The Amber UAV has demonstrated 38-hour continuous mission endurance. Attention is given to prospective development landmarks. O.C.

A89-26674#

CONDOR FOR HIGH ALTITUDES

ABRAHAM M. S. GOO, NEIL ARNTZ (Boeing Co., Seattle, WA), and RONALD D. MURPHY (DARPA, Arlington, VA) Aerospace America (ISSN 0740-722X), vol. 27, Feb. 1989, p. 36, 37.

The totally autonomous unmanned air vehicle (UAV) designated Condor embodies state-of-the-art advancements in composite primary structures, propulsion, aerodynamics, and autonomous avionics to yield mission endurances of the order of days rather than hours. Such a UAV will be applicable to drug interdiction, border patrol, storm research, mapping, oceanic law enforcement, shore pollution monitoring, and radio/TV relays. The Condor UAV's two 175-hp engines achieve their high propulsion efficiency through the use of two turbocharging stages. O.C.

A89-28204

BUILDING AIRCRAFT ASSEMBLY TOOLS FROM A 3-D DATABASE

PRADEEP K. BHAUMIK (Northrop Corp., Aircraft Div., Hawthorne, SAE, Aerospace Technology Conference and Exposition, CA) Anaheim, CA, Oct. 3-6, 1988. 10 p.

(SAE PAPER 881428)

The use of a data base from an electronic data model of aircraft assembly to produce assembly tools without physical masters is discussed. The assembly tool is designed in three dimensions and the components are numerically controlled, conventionally machined, and inspected on coordinate measuring machines using a data set that is downloaded from the mainframe. The tool is verified using the theodolite, the coordinate measuring machine, or photogrammetry. R.B.

A89-28463*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA

COCKPIT DISPLAY OF GROUND-BASED WEATHER DATA **DURING THUNDERSTORM RESEARCH FLIGHTS**

BRUCE D. FISHER, PHILIP W. BROWN, ALFRED J. WUNSCHEL, JR., and JOSEPH W. STICKLE (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(AIAA 89-0806)

This paper describes an integrated system for providing ground-based cockpit display, transmitting to an aircraft, upon request via VHF radio, important ground-based thunderstorm data such as radar precipitation reflectivity contours, aircraft ground track, and cloud-to-ground lightning locations. Examples of the airborne X-band weather radar display and the ground-based display are presented for two different missions during the NASA Storm Hazards Program. In spite of some limitation, the system was found to be helpful in the selection of the route of flight, the general ground track to be used, and, occasionally, in clarifying the location of a specific cell of interest.

N89-16719# RAND Corp., Santa Monica, CA. AIRCRAFT AIRFRAME COST ESTIMATING RELATIONSHIPS: **ALL MISSION TYPES Interim Report**

R. W. HESS and H. P. ROMANOFF Dec. 1987 147 p

(Contract F49620-86-C-0008)

(AD-A200262; RAND/N-2283/1-AF) Avail: NTIS HC A07/MF A01 CSCL 05C

This Note is part of a series of Notes that derive a set of equations suitable for estimating the acquisition costs of various types of aircraft airframes in the absence of detailed design and manufacturing information. A single set of equations was selected as being the most representative and applicable to the widest range of estimating situations. For all mission types, the equation set used empty weight types and speed as the basic size-performance variable combination. GRA

N89-16720# RAND Corp., Santa Monica, CA. AIRCRAFT AIRFRAME COST ESTIMATING RELATIONSHIPS: FIGHTERS Interim Report

R. W. HESS and H. P. ROMANOFF Dec. 1987 151 p (Contract F49620-86-C-0008)

(AD-A200263; RAND/N-2283/2-AF) Avail: NTIS HC A08/MF A01 CSCL 05C

This note is part of a series of notes that derive a set of equations suitable for estimating the acquisition costs of various types of aircraft airframes in the absence of detailed design and manufacturing information. A single set of equations was selected as being the most representative and applicable to the widest range of estimating situations. For fighters, the equation set uses airframe unit weight as the variable. GRA

N89-16721# RAND Corp., Santa Monica, CA. AIRCRAFT AIRFRAME COST ESTIMATING RELATIONSHIPS: BOMBERS AND TRANSPORTS Interim Report

R. W. HESS and H. P. ROMANOFF Dec. 1987 63 p (Contract F49620-86-C-0008)

(AD-A200264; RAND/N-2283/3-AF) Avail: NTIS HC A04/MF A01 CSCL 05C

This note is part of a serious of notes that derive a set of equations suitable for estimating the acquisition costs of various types of aircraft airframes in the absence of detailed design and manufacturing information. A single set of equations was selected as being the most representative and applicable to the widest range of estimating situations. For bombers and transports, no single acceptable estimating relationship could be identified. Estimates for these aircraft should be developed by analogy or by using the equation set developed for all mission types. GRA

N89-16722# RAND Corp., Santa Monica, CA. AIRCRAFT AIRFRAME COST ESTIMATING RELATIONSHIPS: ATTACK AIRCRAFT Interim Report

R. W. HESS and H. P. ROMANOFF Dec. 1987 60 p (Contract F49620-86-C-0008)

(AD-A200265; RAND/N-2283/4-AF) Avail: NTIS HC A04/MF A01 CSCL 05C

This note is part of a series of notes that derive a set of equations suitable for estimating the acquisition costs of various types of aircraft airframes in the absence of detailed design and manufacturing information. A single set of equations was selected as being the most representative and applicable to the widest range of estimating situations. For attack aircraft, no single acceptable estimating relationship could be identified because sample sizes were small and not homogeneous. Estimates for these aircraft should be developed by analogy or by using the equation set developed for all mission types. GRA

N89-17564# Army Missile Command, Redstone Arsenal, AL. REMOTELY PILOTED VEHICLE (RPV) TWO VERSUS THREE LEVEL MAINTENANCE SUPPORT CONCEPT STUDY Final Report

JOSEPH H. NORDMAN, WAYNE M. LEONARD, JR., and ADRIAN A. ABRAMS 15 Jan. 1988 67 p

(AD-A200665; AMSMI/LC-TA-88-01) Avail: NTIS HC A04/MF A01 CSCL 01C

Two maintenance support concepts for selected RPV subsystems lifetime supply and maintenance (S and M) costs are: (1) two levels of support, organizational and depot; and (2) three

levels of support, organizational, intermediate (direct support and general support) and depot. Lifetime costs applicable to current peacetime conditions are estimated through the method of the Optimum Supply and Maintenance Model (OSAMM) which uses the supply model, called Selected Essential-Item Stockage for Availability Method (SESAME), as a subroutine. The unique features of OSAMM allows it to simultaneously minimize costs, develop maintenance task distributions, and quantities and placement of test equipment and stockage while achieving a pre-stated operational availability target. Results are presented over a range of operational availability values of interest in which supply quantities are variants. It is concluded that the three level support concept is less expensive than the two level concept for every selected subsystem studied except one - that one exception has a small cost impact. Another interesting conclusion reached for the three level concept is that the operational availability can be significantly improved with small stockage cost increases. GRA

02

AERODYNAMICS

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

A89-24922#

STABILITY AND TRANSITION OF TWO-DIMENSIONAL LAMINAR BOUNDARY LAYERS IN COMPRESSIBLE FLOW OVER AN ADIABATIC WALL

D. ARNAL (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 4, 1988, p. 15-32. refs

Laminar stability theory is applied to two-dimensional boundary-layer profiles on an adiabatic wall, for Mach numbers 0-10. The stability diagrams show complex compressibility effects such as the appearance of multiple unstable modes at supersonic Mach numbers. Some examples are also presented of profiles of fluctuating amplitude. The e exp n method is used for estimating the transition Reynolds numbers for cones or flat plates; these calculations illustrate the difficulties encountered in simulating flight conditions in conventional wind tunnels.

A89-24923#

FAST LAMINAR NEAR WAKE FLOW CALCULATION BY AN IMPLICIT METHOD SOLVING THE NAVIER-STOKES EQUATIONS

D. DEVEZEAUX, H. HOLLANDERS, and C. MARMIGNON (ONERA, Chatillon-sous-Bagneux, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 4, 1988, p. 33-44. Research sponsored by the Delegation Generale pour l'Armement and Aerospatiale. Previously cited in issue 19, p. 3173, Accession no. A88-46328. refs

A89-24925#

AERODYNAMIC VISUALIZATION FOR IMPULSIVELY STARTED AIRFOILS

F. FINAISH and P. FREYMUTH (Colorado, University, Boulder) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 4, 1988, p. 55-62. refs

(Contract F49620-84-C-0065)

An experimental system has been designed which generates and visualizes impulsive starting flow over airfoils in air. The system has been used for a parametric visual study of vortex development over NACA 0015 airfoils at high angles of attack and at low Reynolds numbers. Author

A89-25002#

HYPERSONIC SCRAMJET INLET FLOW INVESTIGATIONS, M1 = 16-26

H. T. NAGAMATSU (Rensselaer Polytechnic Institute, Troy, NY),

K. Y. CHOI, and R. E. SHEER, JR. AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 8 p. refs (AIAA PAPER 89-0003)

The inlet flow phenomena for a two-dimensional scramjet model describing hypersonic Mach numbers of 10-26 with a stagnation temperature of 1400 K were studied in a combustion driven hypersonic shock tunnel. The effect of viscosity on the shock wave angle, pressure, temperature, density, and Mach number after the shock wave is insignificant at M = 10. It is significant at M in the range of 16-26 for nearly perfect conditions. K K

A89-25003#

ZONAL MODELLING OF FLOWS THROUGH MULTIPLE **INLETS AND NOZZLES**

JAMES A. RHODES and JOHN E. CROXFORD (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs

(AIAA PAPER 89-0005)

A two-dimensional zonal grid generation code, INOZG, and a flow solver, FANSI, have been developed which, when used together, can analyze turbulent flow in complicated multiple passage inlet and nozzle configurations. The grid generation code utilizes algebraic and elliptic techniques and offers flexibility in the manner in which the grids are constructed. Currently, grids containing up to 30 zones can be constructed. Information on the coupling of the various zones and the type of boundaries in each zone is created in the grid code and passed to the flow solver. The flow solver uses a 2nd order upwind scheme to solve either the Euler or Navier-Stokes equations. Author

A89-25016*# Douglas Aircraft Co., Inc., Long Beach, CA. AN INTERACTIVE BOUNDARY-LAYER PROCEDURE FOR **OSCILLATING AIRFOILS INCLUDING TRANSITION EFFECTS**

TUNCER CEBECI, HONG-MING JANG (Douglas Aircraft Co., Long Beach, CA), and L. W. CARR (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs (Contract F49720-85-C-0063)

(AIAA PAPER 89-0020)

An interactive boundary-layer method previously developed and tested for steady flows is used here in a quasi-steady manner to examine the evolution of the flow behavior around oscillating airfoils operating inlight stall conditions. The calculations encompass the airfoil and wake flows at angles of attack which lead to flow separation. The location of the onset of transition is represented by a correlation based on steady flows. The results show the large effects of the viscous layer on the variation of lift coefficient with angle of attack and reduced frequency. Author

A89-25017#

THEORETICAL AND NUMERICAL STUDIES OF OSCILLATING **AIRFOILS**

ISMAIL H. TUNCER, JAMES C. WU, and C. M. WANG (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. Research supported by the U.S. Army and USAF. refs

(AIAA PAPER 89-0021)

Unsteady flow fields around airfoils oscillating in pitch and associated dynamic stall phenomena are investigated. A viscous flow analysis and a simplified vortical flow analysis, both based on the integrodifferential formulation of the Navier-Stokes equations are developed and calibrated. The formulation of the viscous flow analysis confines the computations only to the viscous region of the flow and lead to an efficient zonal solution procedure. In the simplified vortical flow analysis, computational demands are greatly reduced by partial analytic evaluations. Simulated flow fields and computed aerodynamic loads are in good agreement with available experimental data. Author

A89-25018#

A STATE-SPACE MODEL OF UNSTEADY AERODYNAMICS IN A COMPRESSIBLE FLOW FOR FLUTTER ANALYSES

J. GORDON LEISHMAN and GILBERT L. CROUSE, JR. (Marvland, University, College Park) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. Research supported by the U.S. Army, refs

(AIAA PAPER 89-0022)

A method is presented to model the unsteady lift, moment, and drag acting on a two-dimensional airfoil in a compressible flow. Starting from suitable generalizations to indicial aerodynamic functions, the unsteady loads due to an arbitrary forcing are represented in state-space (differential equation) form. The aerodynamic model is validated against various experimental data and computational fluid dynamic solutions for harmonic pitch oscillations at Mach numbers up to 0.875. It is shown that even for transonic flow, the method provides a good approximation to the unsteady lift and moment behavior of an airfoil. The aerodynamic model is coupled to the structural equations of a typical airfoil section with two degrees-of-freedom. The stability of the resulting aeroelastic system is determined both by direct time integration of the state equations and by eigenanalysis of the system state matrix. Author

A89-25019*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FLOW VISUALIZATION STUDIES OF THE MACH NUMBER EFFECTS ON THE DYNAMIC STALL OF AN OSCILLATING AIRFOIL

M. S. CHANDRASEKHARA (Navy-NASA Joint Institute of Aeronautics, Monterey, CA) and L. W. CARR (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. Research supported by the U.S. Navy, U.S. Army, and USAF. refs

(AIAA PAPER 89-0023)

Compressibility effects on the dynamic stall of a NACA 0012 airfoil undergoing sinusoidal oscillatory motion were studied using a stroboscopic schlieren system. Schlieren pictures and some quantitative data derived from them are presented and show the influence of free-stream Mach number and reduced frequency on the dynamic-stall vortex. This study shows that a dynamic stall vortex always forms near the leading edge and convects on the airfoil upper surface at approximately 0.3 times the free stream velocity for all cases studied. The results also demonstrate that initiation of the dynamic stall vortex is delayed to higher angles of attack with increased reduced frequency, but that dynamic stall occurs at lower angles of incidence with increasing Mach numbers. Author

A89-25020*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

COMPRESSIBLE STUDIES ON DYNAMIC STALL

J. A. EKATERINARIS (NASA, Ames Research Center; Sterling Federal Systems, Inc., Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. Research sponsored by the U.S. Navy. refs

(AIAA PAPER 89-0024)

The purpose of this work is to investigate the effects of compressibility on the dynamic stall phenomenon by numerical simulation of the unsteady flow. The full two-dimensional unsteady compressible Navier-Stokes equations are solved for flows over oscillating airfoils and airfoils pitching rapidly to high angles of attack. The free-stream speeds vary from low subsonic with mild compressibility effects, to moderate subsonic where strong compressibility effects appear close to the leading edge at high angles of attack. An Alternating Direction Implicit scheme is implemented for the numerical solution with the viscous terms retained in both directions. The numerical results are compared with available experimental data for a Sikorsky airfoil for compressible high Reynolds number flows. There is good agreement between the computed and measured unsteady lift and pitching moment coefficient time histories. The computed high-speed subsonic unsteady results give a good picture of the entire flow field, and the dynamic stall progression in the compressible flow regime. It was observed that compressibility

effects are more severe close to the leading edge at moderate angles of attack, and that the dynamic stall vortex appears at lower angles of attack as the free-stream speed increases.

Author

A89-25021# EXTENDED PITCH AXIS EFFECTS ON FLOW ABOUT A PITCHING AIRFOIL

E. J. STEPHEN, J. M. WALKER, J. ROH, T. ELDRED, and M. BEALS (U.S. Air Force Academy, Colorado Springs, CO) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 p. refs

(AIAA PAPER 89-0025)

A pitching NACA 0015 airfoil was tested in the wind tunnel with several pitch axes at locations from 1/2 chord forward of the airfoil to 1/2 chord aft. The results indicated that moving the pitch axis aft delays the dynamic stall. They also indicate that the maximum lift from the pitching airfoil decreases the aft axis movement. Finally, they may indicate that the effects of moving the pitch axis reach a limit as the axis is moved to extreme Author positions.

National Aeronautics and Space Administration. A89-25022*# Langley Research Center, Hampton, VA.

FLOW-FIELD CHARACTERISTICS AND NORMAL-FORCE

CORRELATIONS FOR DELTA WINGS FROM MACH 2.4 TO 4.6 PETER F. COVELL (NASA, Langley Research Center, Hampton, VA) and GARY F. WESSELMANN (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (AIAA PAPER 89-0026)

An experimental investigation has been conducted to determine the upper-surface flowfield types and the normal-force characteristics of a series of delta wing models at supersonic speeds. Flow-visualization data were used to classify the flowfields into seven primary types: shockless attached flow, separation bubble, classical vortex, vortex with shock, shock with no separation, shock-induced separation, and separation bubble with shock. The pressure distributions were integrated to obtain upper and lower surface normal-force loadings. A minimal effect of sweep was observed on the upper-surface normal force at constant Mach number and a minimal effect of Mach number was noted for the 75 deg delta wing lower-surface normal force. The normal-force coefficients for all test conditions were correlated, and a single empirical equation was formulated from which the normal-force coefficient could be calculated as a function of Mach number, C.D. angle of attack, and wing aspect ratio.

National Aeronautics and Space Administration. A89-25023*#

Langley Research Center, Hampton, VA. EVALUATION OF LEADING- AND TRAILING-EDGE FLAPS ON FLAT AND CAMBERED DELTA WINGS AT SUPERSONIC SPEEDS

GLORIA HERNANDEZ, RICHARD M. WOOD (NASA, Langley Research Center, Hampton, VA), and ROBERT E. COLLINS (Planning Research Corp., Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs (AIAA PAPER 89-0027)

An experimental investigation has been conducted to evaluate the effectiveness of leading- and trailing-edge flaps on a flat and cambered wing at superconic speeds. Results from the experimental tests showed that highly complex and threedimensional flow can occur over the wings with leadingand/or trailing-edge flaps deflected. An analysis of the data also showed that flap effectiveness varies significantly between a cambered and flat wing of identical planform and flap geometry. Mach number effects are similar for both flat and cambered wings for all aerodynamic parameters. Author

A89-25024#

PREDICTION OF SUPERSONIC/HYPERSONIC VISCOUS FLOWS OVER RVS AND DECOYS

DONG JOO SONG, BILAL A. BHUTTA, and CLARK H. LEWIS (VRA, Inc., Blacksburg, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 20 p. refs (AIAA PAPER 89-0028)

The background and applications of a new unified series of codes for predicting large angle-of-attack viscous supersonic/hypersonic flows over spherically blunt reentry vehicles and decoys are discussed. Several test cases are presented for various multiconic and three-dimensional geometries under zero and non-zero angles of attack. The results of these test cases are used to demonstrate the accuracy, efficiency and robustness of the unified solution scheme. Author

A89-25025*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HEAT TRANSFER AND PRESSURE COMPARISONS BETWEEN COMPUTATION AND WIND TUNNEL FOR A RESEARCH HYPERSONIC AIRCRAFT

PAMELA F. RICHARDSON (NASA, Langley Research Center, Hampton, VA), EDWARD B. PARLETTE (Vigyan Research Associates, Inc., Hampton, VA), JOSEPH H. MORRISON, GEORGE F. SWITZER, A. DOUGLAS DILLEY (Analytical Services and Materials, Inc., Hampton, VA) et al. AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs (AIAA PAPER 89-0029)

Comparisons between solutions obtained with a perfect gas, thin-layer Navier Stokes code developed at NASA Langley Research Center and wind tunnel results obtained in Calspan's 96-inch shock tunnel on a research hypersonic aircraft will be presented in this paper. Results cover data obtained between Mach 11 and Mach 19. Comparisons shown in this paper include both pressure and heat transfers. Effects of grid refinement on the computational solution and nose bluntness effects on the Author comparisons will be discussed.

A89-25026*# Analytical Services and Materials, Inc., Hampton, VA

A NUMERICAL STUDY OF HYPERSONIC

PROPULSION/AIRFRAME INTEGRATION PROBLEM J. R. NARAYAN (Analytical Services and Materials, Inc., Hampton, VA) and A. KUMAR (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 10 p. refs

(AIAA PAPER 89-0030)

A numerical analysis procedure useful in the propulsion-airframe integration problem has been established. Flow around a generic hypersonic vehicle forebody is solved using Parabolized Navier-Stokes equations and Thin Layer Navier-Stokes equations. Forebody cross sectional geometry corresponds to a two-ellipse configuration. Effect of forebody geometry on the flow structure, especially at the engine inlet location, is analyzed. Author

National Aeronautics and Space Administration. A89-25028*# Ames Research Center, Moffett Field, CA.

THE EFFECT OF EXHAUST PLUME/AFTERBODY

INTERACTION ON INSTALLED SCRAMJET PERFORMANCE T. A. EDWARDS (NASA, Ames Research Center, Moffett Field,

CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 18 p. refs (AIAA PAPER 89-0032)

An upwind implicit Navier-Stokes code has been used to study hypersonic exhaust plume/afterbody flow fields. It is found that afterbody forces varied linearly with the nozzle exit pressure for moderately underexpanded jets, and that exhaust gases with low isentropic exponents (gamma) contribute up to 25 percent more force than high-gamma exhaust gases. Highly underexpanded jets are shown to create a strong plume shock, and the interaction of this shock with the afterbody produces a complicated pattern of R.R. crossflow separation.

A89-25031*# Boeing Commercial Airplane Co., Seattle, WA. STABILITY OF 3D WING BOUNDARY LAYER ON A SST CONFIGURATION

P. G. PARIKH, P. P. SULLIVAN, E. BERMINGHAM, and A. L. NAGEL (Boeing Commercial Airplanes, Seattle, WA) AIAA. Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 14 p. refs

(Contract NAS1-15325; NASA TASK 21)

(AIAA PAPER 89-0036)

Tollmien-Schlichting (TS) and cross-flow (CF) instability growth characteristics were studied in three dimensions, for the case of a Mach 2.4 SST with double-delta planform whose inboard leading-edge is subsonic and outboard leading-edge is supersonic. Attention is given to the requirements for supersonic speed laminarization of both highly swept, rounded leading-edge wings and moderately-swept, sharp leading-edge wings. Suction requirements for the control of both TS and CF instabilities are calculated; it is found that while mild suction and surface cooling are effective in TS-instability damping, the CF influence of such techniques is rather weak. CF instability control must be via pressure-distribution tailoring and suction. O.C.

A89-25037*# North Carolina State Univ., Raleigh.

LASER HOLOGRAPHIC INTERFEROMETRIC MEASUREMENTS OF THE FLOW IN A SCRAMJET INLET AT MACH 4

J. CRAIG MCARTHUR (North Carolina State University, Raleigh), WILLIAM J. YANTA, W. CHARLES SPRING, III, and KIMBERLY UHRICH GROSS (U.S. Navy, Naval Surface Warfare Center, Silver Spring, MD) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. refs (Contract NAGW-1072)

(AIAA PAPER 89-0043)

The need for quantitative data is addressed by laser holographic interferometry (LHI) by efficiently recording and reducing high resolution density data. This paper investigates the potential to get quantitative data from an interferogram created from two separate holographic plates. The LHI measurements were made on a scramjet inlet at Mach 4. LHI successfully generated results for both internal and external flows, and demonstrated its ability to map entire flow fields. Of the three data reduction techniques used, the four-bucket method gave better results than the three-bucket or three-by-three methods. This technique requires high quality holograms as well as a good resolution in the digital images to produce good data. Author

A89-25039*# Aerojet TechSystems Co., Sacramento, CA. CFD SIMULATION OF SQUARE CROSS-SECTION, **CONTOURED NOZZLE FLOWS - COMPARISON WITH DATA**

MARK J. OSTRANDER (Aerojet TechSystems Co., Sacramento, CA), SCOTT R. THOMAS, RANDALL T. VOLAND, ROBERT W. GUY (NASA, Langley Research Center, Hampton, VA), and SHIVAKUMAR SRINIVASAN (Analytical Services and Materials, Inc., Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. refs

(AIAA PAPER 89-0045)

Computational analyses have been made of the flow in NASA Langley's Arc-Heated Scramjet Test Facility's Mach 4.7 and Mach 6 square cross-section contoured nozzles, for comparison with experimental results. The analyses, which were performed using a three-dimensional RANS computer code assuming a single species gas with constant specific heats, were intended to provide insight into the nature of the flow development in this type of nozzle. The computational results showed the exit flow distribution to be affected by counter-rotating vortices along the centerline of each nozzle sidewall. Calculated flow properties show general, but not complete, agreement with experimental measurements in both nozzles. Author

A89-25040#

UNSTEADY WALL INTERFERENCE IN ROTARY TESTS

MARTIN E. BEYERS (National Aeronautical Establishment, Ottawa, Canada) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(AIAA PAPER 89-0046)

The mechanisms of transverse acoustic interference and vortex-wake/wall interaction are identified as the sources of unsteady wind-tunnel wall interference in rotary balance tests. It is suggested that the convective effects associated with vortex-wake/wall interactions are more likely to be a problem when the rotating system is large in relation to the minimum test-section dimension. Related oscillatory results indicate that unsteady wall interference effects can be significant at high angles of attack.

R.R.

A89-25071*# Old Dominion Univ., Norfolk, VA. UNSTEADY NAVIER-STOKES COMPUTATIONS PAST **OSCILLATING DELTA WING AT HIGH INCIDENCE**

OSAMA A. KANDIL and H. ANDREW CHUANG (Old Dominion University, Norfolk, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 13 p. - refs (Contract NAG1-648) (AIAA PAPER 89-0081)

The unsteady, thin-layer, compressible Navier-Stokes equations, written in the moving frame of reference for the flow relative motion, is solved for the steady and unsteady supersonic flow around a round-edged delta wing. For supersonic flow, local conical flow solution has been obtained from the three-dimensional equations. Pseudotime stepping is used for the steady flow, while time-accurate stepping is used for the unsteady flow. The computational scheme is an implicit approximately-factored finite volume scheme which uses explicit and implicit dissipation terms. The scheme is verified for the steady flow solution. The scheme is then applied to a delta wing undergoing rolling oscillation at a reduced frequency of 1.137 with 15- deg maximum amplitude about a mean angle of attack of 10 deg for a Mach number of 2 and a Reynolds number of 500,000. Author

A89-25072*# Pennsylvania State Univ., University Park. AN EXPERIMENTAL STUDY OF SHOCK WAVE/VORTEX INTERACTION

O. M. METWALLY, G. S. SETTLES (Pennsylvania State University, University Park), and C. C. HORSTMAN (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs (Contract NCA2-235)

(AIAA PAPER 89-0082)

The interaction of a supersonic streamwise vortices (of Mach number 2.2, 3.0, and 3.5) with a normal shock wave has been experimentally investigated, and is found to be highly unsteady. Five-hole pressure-probe and temperature measurements ahead of the interaction are used as initial conditions for an axisymmetric Navier-Stokes calculation. The numerical results supports the hypothesis that supersonic vortex breakdown is an important factor in the observed interaction flow pattern. R.R.

A89-25073*# Imperial Coll. of Science and Technology, London (England).

VORTEX/BOUNDARY LAYER INTERACTIONS

A. D. CUTLER and P. BRADSHAW (Imperial College of Science and Technology, London, England) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (Contract NAGW-581)

(AIAA PAPER 89-0083)

Detailed and high quality measurements with hot-wires and pressure probes are presented for two different interactions between a vortex pair with common flow down and a turbulent boundary layer. The interactions studied have larger values of the vortex circulation parameter than those studied previously. The results indicate that the boundary layer under the vortex pair is thinned by lateral divergence and that boundary layer fluid is entrained into the vortex. The effect of the interaction on the vortex core (other than the inviscid effect of the image vortices behind the surface) is small. Author

A89-25074*# Naval Coastal Systems Center, Panama City, FL. AN EXPERIMENTAL INVESTIGATION OF DELTA WING VORTEX FLOW WITH AND WITHOUT EXTERNAL JET BLOWING

KENNETH P. IWANSKI (U.S. Navy, Naval Coastal Systems Center,

Panama City, FL), T. TERRY NG (Eidetics International, Inc., Torrance, CA), and ROBERT C. NELSON (Notre Dame, University, AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 19 p. Research supported by the University of Notre Dame. refs

(Contract NCA2-162)

(AIAA PAPER 89-0084)

A visual and quantitative study of the vortex flow field over a 70-deg delta wing with an external jet blowing parallel to and at the leading edge was conducted. In the experiment, the vortex core was visually marked with TiCl4, and LDA was used to measure the velocity parallel and normal to the wing surface. It is found that jet blowing moved vortex breakdown farther downstream from its natural position and influenced the breakdown characteristics.

R.R.

National Aeronautics and Space Administration. A89-25075*# Langlev Research Center, Hampton, VA

INFLUENCE OF WING GEOMETRY ON LEADING-EDGE VORTICES AND VORTEX-INDUCED AERODYNAMICS AT SUPERSONIC SPEEDS

RICHARD M. WOOD, STEVEN X. S. BAUER (NASA, Langley Research Center, Hampton, VA), JAMES E. BYRD, BRIAN E. MCGRATH (Planning Research Corp., Hampton, VA), and GARY F. WESSELMANN (NASA, Langley Research Center, Hampton, VA: USAF, Arnold Engineering Development Center, Arnold AFB, TN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (AIAA PAPER 89-0085)

An assessment of the influence of wing geometry on wing leading-edge vortex flows at supersonic speeds is discussed as well as the applicability of various aerodynamic codes for predicting these results. A series of delta-wing wind-tunnel models were tested in the NASA Langley Research Center Unitary Plan Wind Tunnel over a Mach number range from 1.6 to 4.6. The data show that wing airfoil has a significant impact on the localized loading on the wing. The experimental data for the flat wings were compared with results from full-potential, Euler, and Parabolized Navier-Stokes (PNS) computer codes. The theoretical evaluation showed that the full-potential analysis predicted accurate results for the attached-flow (alpha = 0 deg) conditions and that the Euler and PNS analyses made reasonable predictions for both attached and Author separated flow conditions.

A89-25076#

EFFECTS OF LEADING-EDGE SHAPE AND VORTEX BURST ON THE FLOWFIELD OF A 70-DEGREE-SWEEP DELTA-WING

JEROME T. KEGELMAN and FREDERICK W. ROOS (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA. Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(AIAA PAPER 89-0086)

The low-speed flowfields of several thin, flat, 70 degree-sweep delta wings are studied. It is found that the leading-edge shape significantly affects the location of leading-edge vortex bursts. The coupling between vortex burst and lift is not strong for wings with sweep angle of 70 deg or less. Bursting of the leading-edge vortex is noticeably asymmetrical. The primary effect of burst appears to be a slight reduction of the local growth rate of the vortex. The separation characteristics near the leading edge and the strength of the leading-edge vortex appear to be the most important features C.D. for determining vortex lift.

A89-25085#

CONVERGENCE ACCELERATION THROUGH THE USE OF TIME INCLINING

JOHN F. DANNENHOFFER, III (United Technologies Research Center, East Hartford, CT) and MICHAEL B. GILES (MIT, Cambridge, MA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs

(AIAA PAPER 89-0096)

The use of time inclining for accelerating the convergence to steady state of inviscid flow computations is examined. This technique, which was originally developed for the efficient computation of time-accurate rotor-stator interactions, is based upon a local inclination in time of the computational cells. For convergence acceleration, these inclinations are chosen so as to balance the time-step restrictions for the upwindand downwind-running pressure waves. The inclusion of time inclining into Ni's Lax-Wendroff-type integration scheme is discussed in detail, both in terms of the additional transformations required as well as the selection of inclining parameters for near-optimal convergence rates. The technique is very easy to implement due to its local character and thus makes it an ideal candidate for structured as well as unstructured grid calculation procedures. The effectiveness of time inclining is demonstrated in two dimensions with free-stream Mach numbers ranging from 0.2 to 3.0. The results show that while the steady-state accuracy is not affected by inclining, the convergence rate can be more than doubled by optimally inclining the time. Author

A89-25090#

EFFICIENT FINITE-VOLUME PARABOLIZED NAVIER-STOKES SOLUTIONS FOR THREE-DIMENSIONAL, HYPERSONIC, CHEMICALLY REACTING FLOWFIELDS

THOMAS P. GIELDA and RAMESH K. AGARWAL (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA. Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 14 p. refs (AIAA PAPER 89-0103)

The development of an explicit, three-dimensional, finite-volume, parabolized Navier-Stokes code based on MacCormack's predictor-corrector algorithm is described. The code strongly couples an eight-equation chemical kinetics model with the fluid-dynamics equations for calculating hypersonic, turbulent, chemically reacting flowfields. The code is certified by computing a variety of test cases. The computations compare favorably with experimental data. Author

National Aeronautics and Space Administration. A89-25099*# Langley Research Center, Hampton, VA.

AN INTERACTIVE THREE-DIMENSIONAL BOUNDARY-LAYER METHOD FOR TRANSONIC FLOW OVER SWEPT WINGS

SHAWN H. WOODSON, JAMES F. CAMPBELL (NASA, Langley Research Center, Hampton, VA), and FRED R. DEJARNETTE (North Carolina State University, Raleigh) AIAA, Aerospac Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs AIAA, Aerospace (AIAA PAPER 89-0112)

A three-dimensional laminar/turbulent boundary-layer method is developed for transonic flow over swept wings. The governing equations and curvature terms are written for a nonorthogonal body-oriented curvilinear coordinate system. The viscous method is coupled to the full-potential inviscid code, FLO-30, through a displacement-surface interaction. Typically, for transonic Mach numbers and moderate sweep angles, between 5 and 12 viscous updates are required for convergence. The method is applied to a variety of wing planforms, and the results are also compared to those obtained with the three-dimensional integral inviscid-viscous interaction method TAWFIVE (Streett and Melson, 1983). Author

A89-25100#

SUPERSONIC INLET CALCULATIONS USING AN UPWIND FINITE-VOLUME METHOD ON ADAPTIVE UNSTRUCTURED GRIDS

STEPHEN R. KENNON (Texas, University, Arlington) AIAA. Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs

(AIAA PAPER 89-0113)

Euler calculations are presented using an upwind finite-volume method on adaptive unstructured grids. The method combines the attractive features of upwind methods with the geometric generality provided by the use of unstructured grids. The flow solver is coupled to an adaptive unstructured grid generation method developed for non-convex domains. Results are presented for representative transonic and supersonic flows including high-speed, complex-Author geometry inlet flows.

A89-25102*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

UNSTEADY EULER AIRFOIL SOLUTIONS USING

UNSTRUCTURED DYNAMIC MESHES

JOHN T. BATINA (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(AIAA PAPER 89-0115)

Two algorithms for the solution of the time-dependent Euler equations are presented for unsteady aerodynamic analysis of oscillating airfoils. Both algorithms were developed for use on an unstructured grid made up of triangles. The first flow solver involves a Runge-Kutta time-stepping scheme with a finite-volume spatial discretization that reduces to central differencing on a rectangular mesh. The second flow solver involves a modified Euler time-integration scheme with an upwind-biased spatial discretization based on the flux-vector splitting of Van Leer. The paper presents descriptions of the Euler solvers and dynamic mesh algorithm along with results which assess the capability. Author

A89-25103#

AN ACCELERATION METHOD FOR SOLVING THE EULER EQUATIONS ON AN UNSTRUCTURED MESH BY APPLYING MULTIGRID ON AN AUXILIARY STRUCTURED MESH

JOHN VASSBERG (Douglas Aircraft Co., Long Beach, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. Research supported by U.S. Navy. refs (AIAA PAPER 89-0116)

An alternative approach to accelerate the convergence of the two-dimensional Euler equations on an unstructured mesh is presented. The basic Euler equation solver is derived using techniques advocated by Jameson (1986), while the acceleration of the solution is accomplished using multigrid on a sequence of nonbody-conforming structured meshes. The method developed is general and can be extended to three dimensions. Results for Joukowski and NACA 0012 airfoils are presented and compared with exact incompressible solutions and AGARD test-case solutions, respectively.

A89-25104#

APPLICATION OF CONTINUOUS VORTICITY PANELS IN THREE-DIMENSIONAL LIFTING FLOWS WITH PARTIAL SEPARATION

MEUNG J. KIM (Northern Illinois University, DeKalb, IL) and D. T. MOOK (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 12 p. refs

(AIAA PAPER 89-0117)

A panel method for studying aerodynamic characteristics over various configurations of lifting surfaces with partial separation is developed. The method uses piecewise linear vorticity distribution over a flat triangular element for the lifting surface and constant circulation vortex filaments for the force-free wakes. The scheme overcomes two major difficulties: the possibility of an ill-posed matrix due to the linear dependence of the divergenceless conditions and tangency condition of surface vorticities. The numerical results predicted by the method for various lifting configurations show good quantitative agreement with experimental data and other numerical results. C.D.

A89-25108*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

LOW REYNOLDS NUMBER NUMERICAL SOLUTIONS OF CHAOTIC FLOW

THOMAS H. PULLIAM (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 16 p. refs

(AIAA PAPER 89-0123)

Numerical computations of two-dimensional flow past an airfoil at low Mach number, large angle of attack, and low Reynolds number are reported which show a sequence of flow states leading from single-period vortex shedding to chaos via the period-doubling mechanism. Analysis of the flow in terms of phase diagrams, Poincare sections, and flowfield variables are used to substantiate these results. The critical Reynolds number for the period-doubling bifurcations is shown to be sensitive to mesh refinement and the influence of large amounts of numerical dissipation. In extreme cases, large amounts of added dissipation can delay or completely eliminate the chaotic response. The effect of artificial dissipation at these low Reynolds numbers is to produce a new effective Reynolds number for the computations. C.D.

A89-25110#

COMPUTATIONAL STUDIES OF A LOCALIZED SUPERSONIC SHEAR LAYER

J. P. BORIS, E. S. ORAN, J. H. GARDNER, K. KAILASANATH, and T. R. YOUNG, JR. (U.S. Navy, Naval Research Laboratory, Washington, DC) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 14 p. Research supported by the U.S. Navy and DARPA. refs

(AIAA PAPER 89-0125)

A series of two-dimensional time-dependent numerical simulations of shear layers is presented, in which the velocity and the convective Mach number of each stream varies from subsonic to supersonic. The simulations performed are for an ideal gas, gamma = 1.4, at STP with free-stream velocities from + or -200 to + or -800 m/s, corresponding to convective Mach numbers Me from 0.6 to 2.4. The calculations show three regimes for the flow: a low (subsonic) Mach-number regime behaving initially like a periodic temporal simulation, but then evolving into a nearly stationary potential flow; a high Mach-number, supersonic shear-layer regime that forms strong shocks associated with inhibited mixing and suppressed vortex formation and growth; and an intermediate regime in which two dynamic shocks arise in the slot whose strength and position vary, apparently chaotically, in time. The dynamics of the flow are analyzed to isolate and study the mixing and high-speed vortex dynamics of each case.

Author

A89-25111# STRUCTURE OF THE COMPRESSIBLE TURBULENT SHEAR LAYER

DIMITRI PAPAMOSCHOU (California Institute of Technology, Pasadena) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. Research sponsored by the Rockwell International Foundation. refs

(Contract N00014-85-K-0646)

(AIAA PAPER 89-0126)

The large-scale structure of the turbulent compressible shear layer is investigated in a two-stream supersonic wind tunnel through a series of experiments. Double-exposure schlieren photography reveals that the two convective Mach numbers, corresponding to each side of the shear layer, are very different, one sonic or supersonic and the other low subsonic. This contradicts the current isentropic model of the structure which predicts them to be equal or very close. It is shown that addition of shock-wave effects to that model allows for the asymmetric trends observed in the experiments. An inclined view of the flow provides sketchy information about the spanwise orientation of the large-scale structure and does not reveal any pronounced obliquity. Attempts to enhance mixing by modifying the trailing edge were unsuccessful.

A39-25115*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THREE-DIMENSIONAL COMPRESSIBLE BOUNDARY LAYER CALCULATIONS TO FOURTH ORDER ACCURACY ON WINGS AND FUSELAGES

VENKIT IYER and JULIUS E. HARRIS (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 18 p. refs

(Contract NAS1-17919)

(AIAA PAPER 89-0130)

Laminar flow control and drag reduction research requires accurate boundary layer solutions as input to the three-dimensional stability analysis procedures currently under development. In

02 AERODYNAMICS

support of these major programs, a fourth-order accurate finite difference scheme for solving the three-dimensional, compressible boundary layer equations has been developed and is presented in this paper. The method employs a two-point scheme in the wall normal direction and second order zigzag scheme in the cross flow direction. Accurate procedures to interface with the inviscid results are also presented. The results of applying the procedure to laminar flow on wings and fuselages are presented. Author

A89-25123#

STREAMLINES AND STREAMRIBBONS IN AERODYNAMICS

G. VOLPE (Grumman Corporate Research Center, Bethpage, NY) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p.

(AIAA PAPER 89-0140)

The interpretation and understanding of numerically computed flow fields are facilitated and can be enhanced by the portrayal of streamlines and streamribbons of the flow. The graphical displays of these flow features can be used both as diagnostic tools and as a means of conveying information, not only of a qualitative but also of a quantitative nature, to others. Methods of computing and displaying them are described. Their usefulness in a postprocessing environment and in the creation of instructive and visually striking portraits of aerodynamic flow are illustrated.

Author

A89-25133*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. FLOW QUALITY MEASUREMENTS FOR THE LANGLEY

FLOW QUALITY MEASUREMENTS FOR THE LANGLEY 8-FOOT TRANSONIC PRESSURE TUNNEL LFC EXPERIMENT GREGORY S. JONES, P. CALVIN STAINBACK, CHARLES D

GREGORY S. JONES, P. CALVIN STAINBACK, CHARLES D. HARRIS, CUYLER W. BROOKS, JR., and STEVEN J. CLUKEY (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 26 p. refs (AIAA PAPER 89-0150)

Laminar flow experiments were performed in an 8-foot transonic pressure tunnel which was modified in order to simulate the conditions of an infinite span yawed wing. A liner in the tunnel provided a flow field around the yawed airfoil. The results were evaluated using hot-wire and fluctuating pressure measurements. Data were obtained for root-mean-square fluctuations, their spectra, and various cross product terms. R.R.

A89-25166#

VISUALIZATION MEASUREMENTS OF VORTEX FLOWS

MARTIN V. LOWSON (Bristol, University, England) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(AIAA PAPER 89-0191)

Novel flow-visualization experiments have been used on the separated vortex flow on a delta wing at low speed Re = 3000 -30,000 to give preliminary measurements of flow parameters for comparison with theory. Data on vortex core position, vortex sheet shape, and local velocity magnitude and direction in the core have been determined. The results show divergencies from established theoretical models and suggest areas where care should be taken in extrapolating results at low Re to flight cases. Author

A89-25167*# Notre Dame Univ., IN.

A FLOW VISUALIZATION AND AERODYNAMIC FORCE DATA EVALUATION OF SPANWISE BLOWING ON FULL AND HALF SPAN DELTA WINGS

K. D. VISSER, R. C. NELSON (Notre Dame, University, IN), and T. T. NG (Eidetics International, Inc., Torrance, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 21 p. Research supported by the University of Notre Dame. refs (Contract NCA2-162)

(AIAA PAPER 89-0192)

A wind-tunnel investigation has been performed to quantify the effects of a jet on the leading-edge vortices generated by a 70-deg-sweep sharp-edged delta wing at low Reynolds numbers. Efforts were made ot optimize the jet nozzle position with respect to maximum lift increments. Both half-span force-balance testing

and half- and full-span flow visualization tests were conducted. Two angles of attack were investigated, 30 and 35 deg, at Reynolds numbers of 150,000 and 200,000. Aerodynamic enhancement, including lift and drag gains of about 20 and 17 percent respectively, were measured. Results indicate an optimum jet nozzle location to be close to the leading edge, tangent to the upper wing surface, and in a direction aligned parallel to the leading edge. Nozzle interference effects, especially near the apex, were not negligible. Author

A89-25168#

THE EFFECTS OF A CONTOURED APEX ON VORTEX BREAKDOWN

RONALD L. PANTON (Texas, University, Austin) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. Research supported by Lockheed Advanced Aeronautics Co. and General Dynamics Corp. refs

(AIAA PAPER 89-0193)

Strong vortices above delta wings break down at high angle-of-attack. Vortex breakdown is sensitive to the exact nature of the vortex structure and to the flow field in which the vortex is embedded. Mathematically, a uniform symmetric isolated vortex can be completely prescribed by radial profiles of total pressure and of stream-wise vorticity. The subject of this paper is to alter these profiles and observe the effect on vortex breakdown. The total pressure was changed by adding friction to the flow as the fluid crosses the leading edge. Three wings with different friction were tested in a water channel. The vorticity distribution was changed by increasing the sweep angle of the apex region. Six plan forms with a variety of apex contours were tested. The vortex breakdown position as a function of angle-of-attack for each wing is reported. Friction always caused breakdown to occur earlier. that is at a lower angle-of-attack. An extended apex delayed breakdown. The maximum delay was 10 degrees. Author

A89-25169*# Notre Dame Univ., IN. THE SEPARATED FLOW FIELD ON A SLENDER WING

UNDERGOING TRANSIENT PITCHING MOTIONS S. A. THOMPSON, S. M. BATILL, and R. C. NELSON (Notre Dame, University, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. Research sponsored by the University of Notre Dame. refs

(Contract NAG1-727) (AIAA PAPER 89-0194)

The flow field surrounding a delta wing undergoing a transient pitching motion was studied experimentally. Of particular importance was the location of the leading edge vortices over the surface of the wing. The study was conducted on a 70-deg sweep flat-plate delta wing pitched about its one-half chord position. It is found that the maximum pitch rate is the key factor involved in the amount of lag experienced by the vortex breakdown during the transient pitching motion. K.K.

A89-25170*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NUMERICAL SIMULATION OF VORTEX UNSTEADINESS ON SLENDER BODIES OF REVOLUTION AT LARGE INCIDENCE LEWIS B. SCHIFF, DAVID DEGANI (NASA, Ames Research Center, Moffett Field, CA), and SHARAD GAVALI (Amdahl Corp., Sunnyvale, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 15 p. refs

(AIAA PAPER 89-0195)

Time-accurate, fine-grid Navier-Stokes solutions were obtained for flow over a slender ogive-cylinder body of revolution at angles of attack ranging from 10 deg to 40 deg. The results indicate the progressive growth of crossflow separation and the development of the leeward side vortex pattern with increasing incidence. The computed flows show good agreement with experimental measurements. As the angle of attack was increased, the flows become less damped, and at 40 deg a nonsteady flow exhibiting self-sustained fluctuations was observed. The nonsteadiness was linked to the presence of small-scale three-dimensional vortices moving along the primary surfaces of crossflow separation. The behavior of the fluctuations with incidence parallels the trend observed in experiments. Author

A89-25172#

ESTIMATES OF OXIDES OF NITROGEN FORMED IN AN INLET AIR STREAM FOR HIGH MACH NUMBER FLIGHT CONDITIONS

L. M. CHIAPPETTA and J. J. SANGIOVANNI (United Technologies Research Center, East Hartford, CT) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. Research supported by United Technologies Corp. refs (AIAA PAPER 89-0197)

Estimates of oxides of nitrogen formed in the inlet air stream were made for the forebody and internal sections of a generic inlet operating at high-speed flight conditions. Computational fluid dynamics analyses were used to compute typical inlet flow fields. Oxides of nitrogen levels were calculated using these flow fields together with a reaction rate mechanism and a chemical kinetics code. It was found that significant amounts of these species are produced only in a small region of the air flow captured by the inlet and located near its surfaces. Author

A89-25174*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A SET OF STRONGLY COUPLED, UPWIND ALGORITHMS FOR COMPUTING FLOWS IN CHEMICAL NONEQUILIBRIUM

GREGORY A. MOLVIK (NASA, Ames Research Center, Moffett Field, CA) and CHARLES L. MERKLE (Pennsylvania State University, University Park) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 21 p. refs

(Contract NCC2-498) (AIAA PAPER 89-0199)

Two new algorithms have been developed to predict the flow of viscous, hypersonic, chemically reacting gases over three-dimensional bodies. Both take advantage of the benefits of upwind differencing, Total Variation Diminishing (TVD) techniques and of a finite-volume framework, but obtain their solution in two separate manners. The first algorithym is a time-marching scheme, and is generally used to obtain solutions in the subsonic portions of the flow field. The second algorithm is a much less expensive, space-marching scheme and can be used for the computation of the larger, supersonic portion of the flow field. Both codes compute their interface fluxes with a new temporal Riemann solver and the resulting schemes are made fully implicit including the chemical source terms. Author

A89-25178#

PREDICTION OF 3D MULTI-STAGE TURBINE FLOW FIELD USING A MULTIPLE-GRID EULER SOLVER

RON-HO R. NI and JEFFREY C. BOGOIAN (United Technologies Corp., Engineering Div., East Hartford, CT) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (AIAA PAPER 89-0203)

A three-dimensional Euler solver used for the prediction of flow fields through turbomachinery cascades is described. It is based upon the solution algorithm of the explicit multiple-grid scheme for solving the Euler equations presented by Ni (1982). Both the numerical equations for updating the solution at interior nodes and the method for implementing the boundary conditions are given in detail. Two sets of results from turbine flow applications, including a two-stage high pressure turbine, are shown to demonstrate the capability of the Euler solver. Author

A89-25179#

ADAPTIVE GRID EMBEDDING NAVIER-STOKES TECHNIQUE FOR CASCADE FLOWS

ROGER L. DAVIS and JOHN F. DANNENHOFFER, III (United Technologies Research Center, East Hartford, CT) AIAA. Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. Research supported by United Technologies Corp. refs (AIAA PAPER 89-0204)

A new two-dimensional adaptive grid embedding technique for

the efficient and accurate calculation of the Navier-Stokes equations is presented. Steady-state solutions are computed using an explicit, finite volume, time marching technique in which global and embedded meshes are coupled via a multiple-grid algorithm. Solutions are presented for inviscid as well as turbulent viscous flows through quasi-three-dimensional turbomachinery cascades demonstrating that the current procedure can accurately and efficiently track complex flows with multiple length scale phenomena such as shocks, separated flows, shock/boundary layer interactions, trailing edge base flows, and wakes, Author

A89-25182#

EVALUATION OF AN OH GRID FORMULATION FOR VISCOUS CASCADE FLOWS

DAESUNG LEE and CHARLES J. KNIGHT (Avco Research Laboratory, Inc., Everett, MA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. Research sponsored by Textron Lycoming's Research and Development Program. refs (AIAA PAPER 89-0207)

A zonal, mixed topology code has been evolved for steady viscous flow in three-dimensional linear cascades. It is based on the scalar or diagonalized form of approximate factorization and features fully implicit coupling between zones. A q-omega turbulence model is used as in prior work, with low Revnolds number source terms allowing sublayer resolution to y(+) of about 1. Detailed comparisons are given for both H and O-H grid topologies, considering two- and three-dimensional configurations. This includes a reexamination of heat transfer predictions for the Langston cascade, and trends in predicted boundary layer transition. Author

A89-25184#

AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF A BASE CAVITY ON THE NEAR-WAKE FLOWFIELD OF A BODY AT SUBSONIC AND TRANSONIC SPEEDS

R. W. KRUISWYK and J. C. DUTTON (Illinois, University, Urbana) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(Contract DAAL03-87-K-0010)

(AIAA PAPER 89-0210)

An experimental investigation has been conducted to study the effects of a base cavity on the near-wake flowfield of a slender, two-dimensional body in the subsonic and transonic speed ranges. Three base configurations were investigated and compared: a blunt base, a shallow rectangular cavity base of depth equal to one-half the base height, and a deep rectangular cavity base of depth equal to one base height. Each configuration was studied at three freestream Mach numbers, ranging from the low to high subsonic range. Schlieren photographs revealed that the basic qualitative structure of the vortex street was unmodified by the presence of a base cavity. However, the vortex street was weakened by the base cavity, apparently due to enhanced fluid mixing occurring at the entrance of the cavity. Author

A89-25186#

MODIFICATION OF COMPRESSIBLE TURBULENT BOUNDARY LAYER STRUCTURES BY STREAMLINED DEVICES

G. A. GEBERT and H. M. ATASSI (Notre Dame, University, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs (AIAA PAPER 89-0212)

An analysis is presented for the mechanism by which streamlined devices affect the structures of turbulent compressible boundary layers. The analysis is based on the rapid distortion approximation of turbulence and unsteady aerodynamic theory. The fluctuating velocity downstream of the device is calculated throughout the boundary layer for two-dimensional and three-dimensional harmonic disturbances. The results show that such devices suppress the wall normal fluctuating velocity for a range of eddy structures depending upon the device chord length. its height, and the flow Mach number. Criteria for the effectiveness of a device are thus established based on the magnitude of suppression and the breadth of the frequency range. At higher

02 AERODYNAMICS

Mach number flows the degree of suppression can be greater, but the frequency range for maximum suppression is narrower indicating a higher selectivity for the device. Devices in tandem arrangement produce a definite broadening of the maximum suppression range. Author

A89-25188#

OSCILLATORY FLOW FIELD SIMULATION IN A BLOW-DOWN WIND TUNNEL AND THE PASSIVE SHOCK WAVE/BOUNDARY LAYER CONTROL CONCEPT

HENRY T. NAGAMATSU (Rensselaer Polytechnic Institute, Troy, NY), GREGORY A. NYBERG (McDonnell Aircraft Co., Saint Louis, MO), and TODD J. MITTY AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 16 p. Research supported by the U.S. Army. refs

(AIAA PAPER 89-0214)

An apparatus for simulating unsteady helicopter rotor-tip Mach numbers over the upper surface of a Bell FX69-H-098 airfoil section with both solid and porous surfaces was implemented in the R.P.I. 3 x 8-inch Transonic Wind Tunnel. Design and construction of the test facility is discussed, as well as methods of data acquisition. Bottom-wall Mach numbers ranged from 0.45 to 0.85, and oscillation frequencies ranged from 5 Hz to 10 Hz. Results obtained for the solid and porous surfaces from the oscillating wind tunnel operation include: airfoil surveys, cavity pressures, wake total pressure recovery surveys, and section drag coefficients. This work is a fundamental foundation for future investigations into rotor simulation in a blow-down wind tunnel and unsteady flow effects in both shock wave/boundary layer interactions and the passive drag reduction concept.

A89-25207*# Vigyan Research Associates, Inc., Hampton, VA. THREE-DIMENSIONAL FLOW SIMULATION ABOUT THE AFE VEHICLE IN THE TRANSITIONAL REGIME

M. CEVDET CELENLIGIL (Vigyan Research Associates, Inc., Hampton, VA), JAMES N. MOSS, and ROBERT C. BLANCHARD (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs (AIAA PAPER 89-0245)

The direct-simulation Monte Carlo technique is used to analyze the hypersonic rarefied flow about the three-dimensional NASA Aeroassist Flight Experiment vehicle. Results are given for typical transitional flows encountered during the vehicle's atmospheric entry from altitudes of 200-100 km with an entry velocity of 9.9 km/s. It is found that dissociation is important at altitudes of 110 km and below, and that transitional effects are significant even at an altitude of 200 km. R.R.

A89-25219*# Queensland Univ., Brisbane (Australia). THERMODYNAMICS AND WAVE PROCESSES IN HIGH MACH NUMBER PROPULSIVE DUCTS

R. J. STALKER (Queensland, University, Brisbane, Australia) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 27 p. Research supported by the Australian Grants Scheme. refs

(Contract NAGW-674)

(AIAA PAPER 89-0261)

Analysis of the flow in a propulsive duct indicates that, at high Mach numbers, the thermodynamic energy of the fluid is delivered directly into compression and expansion waves. The importance of the resulting wave phenomena is explored by considering the net thrust delivered by a two dimensional convergent-divergent duct with a simplified, planar heat addition zone. It is found that net thrust is reduced when operating at other than the design Mach number, an effect which is most severe for Mach numbers exceeding the design value. An idealized model is developed, involving a self-induced heat injection cycle, and it is seen that the waves produced by this cycle can be the dominant agency in producing thrust.

A89-25222#

TRANSONIC EULER SOLUTIONS ON MUTUALLY INTERFERING FINNED BODIES

LAWRENCE E. LIJEWSKI (USAF, Armament Laboratory, Eglin AFB, FL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(AIAA PAPER 89-0264)

The ability of an Euler code to predict mutual aerodynamic interference in the transonic regime was investigated. One, two, and three body combinations of a cruciform finned configuration were examined at Mach numbers from 0.80 to 1.20 and angles of attack up to ten degrees. Predicted surface pressure distributions were compared with wind tunnel data for the first time on three finned bodies with success. The Euler code was found to predict body pressures well in many interference regions, although shock location often was less accurate due to viscous effects in the strongest interference flowfield near Mach 1. Rigid body physics of the three body combination was investigated from integrated pressure distributions. Force and moment behavior was found to be strongly dependent upon Mach nimber.

A89-25223*# Vigyan Research Associates, Inc., Hampton, VA. UPWIND NAVIER-STOKES SOLUTIONS FOR LEADING-EDGE VORTEX FLOWS

C.-H. HSU (Vigyan Research Associates, Inc., Hampton, VA) and C. H. LIU (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(Contract NAS1-18585)

(AIAA PAPER 89-0265)

An incompressible Navier-Stokes solver using an upwind finite-difference algorithm is employed to investigate low-speed, three-dimensional, laminar, leading-edge vortex flows over three round-edged low-aspect-ratio wings. The effects of grid density, Reynolds number, and wing planform on the flowfield structures and integral values are studied. Computed results show good qualitative and quantitative agreement with the available experimental data. Author

A89-25224*# Analytical Services and Materials, Inc., Hampton, VA.

EVALUATION OF AN ANALYSIS METHOD FOR LOW-SPEED AIRFOILS BY COMPARISON WITH WIND TUNNEL RESULTS RAQUEL EVANGELISTA and CHANDRA S. VEMURU (Analytical Services and Materials, Inc., Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (Contract NAS1-18235; NAS1-18599)

(AIAA PAPER 89-0266)

Results obtained by the airfoil analysis method of Drela (1980) for three airfoils are compared with wind tunnel test results. The method is shown to be accurate in predicting the aerodynamic characteristics of low-speed airfoils in the chord Reynolds number range from 200,000 to 3 million. It is noted that a high value for the transition criterion was necessary to accurately study the case of laminar separation.

A89-25225#

HIGH-LIFT AERODYNAMICS FOR TRANSPORT AIRCRAFT BY INTERACTIVE EXPERIMENTAL AND THEORETICAL TOOL DEVELOPMENT

J. SZODRUCH and H. SCHNIEDER (Messerschmitt-Boelkow-Blohm GmbH, Bremen, Federal Republic of Germany) AIAA, Aerospace Sciences Meeting, 27th Reno, NV, Jan. 9-12, 1989. 12 p. Research supported by BMFT. refs

(AIAA PAPER 89-0267)

Advanced high-lift systems design for transport aircraft requires an interactive effort of experiment and theoretical aerodynamics. Selected two- and three-dimensional experiments have been performed according to the wind tunnel program executed during aircraft development. Detailed boundary layer experiments on all configurations were used to improve the modeling of the flow physics and to compare and validate CFD codes. A new two-dimensional CFD method yields improved results even at complex high-lift flow fields. The complementary work of CFD and experiment in future development of high-lift systems is discussed. Author

A89-25226#

ANALYSIS OF THREE-DIMENSIONAL AEROSPACE CONFIGURATIONS USING THE EULER EQUATIONS

N. KROLL, C. C. ROSSOW, S. SCHERR, J. SCHOENE, and G. WICHMANN (DFVLR, Institut fuer Entwurfsaerodynamik, Brunswick, Federal Republic of Germany) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 20 p. Research supported by CNES. refs

(AIAA PAPER 89-0268)

This paper describes the analysis of three-dimensional flow fields around complex aerospace configurations using a method for solving the Euler equations. The numerical procedure is based on a finite-volume method with cell-vertex discretization using an explicit Runge-Kutta time-stepping scheme. The application of the code to flow around four different types of aerospace configurations is presented: (1) the influence of a body on a wing under transonic cruise conditions, (2) the vortex-vortex interaction when a canard is added to a delta wing, (3) the performance of sharp-nosed vehicles in supersonic flowfields, and (4) the flow around a realistic reentry vehicle with supersonic outflow Mach number. Author

A89-25227#

LARGE-ANGLE-OF-ATTACK VISCOUS HYPERSONIC FLOWS **OVER COMPLEX LIFTING CONFIGURATIONS**

BILAL A. BHUTTA and CLARK H. LEWIS (VRA, Inc., Blacksburg, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 27 p. refs

(AIAA PAPER 89-0269)

A new three-dimensional parabolized Navier-Stokes scheme for studying perfect gas and equilibrium-air viscous hypersonic flows around complex three-dimensional configurations has been developed. This scheme is unconditionally timelike in the subsonic and supersonic flow regions and does not require any sublaver approximation. A predictor-corrector solution scheme and different grid-generation algorithms are used together with an implicit shock-fitting scheme to predict the three-dimensional flowfields around some typical lifting configurations. A new fourth-order accurate smoothing approach is used to enhance solution accuracy. The results show that substantial three-dimensional crossflow effects exist in the predicted flowfields, and that for threedimensional geometries with convex cross sections, a slightly modified variation of a body-normal grid generation scheme shows the best characteristics. C.D.

A89-25228*# Old Dominion Univ., Norfolk, VA. EFFECT OF NOSE BLUNTNESS ON FLOW FIELD OVER SLENDER BODIES IN HYPERSONIC FLOWS

D. J. SINGH, S. N. TIWARI (Old Dominion University, Norfolk, VA), and A. KUMAR (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 13 p. refs

(AIAA PAPER 89-0270)

A parametric study has been conducted to determine the effects of nose bluntness on the enire flowfield over slender bodies under different hypersonic freestream conditions. The analysis is carried out for air under perfect- and equilibrium-gas assumptions. The analyses range from a few simplified approaches to the solution of the complete Navier-Stokes equations. Specific results obtained for spherically blunted cones and ogives demonstrate that there are significant differences in flowfield and surface quantities between sharp and blunted bodies. Depending upon the flow conditions and geometry, the differences are found to persist as far as 260 nose radii downstream. Author

A89-25230#

NUMERICAL SIMULATION OF HYPERSONIC FLOW AROUND A SPACE PLANE AT HIGH ANGLES OF ATTACK USING IMPLICIT TVD NAVIER-STOKES CODE

YUKIMITSU YAMAMOTO (National Aerospace Laboratory, Chofu, Japan) and SHIN KUBO (Total Systems, Inc., Tokyo, Japan) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 16 p. refs (AIAA PAPER 89-0273)

Flux-split upwind TVD scheme has been applied to the hypersonic flow around a space plane proposed by National Aerospace Laboratory (NAL). Thin-laver Navier-Stokes equations in a finite volume formulation are solved by using an implicit approximately factored ADI algorithm. Numerical computations are performed for the conditions of Mach number of 7.0 and Reynolds number of 4.4 x 10 to the 6th at angles of attack up to 50 degrees. Numerical results are compared with experimental data obtained from the hypersonic wind tunnel tests at NAL. Through these comparisons, it is demonstrated that the present TVD Navier-Stokes code has the excellent capabilities for evaluating total aerodynamic performance and investigating the aerodynamic heating, which are of great significance in the design of a space plane configuration. Author

A89-25231#

AN IMPLICIT FLUX-VECTOR SPLITTING SCHEME FOR THE COMPUTATION OF VISCOUS HYPERSONIC FLOW

D. HAENEL and R. SCHWANE (Aachen, Rheinisch-Westfaelische Technische Hochschule, Federal Republic of Germany) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs

(AIAA PAPER 89-0274)

An upwind relaxation method based on flux-vector splitting for the Euler terms, is used for the solution of the three-dimensional Navier-Stokes equations. The numerical method was adopted for the conditions of hypersonic, viscous flows to achieve sufficient convergence and accuracy there. The use of the critical speed of sound for sonic switching and rearrangements of the implicit solution procedure have made the algorithm more robust even for very small values of density or temperature. The spatial accuracy in viscous regions could be improved by using a new split energy flux, and by one-sided upwinding of the tangential velocity in the flux-vector splitting formulation. Applications are shown for hypersonic flows around blunt bodies. Author

A89-25232*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

COMPARISON OF LDV MEASUREMENTS AND NAVIER-STOKES SOLUTIONS IN A TWO-DIMENSIONAL **180-DEGREE TURN-AROUND DUCT**

DARYL J. MONSON, H. LEE SEEGMILLER (NASA, Ames Research Center, Moffett Field, CA), and PAUL K. MCCONNAUGHEY (NASA, Marshall Space Flight Center, Huntsville, AL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV. Jan. 9-12, 1989. 10 p. refs

(AIAA PAPER 89-0275)

Results from an experimental and numerical investigation of turbulent subsonic flow inside a two-dimensional, strongly curved, 180 deg turn-around duct are presented. Data measured with a two-component, two-color laser Doppler velocimeter include profiles of mean axial velocity and local flow angle. Static pressure distributions are also measured. Results are obtained at a Mach number of 0.1, and at Reynolds numbers of 100,000 and a million based on channel height. Numerical calculations are performed using the incompressible Navier-Stokes equations with a Prandtl mixing length zero-equation turbulence model modified for internal flows. Theory and experiment are compared to evaluate the ability of the turbulence model to predict this class of internal flows with strong curvature. Author

A89-25237#

VISCOUS SWIRLING NOZZLE FLOW

CHAU-LYAN CHANG and CHARLES L. MERKLE (Pennsylvania State University, University Park) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. Research supported by USAF. refs

(AIAA PAPER 89-0280)

Swirling viscous flow in transonic and supersonic propulsion nozzles has been investigated numerically. Central-differenced ADI and flux-vector split upwind algorithms are utilized to solve the thin-layer Navier-Stokes equations for axisymmetric twodimensional flows with swirl. The effects of swirl on viscous

02 AERODYNAMICS

flowfields are studied for nozzles with mild to high expansion ratios. Both flowfield details and integral nozzle performance are compared to previously published inviscid calculations. The results show that the presence of swirl has a significant effect on the flowfield as well as nozzle performance, especially for plug nozzles and high expansion ratio contoured nozzles. Author

A89-25238#

THREE-DIMENSIONAL HYBRID FINITE VOLUME SOLUTIONS TO THE EULER EQUATIONS FOR

SUPERSONIC/HYPERSONIC AIRCRAFT

M. J. SICLARI (Grumman Corporate Research Center, Bethpage, NY) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 19 p. refs (AIAA PAPER 89-0281)

A new, efficient numerical scheme is presented to solve the Euler equations about three-dimensional surfaces for supersonic flows. The unsteady Euler equations are cast in a spherical coordinate system. A node centered, physical space, finite volume, central difference scheme is applied to the crossflow mesh on spherical surfaces. A fully implicit marching scheme is then used to solve for the steady state solution in each spherical crossflow plane using an unsteady, explicit, pseudo-time Runge-Kutta integration scheme. The marching derivatives are treated implicitly using a finite difference upwind discretization in the computational space. This method has been found to be successful in treating both wings and bodies. The present paper extends the application of this method to aircraft configurations with and without inlets. The computed results for four aircraft configurations are presented illustrating both attached and separated flows. Author

A89-25242*# Stanford Univ., CA.

THE EFFECT OF MACH NUMBER ON THE STABILITY OF A PLANE SUPERSONIC WAVE

JACQUELINE H. CHEN, BRIAN J. CANTWELL (Stanford University, CA), and NAGI N. MANSOUR (NASA, Ames Research Center, AIAA, Aerospace Sciences Meeting, 27th, Moffett Field, CA) Reno, NV, Jan. 9-12, 1989. 23 p. Research sponsored by Sandia National Laboratories. refs

(AIAA PAPER 89-0285)

The influence of compressibility on the mechanisms governing the various stages of transition in a supersonic wake is investigated. Results from linear stability theory are used to provide physical insights into the observed reduction in growth rate at high Mach numbers. A newly developed hybrid algorithm is used to solve the compressible inviscid linear disturbance equations. Growth rates for both antisymmetric and symmetric modes of two-dimensional and oblique waves are computed for a wide range of Mach numbers. Results from two and three-dimensional direct numerical simulations of a forced compressible time-developing wake are presented in order to understand the nonlinear stages of transition at high Mach numbers. Observed nonlinear growth rate comparisons are made for wakes at two different Mach numbers. The reduction in growth rate at high Mach numbers is explained by examining contour plots of baroclinic torques and the product C.D. of dilatation and vorticity.

A89-25244#

ON THE STRUCTURE OF TWO- AND THREE-DIMENSIONAL SEPARATION

LAURA L. PAULEY (Pennsylvania State University, University Park), PARVIZ MOIN, and WILLIAM C. REYNOLDS (Stanford University, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (Contract N00014-84-K-0232)

(AIAA PAPER 89-0287)

The separation of a laminar boundary layer under the influence of an external adverse pressure gradient was studied in both two and three dimensions. The unsteady incompressible Navier-Stokes equations were solved using a fractional time-step method. In two dimensions, a strong pressure gradient created periodic shedding

from the leading separation. A criterion for shedding was established in terms of a general nondimensional pressure gradient. Three-dimensional separation was studied by impulsively applying a three-dimensional adverse pressure gradient to a two-dimensional boundary layer. The separation passed through several different topologies before becoming fully developed. When instantaneous streamlines were used to study the flow, a cross-stream vortex was seen to bend at the centerline and lift away from the wall as Author the separation developed.

A89-25245#

UNSTEADY, SEPARATED FLOW BEHIND AN OSCILLATING, TWO-DIMENSIONAL FLAP

CURTIS F. NELSON, DENNIS J. KOGA, and JOHN K. EATON AIAA, Aerospace Sciences Meeting, (Stanford University, CA) 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs (Contract AF-AFOSR-86-0159)

(AIAA PAPER 89-0288)

Unsteady, separated flow produced behind a two-dimensional, lifting flap was examined in detail using phase-averaged LDA and surface pressure measurements. Both sinusoidal oscillations with reduced frequencies in the range 0.025 to 0.06 and pitch-and-hold motions of the flap were investigated. Phase-averaged vorticity was calculated from the velocity data and the development of the unsteady vortex formed downstream of the flap was analyzed. The dominant mechanism of vorticity transport is shown to be convective, justifying the use of discrete-vortex computations for Author modeling this flow.

A89-25246*# Purdue Univ., West Lafayette, IN. OSCILLATING AERODYNAMICS AND FLUTTER OF AN AERODYNAMICALLY DETUNED CASCADE IN AN **INCOMPRESSIBLE FLOW**

HSIAO-WEI D. CHIANG and SANFORD FLEETER (Purdue AIAA, Aerospace Sciences University, West Lafayette, IN) Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. Research sponsored by NASA. refs

(AIAA PAPER 89-0289)

A mathematical model is developed and utilized to demonstrate the enhanced torsion mode stability associated with alternate blade circumferential aerodynamic detuning of a rotor operating in an incompressible flow field. The oscillating cascade aerodynamics, including steady loading effects, are determined by developing a complete first order unsteady aerodynamic analysis. An unsteady aerodynamic influence coefficient technique is then utilized, thereby enabling the stability of both conventional uniformly spaced rotors and detuned nonuniform circumferentially spaced rotors to be determined. To demonstrate the enhanced flutter aeroelastic stability associated with this aerodynamic detuning mechanism, this model is applied to a baseline unstable rotor with a Gostelow Author flow geometry.

A89-25248#

VORTICAL FLOWS PAST NORMAL PLATE AND SPOILER OF TIME DEPENDENT HEIGHT

KALPANA CHAWLA and CHUEN-YEN CHOW (Colorado, University, Boulder) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 14 p. refs

(Contract F49620-88-C-0098)

(AIAA PAPER 89-0291)

Studied in this paper are unsteady, two-dimensional, vortical flows past normal plates and flat-plate airfoil with a spoiler mounted on the upper surface at the mid-chord position. The height of the plate or that of the spoiler may either be a constant or a sinusoidal function of time. These flow problems are solved using the discrete vortex method. For an accelerating flow past a normal plate of constant height, the computed time history of vortical development agrees very well with that photographed in the laboratory. For the airfoil configuration, the effects of spoiler oscillation on vortical structures as well as on unsteady lift and drag are examined Author numerically.

A89-25252*# Stanford Univ., CA.

LOW SPEED WIND TUNNEL INVESTIGATION OF THE FLOW ABOUT DELTA WING, OSCILLATING IN PITCH TO VERY HIGH ANGLE OF ATTACK

MOHAMMAD-AMEEN M. JARRAH (Stanford University, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. refs

(Contract AF-AFOSR-84-0099; NCA2-287)

(AIAA PAPER 89-0295)

Six-component airload histories were obtained for models of aspect ratio 1, 1.5, and 2. Examples are given from data obtained over a range of 'reduced frequency' parameters from 0.01 to 0.08. They include the unsteady response of the leading-edge vortices, as evidenced both by the time-dependent airloads and motion pictures of smoke released from the leading edge and illuminated by a thin sheet of laser light. KK

A89-25253#

MOVING SURFACE BOUNDARY-LAYER CONTROL AS APPLIED TO TWO-DIMENSIONAL AIRFOILS

V. J. MODI, F. MOKHTARIAN, M. S. U. K. FERNANDO, and T. YOKOMIZO (British Columbia, University, Vancouver, Canada) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract NSERC-A-2181)

(AIAA PAPER 89-0296)

The concept of moving surface boundary layer control, as applied to a Joukowsky airfoil, is studied. The moving surface was provided by rotating cylinders located at the leading edge and upper surface of the airfoil. It is found that the concept can provide a substantial increase in lift and a delay in stall. K.K.

A89-25273#

COMPUTATIONS OF 3D VISCOUS FLOWS IN ROTATING TURBOMACHINERY BLADES

D. CHOI and C. J. KNIGHT (Avco Research Laboratory, Inc., Everett, MA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. Research sponsored by Textron Lycoming's Research and Development Program. refs (AIAA PAPER 89-0323)

A thin-layer Navier-Stokes code has been developed to analyze three-dimensional viscous flowfields in rotating turbomachinery blades. This code solves mass, momentum, and energy conservation equations plus two turbulence-model equations, based on rotating curvilinear coordinates, using a time-asymptotic method for steady-state solutions in the relative frame. It employs scalar implicit approximate factorization in time and a finite-volume formulation with second-order upwind TVD differencing in space. For turbulence effects, a two-equation q-omega turbulence model has been used with low-Reynolds-number terms allowing sublayer resolution down to y(+) of about 1. The code has been validated by considering experimental studies on a subsonic centrifugal impeller and a transonic axial compressor. Author

A89-25274*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

GRID REFINEMENT STUDIES OF TURBINE ROTOR-STATOR INTERACTION

N. K. MADAVAN, M. M. RAI (NASA, Ames Research Center, Moffett Field, CA), and S. GAVALI (Amdahl Corp., Sunnyvale, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 16 p. Research supported by the U.S. Navy. refs (AIAA PAPER 89-0325)

Results from a three-dimensional, time-accurate Navier-Stokes simulation of rotor-stator interaction in an axial turbine stage are presented. The present study uses a fine grid in the spanwise direction to better resolve endwall and tip cllearance effects and complements coarse-grid calculations that were reported earlier. A realistic turbine stage with 22 stator vanes and 28 rotor blades is simulated as a single-stator, single-rotor airfoil combination with the stator geometry modified to properly account for blockage effects. This is in contrast to the earlier coarse-grid calculations where the rotor geometry was modified. The improved grid resolution and the unmodified rotor geometry result in a more accurate simulation of the flow field, particularly in the rotor channel where the interaction effects are more severe. The numerical results are compared to experimental data wherever possible and to earlier calculations. Author

A89-25276#

MEASUREMENT AND MODELLING OF TURBULENT SPOT GROWTH ON A GAS TURBINE BLADE

D. A. ASHWORTH (Rolls-Royce, PLC, Derby, England) and J. E. LAGRAFF (Syracuse University, NY) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs (Contract AF-AFOSR-85-0295)

(AIAA PAPER 89-0328)

The natural transition process on the suction surface of a two-dimensional cascade transonic gas turbine rotor blade has been experimentally investigated, and a new method has been used for the numerical modeling of the development of turbulent spots within a laminar boundary layer. The results show that the unsteady heat transfer data are consistent with Emmons'turbulent spot model of transition and with many low speed observations of spot growth and convection rates even at the transonic condition of these tests. Furthermore, the numerical model based on the Emmons physical model produces results which qualitatively reproduce the unsteady heat transfer behavior and can be used to fit measured intermittency data from other published work.

Author

A89-25284*# Vigyan Research Associates, Inc., Hampton, VA. NAVIER-STOKES SOLUTIONS FOR VORTICAL FLOWS OVER A TANGENT-OGIVE CYLINDER

PETER-M. HARTWICH (Vigyan Research Associates, Inc., Hampton, VA) and R. M. HALL (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(Contract NAS1-17919)

(AIAA PAPER 89-0337)

Reynolds number (Re) effects on low-speed vortical flows over a 3.5 caliber tangent-ogive cylinders at two angles of attack (alpha = 20 and alpha = 30 degrees) are computationally assessed for Re(D) = 0.2 -3.0 million (D: maximum diameter). The flow field results are steady-state solutions to the three-dimensional, incompressible Navier-Stokes equations in their thin-layer approximation. Using a properly modified algebraic turbulence model, the numerical results are in good to excellent agreement with experiments. Author

A89-25285*# Vigyan Research Associates, Inc., Hampton, VA. NAVIER-STOKES SOLUTIONS ABOUT THE F/A-18 FOREBODY-LEX CONFIGURATION

FARHAD GHAFFARI, BRENT L. BATES (Vigyan Research Associates, Inc., Hampton, VA), JAMES M. LUCKRING, and JAMES L. THOMAS (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 24 p. refs (Contract NAS1-17919)

(AIAA PAPER 89-0338)

Three-dimensional viscous flow computations are presented for the F/A-18 forebody-LEX geometry. Solutions are obtained from an algorithm for the compressible Navier-Stokes equations which incorporates an upwind-biased, flux-difference-splitting approach along with longitudinally-patched grids. Results are presented for both laminar and fully turbulent flow assumptions and include correlations with wind tunnel as well as flight-test results. A good quantitative agreement for the forebody surface pressure distribution is achieved between the turbulent computations and wind tunnel measurements at a free-stream Mach number of 0.6. The computed turbulent surface flow patterns on the forebody qualitatively agree well with in-flight surface flow patterns obtained on an F/A-18 aircraft at a free-stream Mach number of 0.34

Author

A89-25286*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA. NUMERICAL SIMULATION OF HIGH-INCIDENCE FLOW OVER

THE F-18 FUSELAGE FOREBODY

LEWIS B. SCHIFF, RUSSELL M. CUMMINGS, REESE L. SORENSON, and YEHIA M. RIZK (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno. NV, Jan. 9-12, 1989. 14 p. refs

(AIAA PAPER 89-0339)

As part of the NASA High Alpha Technology Program, fine-grid Navier-Stokes solutions have been obtained for flow over the fuselage forebody and wing leading-edge extension of the F/A-18 High Alpha Research Vehicle at large incidence. The resulting flows are complex and exhibit cross-flow separation from the sides of the forebody and from the leading-edge extension. A well-defined vortex pattern is observed in the leeward-side flow. Results obtained for laminar flow show good agreement with flow visualizations obtained in ground-based experiments. Further, turbulent flows computed at high-Reynolds-number flight-test conditions show good agreement with surface and off-surface visualizations obtained in flight. Author

A89-25288*# Stanford Univ., CA. NUMERICAL STUDY OF THE EFFECT OF TANGENTIAL LEADING EDGE BLOWING ON DELTA WING VORTICAL FLOW

DAVID T. YEH, DOMINGO A. TAVELLA, LEONARD ROBERTS (Stanford University, CA), and KOZO FUJII (Tokyo, University, Sagamihara, Japan) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract NCC2-341)

(AIAA PAPER 89-0341)

A numerical simulation of tangential blowing along the leading edge of a delta wing is analyzed as a means of controlling the position and strength of the leading-edge vortices. The computation is done by numerical solutions of the three-dimensional thin-layer Navier-Stokes equations. Numerical results are shown to compare favorably with experimental measurements. It is found that the use of tangential leading-edge blowing at low to moderate angles of attack tends to reduce the pressure peaks associated with leading-edge vortices and to increase the suction peak around the leading edge, such that the integrated value of the surface pressure remains about the same. Author

A89-25298#

MACH NUMBER DEPENDENCE OF FLOW SEPARATION INDUCED BY NORMAL SHOCK-WAVE/TURBULENT BOUNDARY-LAYER INTERACTION AT A CURVED WALL

P. DOERFFER (Polska Akademia Nauk, Instytut Maszyn Przeplywowych, Gdansk, Poland) and U. DALLMANN (DFVLR, Institut fuer theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (AIAA PAPER 89-0353)

The topological flow structures which are induced by a normal shock-wave/turbulent boundary-layer interaction at a Reynolds number of 55,000 and within a Mach number range of 1.35-1.47 are studied experimentally. At a Mach number of 1.35, there are already separated zones adjacent to the side walls. It is found that, for decreasing Mach number value, the length of the time-averaged reversed flow region along the wall center line K.K. decreases.

A89-25299#

CONFINED NORMAL-SHOCK/TURBULENT-BOUNDARY-LAYER INTERACTION FOLLOWED BY AN ADVERSE PRESSURE GRADIENT

M. SAJBEN, M. J. MORRIS, T. J. BOGAR, and J. C. KROUTIL (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 18 p. refs

(AIAA PAPER 89-0354)

A steady, nearly two-dimensional interaction of a normal shock with a turbulent boundary layer over a flat surface is investigated experimentally. The approach Mach number is 1.34 and the Reynolds number based on the momentum thickness of the approach boundary layer is 14,600. The experiment is distinguished from similar past studies by the existence of an adverse pressure gradient region downstream of the shock and by a relatively high ratio of the approach boundary layer thickness to the channel height. This combination of features introduces significant differences over interactions taking place in constant-area channels. The time-mean and fluctuating velocity field was explored in detail using laser Doppler velocimetry. Spatial distributions of turbulence kinetic energy, shear stress, and turbulence production are presented. Author

A89-25300#

AN LDV INVESTIGATION OF A MULTIPLE NORMAL SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTION

BRUCE F. CARROLL (Florida, University, Gainesville) and J. CRAIG DUTTON (Illinois, University, Urbana) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (AIAA PAPER 89-0355)

The interaction of a multiple normal shock with a turbulent boundary layer in a rectangular duct has been investigated experimentally using a two-component LDV. Just upstream of the shock system the Mach number was 1.61; the unit Reynolds number was 30 x 10 to the 6th/m; the boundary-layer thickness was 5.4 mm; and the confinement level as characterized by the ratio of the boundary layer thickness to the duct half height was 0.32. The results presented here identify the fluid-dynamic mechanisms involved in the reacceleration process following each shock in the multiple shock system. Author

A89-25301#

AN EXPLORATORY STUDY OF CORNER BLEED ON A FIN **GENERATED THREE-DIMENSIONAL SHOCK WAVE** TURBULENT BOUNDARY LAYER INTERACTION

S. M. BOGDONOFF (Princeton University, NJ) and A. STEVEN TOBY AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (Contract F49620-86-C-0094)

(AIAA PAPER 89-0356)

The effect of a gap at the fin-plate junction was examined for a 20 deg fin-turbulent boundary layer interaction at M=2.95. Detailed surface pressure distributions and surface flow visualization were used . The results show no sudden changes in the flow field as the gap was varied from zero to more than one-half the boundary layer thickness. The initial part of the interaction moved downstream, but little effect was found downstream of the inviscid shock wave location. Flow-field probing will be required to define any flow-field structural changes.

Author

A89-25306*# Vigyan Research Associates, Inc., Hampton, VA. NUMERICAL SOLUTIONS ON A PATHFINDER AND OTHER CONFIGURATIONS USING UNSTRUCTURED GRIDS AND A FINITE ELEMENT SOLVER

PARESH PARIKH, SHAHYAR PIRZADEH (Vigyan Research Associates, Inc., Hampton, VA), RAINALD LOHNER (George Washington University, Washington, DC), and CLYDE GUMBERT (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. Research supported by DNA, USAF, and U.S. Navy. refs (Contract NAS1-18419; NAS1-18670)

(AIAA PAPER 89-0362)

A three-dimensional unstructured grid generator and a finite element Euler solver are described. The grid generator uses the advancing front concept, and the flow solver is based on the flux corrected transport ideas. Several examples of computed flows past complete three-dimensional configurations are presented to demonstrate the flexibility and robustness of the programs. Current items requiring further attention are identified, and the progress over the last year toward them is reported. Author

A89-25308*# Analytical Services and Materials, Inc., Hampton, VA.

APPLICATION OF DIRECT SOLVERS TO UNSTRUCTURED MESHES FOR THE EULER AND NAVIER-STOKES EQUATIONS USING UPWIND SCHEMES

V. VENKATAKRISHNAN (Analytical Services and Materials, Inc., Hampton, VA) and TIMOTHY J. BARTH (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs

(AIAA PAPER 89-0364)

The application of Newton iteration to inviscid and viscous airfoil calculations on unstructured meshes is examined. A cell-centered finite volume scheme is employed on an unstructured mesh consisting of triangles. Roe's flux difference splitting scheme is used to compute the inviscid fluxes. Higher order accuracy is achieved by an interpolation procedure that makes use of auxiliary gradients. The efficient solution of the sparse linear system of equations which arises upon linearization in time is addressed. Results are presented for inviscid and viscous test cases. The complications which arise due to the introduction of nonlinear limiters are addressed.

A89-25309#

ADAPTIVE H-REFINEMENT ON 3-D UNSTRUCTURED GRIDS FOR TRANSIENT PROBLEMS

RAINALD LOHNER (George Washington University, Washington, DC) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. Research supported by DNA, USAF, and U.S. Navy. refs

(AIAA PAPER 89-0365)

An adaptive finite element scheme for transient problems is presented. The classic h-enrichment/coarsening is employed in conjunction with a tetrahedral finite element discretization in three dimensions. A mesh change is performed every n timesteps, depending on the Courant-number employed and the number of 'protective layers' added ahead of the refined region. In order to simplify the refinement/coarsening logic and to be as fast as possible, only one level of refinement/coarsening is allowed per mesh change. A high degree of vectorizability has been achieved by pre-sorting the elements and then performing the refinement/coarsening groupwise according to the case at hand. Several examples involving shock-shock interactions and the impact of shocks on structures demonstrate the performance of the method, showing considerable savings in both CPU-time and storage for strongly unsteady flows.

A89-25314#

THE COMPRESSIBLE MIXING LAYER - LINEAR THEORY AND DIRECT SIMULATION

N. D. SANDHAM and W. C. REYNOLDS (Stanford University, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. Research supported by USAF. refs

(AIAA PAPER 89-0371)

The paper presents results from a linear stability analysis for a wide variety of mixing layers, including low-speed layers with variable density and high Mach number mixing layers. It is found that three-dimensional modes are dominant in the high-speed mixing layer above a convective Mach number of 0.06. The results suggest that linear theory can be instrumental for investigating the compressible mixing layer. K.K.

A89-25315#

THE EFFECTS OF WALLS ON A COMPRESSIBLE MIXING LAYER

JEFFREY A. GREENOUGH, JAMES J. RILEY, MOELJO SOETRISNO, and D. SCOTT EBERHARDT (Washington, University, Seattle) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 16 p. Research supported by the Johns Hopkins University. refs

(Contract N00014-87-K-0174)

(AIAA PAPER 89-0372)

The stability of confined mixing layers is studied using both linear stability theory and direct numerical simulations. The stability

theory is used to examine the linear stability of two-dimensional confined temporal mixing layers for both continuous and discontinuous mean velocity profiles. It is shown that there are two general types of instabilities: confined Kelvin-Helmholtz modes and supersonic wall modes. Furthermore, the relation between eigenfunction shape and physical properties is discussed for both types of modes. The nonlinear evolution of the two types of instabilities is studied using direct numerical simulation. The confined Kelvin-Helmholtz development shows a familiar vortex pairing mechanism plus an interesting nonlinear self-excitation of the third harmonic. The supersonic wall modes develop by a completely new mechanism wherein the role of shocks is important. With regard to the confined three-dimensional problem, the most unstable disturbances for supersonic relative Mach numbers are shown to be truly three-dimensional Kelvin-Helmholtz type instabilities in the cases considered. Author

A89-25317*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DIRECT NUMERICAL SIMULATION OF COMPRESSIBLE FREE SHEAR FLOWS

SANJIVA K. LELE (NASA, Ames Research Center, Moffett Field; Stanford University, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 16 p. refs (AIAA PAPER 89-0374)

Direct numerical simulations of compressible free shear layers in open domains are conducted. Compact finite-difference schemes of spectral-like accuracy are used for the simulations. Both temporally-growing and spatially-growing mixing layers are studied. The effect of intrinsic compressibility on the evolution of vortices is studied. The use of convective Mach number is validated. Details of vortex roll up and pairing are studied. A simple explanation of the stabilizing effect of compressibility is offered. Acoustic radiation from vortex roll up, pairing and shape oscillations is studied and quantified. Author

A89-25319#

NUMERICAL SIMULATION OF THE GROWTH OF INSTABILITIES IN SUPERSONIC FREE SHEAR LAYERS

WEI TANG, NARAYANAN KOMERATH, and LAKSHMI N. SANKAR (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract N00014-87-K-0132)

(AIAA PAPER 89-0376)

The behavior of the initial region of a supersonic plane shear layer is analyzed through numerical solution of the 2-D Navier-Stokes equations, as well as the 3-D equations under the infinite span assumption. Two schemes are employed and compared: a 2nd order ADI procedure, as well as a modified McCormack scheme that is fourth order accurate in space and second order in time. Small amplitude oscillations in the normal velocity are found to grow as they convect downstream, and eventually lead to organized vortical structures. Normal velocity disturbances are found to be more efficient than streamwise or spanwise disturbances. The growth rate of these disturbances, as well as the intensity of velocity fluctuations, are found to decrease as the convective Mach number of the shear layer increases. The Mach number of the vortical structures with respect to the faster stream are found to be considerably less than the theoretical value of the convective Mach number. Author

A89-25326#

EFFECTS OF ENERGY RELEASE ON HIGH-SPEED FLOWS IN AN AXISYMMETRIC COMBUSTOR

K. KAILASANATH, J. H. GARDNER, E. S. ORAN, and J. P. BORIS (U.S. Navy, Naval Research Laboratory, Washington, DC) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 17 p. Research sponsored by the U.S. Navy. refs (AIAA PAPER 89-0385)

For the two reactive flow cases discussed in this paper, energy release substantially alters the flow field observed in the nonreactive flow simulations. In the first cycle after ignition, fluid expansion due to energy release quickly destroys the pattern of

02 AERODYNAMICS

vortex mergings observed in the cold flow and a new pattern emerges that is dominated by a large vortex. In subsequent cycles, most of the energy release occurs after vortex mergings have produced this large vortex. Energy release in this large vortex is in phase with the pressure oscillation over a substantial region of the combustor and results in the observed amplification of the low-frequency oscillations and leads to combustion instability. The large pressure oscillation also modifies the vortex shedding process. The simulations also show that preenergy release chemistry does not play a dominant role in controlling combustion instabilities in the system considered. Author

A89-25328#

SUPERSONIC SUDDEN-EXPANSION FLOW WITH FLUID INJECTION - AN EXPERIMENTAL AND COMPUTATIONAL STUDY

S. M. CORREA and R. E. WARREN (GE Research and Development Center, Schenectady, NY) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. Research supported by the General Electric Co. refs (AIAA PAPER 89-0389)

Nonreacting supersonic flow over a backward-facing step is studied, with and without the injection of air downstream of the step. The objectives are to assess a numerical scramjet combustor model in the relatively simple case of nonreacting flow, and to add to the database on supersonic sudden-expansion flow. The experiments are performed in a variable geometry Mach 1.8-4.0 windtunnel whose test-section measures 6 in x 6 in. Experimental data include Schlieren photography and wall-static pressures. The flow is characterized by minimal spreading of the injected fluid Author into the supersonic air stream.

A89-25363#

CONFLICTING STEPSIZE REQUIREMENTS FOR STABLE PNS COMPUTATIONS

D. D. CLINE and G. F. CAREY (Texas, University, Austin) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 6 p. refs

(AIAA PAPER 89-0445)

The parabolized Navier Stokes (PNS) equations provide an appropriate model for efficient computation of supersonic flow in two- and three-dimensions. However, these marching solution algorithms have been observed to be sensitive to the flow conditions and there are several open questions related to the choice of appropriate marching stepsize for stable computations. The need to treat the sonic sublayer and ellipticity of the equations together with the use of explicit shock fitting techniques at the outer shock boundary are analyzed here and shown to lead in some instances to conflicting stepsize restrictions. The dependence of these stepsize restrictions on the flow variables is investigated and specific numerical experiments conducted for flows at increasing angles of attack to demonstrate the difficulty. Features of the sublayer models and flow parameters for which the conflicting stepsize requirements are likely to occur are identified. Author

National Aeronautics and Space Administration. A89-25364*# Ames Research Center, Moffett Field, CA.

COMPUTATIONAL DESIGN ASPECTS OF A NASP

NOZZLE/AFTERBODY EXPERIMENT

STEPHEN M. RUFFIN (NASA, Ames Research Center, Moffett Field, CA), ETHIRAJ VENKATAPATHY, EARL R. KEENER, and N. NAGARAJ (Eloret Institute, Sunnyvale, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 17 p. refs (AIAA PAPER 89-0446)

This paper highlights the influence of computational methods on design of a wind tunnel experiment which generically models the nozzle/afterbody flow field of the proposed National Aerospace Plane. The rectangular slot nozzle plume flow field is computed using a three-dimensional, upwind, implicit Navier-Stokes solver. Freestream Mach numbers of 5.3, 7.3, and 10 are investigated. Two-dimensional parametric studies of various Mach numbers, pressure ratios, and ramp angles are used to help determine model loads and afterbody ramp angle and length. It was found that the

center of pressure on the ramp occurs at nearly the same location for all ramp angles and test conditions computed. Also, to prevent air liquefaction, it is suggested that a helium-air mixture be used as the jet gas for the highest Mach number test case. Author

A89-25365#

MODIFICATIONS TO TRANSONIC FLOW CODES FOR UNSTEADY PERTURBATIONS AROUND AN EXPERIMENTAL MEAN

L. C. RODMAN, D. NIXON (Nielsen Engineering and Research, Inc., Mountain View, CA), and L. J. HUTTSELL (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA. Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(Contract F33615-87-C-3211)

(AIAA PAPER 89-0447)

In predictions of unsteady transonic flow the results are sometimes inaccurate because the mean or time-averaged solution does not agree well with experimental data even though the prediction of the time-dependent oscillations is adequate. In transonic flow computations this error frequently is characterized by a time-dependent oscillation about an inaccurate shock location. The work described in this report is concerned with post-processing the unsteady flow prediction to allow oscillations around an experimentally determined mean flow. The transonic perturbation method is used to implement this idea. The technique is applied to both two- and three-dimensional unsteady flows. Author

National Aeronautics and Space Administration. A89-25366*# Ames Research Center, Moffett Field, CA.

A NUMERICAL STUDY OF THE CONTRAROTATING VORTEX

PAIR ASSOCIATED WITH A JET IN A CROSSFLOW KARLIN R. ROTH (NASA, Ames Research Center, Moffett Field, CA), RICHARD L. FEARN (Florida, University, Gainesville), and SIDDHARTH S. THAKUR AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 14 p. refs (AIAA PAPER 89-0448)

An implicit two-factor partially flux split solver for the thinlaver Navier-Stokes equations is used to solve the aerodynamic/propulsive interaction between a subsonic jet exhausting perpendicularly through a flat plate plate into a crossflow. The algorithm is applied to flows with a range of jet to crossflow velocity ratios between 4 and 8. The computed velocity field is analyzed and comparisons are made with experimentally determined properties of the contrarotating vortex pair. K.K.

A89-25367#

NUMERICAL STUDY OF SINGLE IMPINGING JETS THROUGH A CROSSFLOW

J. M. M. BARATA, D. F. G. DURAO (Lisboa, Universidade Tecnica, Lisbon, Portugal), and J. J. MCGUIRK (Imperial College of Science and Technology, London, England) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs (AIAA PAPER 89-0449)

The application of three-dimensional finite-difference calculation procedures to the problem of a jet impinging on a flat plate through the influence of a confined crossflow is described. The goal of the work is the development and validation of a computational method based on the solution of time-averaged Navier-Stokes equations and the k-epsilon turbulence model. The method is used to study phenomena influencing VSTOL craft performance and safety, the formation of a vortex that wraps around the impingement point, and the existence of low pressures in the neighborhood of the jet. K.K.

A89-25377*# Stanford Univ., CA. NONEQUILIBRIUM EFFECTS FOR HYPERSONIC TRANSITIONAL FLOWS USING CONTINUUM APPROACH

ROBERT W. MACCORMACK (Stanford University, CA) and TAHIR GOKCEN AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. Research supported by SDIO. refs (Contract NCA2-243; NAGW-965; DAAL03-86-K-0139;

F33615-86-C-3015) (AIAA PAPER 89-0461)

A new thermochemical nonequilibrium formulation for hypersonic transitional flows of air is presented. Air is assumed to have five chemical species (N2, O2, NO, N, O) and three temperatures corresponding to the translational, rotational, and vibrational modes of energy. In the present study, the no-slip boundary conditions are replaced by slip boundary conditions to extend the range of the Navier-Stokes equations to high-speed low-density flows. K.K.

A89-25379*# Old Dominion Univ., Norfolk, VA. A MULTIGRID AND UPWIND VISCOUS FLOW SOLVER ON 3-D EMBEDDED AND OVERLAPPED GRIDS

OKTAY BAYSAL, KAMRAN FOULADI, and VICTOR R. LESSARD (Old Dominion University, Norfolk, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract NAG1-664)

(AIAA PAPER 89-0464)

A numerically efficient method is presented for solving the three-dimensional governing equations of the viscous compressible flow about complex configurations with topologically different components. The physical domain is decomposed into regions for which the grid generation is relatively simple and virtually with no significant restrictions. The Navier-Stokes equations are solved by an implicit, approximately factored, upwind, finite-volume scheme. The block inversions and the diagonalized scalar inversions of the coefficient matrices are modified to allow the holes created in the computational domain by the embedded and overlapped grids. The convergence is accelerated by a multigrid algorithm despite the existence of such holes. The solution for s supersonic flow past a blunt-nose-cylinder at high angle-of-attack is obtained using a C-O grid embedded in a global Cartesian grid.

A89-25383*# General Dynamics Corp., Fort Worth, TX. VISCOUS-INVISCID INTERACTION AND LOCAL GRID REFINEMENT VIA TRUNCATION ERROR INJECTION

BRIAN D. GOBLE (General Dynamics Corp., Fort Worth, TX) and K.-Y. FUNG (Arizona, University, Tucson) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract AF-AFOSR-83-0071; NCA2-36; NCA2-107) (AIAA PAPER 89-0468)

A methodology is presented which makes it possible to decouple a complex problem having multiple disparate length scales into problems of single length scale so that they can be solved more efficiently on a computer. The method is applied to a viscous transonic flow over an airfoil. It is found that accurate prediction of the flow over an airfoil can be obtained by solving the Euler equations on a relatively coarse global grid with viscous effects computed separately on a boundary-layer type grid and injected into the global grid solution as a combination of vorticity and trucation error. K.K.

A89-25387#

A CELL-VERTEX MULTIGRID EULER SCHEME FOR USE WITH MULTIBLOCK GRIDS

M. T. ARTHUR, T. BLAYLOCK (Royal Aerospace Establishment, Farnborough, England), and J. M. ANDERSON (Glasgow, University, Scotland) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(AIAA PAPER 89-0472)

The feasibility of developing a cell-vertex, finite volume scheme with multigrid acceleration for use in conjunction with multiblock grids is investigated. The aim is to provide a fast, accurate method for calculating the inviscid flow over complex geometries without the need to modify the computer programs for each new case. For the investigation, a method has been developed for two-dimensional flows although a grid generator is available for three-dimensional shapes. The method has been validated by comparing results with those from an equivalent, single-block computer program for a case where that is possible. In addition, results are presented from a calculation using a realistic, multiblock grid for a two-element aerofoil configuration. It is concluded that a cell-vertex, multigrid scheme for use with grids having an irregular, multiblock structure can be developed successfully. However, a degree of flexibility in the flow algorithm is needed if the potential benefits of multigrid and multiblock are to be achieved. Author

A89-25390#

IFM APPLICATIONS TO CAVITY FLOWFIELD PREDICTIONS

A. CENKO, D. CHEN, and R. TURZANSKI (U.S. Navy, Naval Air Development Center, Warminster, PA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs (AIAA PAPER 89-0477)

Recently, a wind-tunnel test was conducted to evaluate the separation characteristics, at M = 0.85 and 1.2, of eight MK-82 500-pound bombs densely packed in a cavity with an L/D ratio of 5.38. This cavity was sized to fit in the channel under an F-14 aircraft. Preliminary results indicate that the critical conditions occur at the aft end of a densely packed cavity. Furthermore, it appears that empty cavity grid test data may not be safely used to predict trajectories for conditions where several bombs are still present in the bay. An attempt was also made to apply the Influence Function Method (IFM) to a cavity environment. Although the technique shows some promise, further testing and analysis will be required before it's validity can be demonstrated.

A89-25418*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

AN EFFICIENT, EXPLICIT FINITE-RATE ALGORITHM TO COMPUTE FLOWS IN CHEMICAL NONEQUILIBRIUM

GRANT PALMER (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 12 p. refs

(AIAA PAPER 89-0522)

An explicit finite-rate code was developed to compute hypersonic viscous chemically reacting flows about threedimensional bodies. Equations describing the finite-rate chemical reactions were fully coupled to the gas dynamic equations using a new coupling technique. The new technique maintains stability in the explicit finite-rate formulation while permitting relatively large global time steps. K.K.

A89-25420#

AERODYNAMIC PREDICTION RATIONALE FOR ANALYSES OF HYPERSONIC CONFIGURATIONS

M. E. MOORE and J. E. WILLIAMS (McDonnell Douglas Astronautics Co., Saint Louis, MO) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract F33615-86-C-3602)

(AIAA PAPER 89-0525)

The establishment of pressure method selection rationale for the Supersonic/Hypersonic Arbitrary Body Program (S/HABP) to define configuration aerodynamics is discussed. Aerodynamic predictions from S/HABP were compared with wind tunnel and flight test data to evaluate the code's capabilities and limitations over a broad range of hypersonic flight conditions. The effort was limited to vehicle control, where aerodynamic forces and moments are prime considerations. Author

A89-25421#

EFFECT OF DYNAMIC CHANGES IN BODY CONFIGURATION ON SHOCK STRUCTURE

KLAUS A. HOFFMANN, TING-LUNG CHIANG, and WALTER H. RUTLEDGE (Texas, University, Austin) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs (AIAA PAPER 89-0526)

A technique is presented for solving the inviscid, chemically-reacting, hypersonic flowfield over axisymmetric blunt bodies. The Euler equations are solved using a fully implicit, flux vector splitting, finite difference scheme. An approximate factorization scheme is also utilized in order to improve computational efficiency. Finite-rate chemical reaction calculations are decoupled from the gasdynamic equations in the current analysis. Complex blunt body shapes, including highly indented nose geometries, are analyzed for Mach numbers from 2 to 18. Author

A89-25424#

SUPERSONIC LOW-DENSITY FLOW OVER AIRFOILS

TSZE C. TAI and MARK S. MORAN (U.S. Navy, David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 p. Research supported by the U.S. Navy. refs (AIAA PAPER 89-0530)

The slip flow and the nonequilibrium transition flow in a rarefied atmosphere are examined. Two-dimensional, Reynolds-averaged, full Navier-Stokes equations for a perfect gas are solved for supersonic, low-density flow at Reynolds numbers ranging from 400 to 35,000. Slip-velocity boundary conditions based on various Knudsen numbers are introduced. Numerical results are obtained for three symmetric airfoils traveling at supersonic speeds at an angle of attack of 1.25 deg. The effect of the slip velocity becomes important for Knudsen numbers greater than 0.1. Author

A89-25426*# Texas A&M Univ., College Station. DETERMINATION OF AERODYNAMIC SENSITIVITY COEFFICIENTS IN THE TRANSONIC AND SUPERSONIC REGIMES

HESHAM M. ELBANNA and LELAND A. CARLSON (Texas A & M University, College Station) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. refs

(Contract NAG1-793)

(AIAA PAPER 89-0532)

The quasi-analytical approach is developed to compute airfoil aerodynamic sensitivity coefficients in the transonic and supersonic flight regimes. Initial investigation verifies the feasibility of this approach as applied to the transonic small perturbation residual expression. Results are compared to those obtained by the direct (finite difference) approach and both methods are evaluated to determine their computational accuracies and efficiencies. The quasi-analytical approach is shown to be superior and worth further investigation.

A89-25427#

FLOW MEASUREMENTS OF AN AIRFOIL WITH SINGLE-SLOTTED FLAP

ZEKI Z. CELIK (Stanford University, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. Research supported by the Boeing Co. refs

(AIAA PAPER 89-0533)

Flow measurements of an airfoil-flap configuration were carried out in a low-speed wind tunnel. The results are presented in the form of a surface pressure distribution, a lift coefficient, and mean velocity distributions in the boundary layer and wake at various flap deflections and gaps. Oil-flow studies revealed that the flow on the air-foil and the flap are two-dimensional along the whole span except in the vicinity of the side-walls for model angles of attack of less than 8 deg. K.K.

A89-25430#

TIP VORTEX/AIRFOIL INTERACTION FOR A CANARD//WING CONFIGURATION AT LOW REYNOLDS NUMBERS

FARUKH A. KHAN and THOMAS J. MUELLER (Notre Dame, University, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 17 p. Research supported by the University of Notre Dame. refs

(Contract N00014-83-K-0239)

(AIAA PAPER 89-0536)

The effects of the vortical wake shed by a finite span canard on a low Reynolds number airfoil were examined. Aerodynamic performance was evaluated through direct measurements of lift, drag and 1/4-chord pitching moment. Spanwise static pressure and surface film visualization data were also acquired. A reduction in the downstream airfoil drag coefficient and an increase in its lift/drag were noted in the presence of the canard for a wide range of configurations. Static pressure and surface visualization data provided indication of some of the boundary layer characteristics responsible for the drag behavior. Author

A89-25431*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NUMERICAL SIMULATION OF VORTICAL FLOWS ON FLEXIBLE WINGS

GURU P. GURUSWAMY (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(AIAA PAPER 89-0537)

A procedure to simultaneously solve the Navier-Stokes equations and modal structural equations of motion is presented for computing aeroelastic responses of wings. The Navier-Stokes flow equations are solved by a finite-difference scheme with dynamic grids. The coupled aeroelastic equations of motion are solved using the linear-acceleration method. The aeroelastic, configuration-adaptive dynamic grids are time-accurately generated using the aeroelastically deformed shape of the wing. The unsteady flow calculations are validated with the experiment. Present development is demonstrated for computing vortical flows over flexible wings.

A89-25432#

AN EXPERIMENTAL EVALUATION OF A LOW-REYNOLDS NUMBER HIGH-LIFT AIRFOIL WITH VANISHINGLY SMALL PITCHING MOMENT

M. SHEPSHELOVICH, D. KOSS (Israel Aircraft Industries, Ltd., Lod), I. WYGNANSKI, and A. SEIFERT (Tel Aviv University, Israel) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 9 p. refs

(AIAA PAPER 89-0538)

This paper describes an experimental evaluation of a new airfoil, designed for the purpose of generating high-lift, vanishingly small pitching moment and mild stall characteristics at low Reynolds numbers ranging from 10 to the 5th to 10 to the 6th. The experimental program included active and passive methods for lift enhancement in the very low end of the Reynolds number range of operation. A technique for reduction and elimination of hysteresis loops was also investigated. Author

A89-25441#

AN IMPROVED UPWIND FINITE VOLUME RELAXATION METHOD FOR HIGH SPEED VISCOUS FLOWS

ARTHUR C. TAYLOR, III, WING-FAI NG, and ROBERT W. WALTERS (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(AIAA PAPER 89-0549)

An upwind relaxation algorithm for the Navier-Stokes equations has been developed and is applied to two test problems of high-speed viscous flows. A lower-upper factorization method is applied to the elliptic region(s) identified near each solid wall boundary, and the results are coupled to a standard line Gauss-Seidel relaxation sweep across the entire domain in the primary flow direction. For the cases of both a high-speed inlet and a shock/boundary layer interaction on a flat plate, the present method is found to be much more efficient than the standard alternating forward/backward vertical line Gauss-Seidel agorithm. R.R.

A89-25443*# Old Dominion Univ., Norfolk, VA. NAVIER-STOKES COMPUTATIONS OF SEPARATED VORTICAL FLOWS PAST PROLATE SPHEROID AT INCIDENCE

TIN-CHEE WONG, OSAMA A. KANDIL (Old Dominion University, Norfolk, VA), and C. H. LIU (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. refs (Contract NAS1-18584)

(AIAA PAPER 89-0553)

The problem of steady incompressible viscous flow past prolate spheroids at incidence is formulated using the unsteady

incompressible and compressible thin-layer Navier-Stokes equations. The two sets of Navier-Stokes equations are solved using a pseudotime stepping of the implicit flux-difference splitting scheme on a curvilinear grid, which is generated by a transfinite grid generator. The Baldwin and Lomax (1978) algebraic eddy-viscosity model is used to model the turbulent flow. The computational applications cover a 6:1 prolate spheroid at different angles of attack and Reynolds numbers. The results are compared with experimental data. Author

A89-25444#

STUDY OF THE VORTICAL WAKE PATTERNS OF AN **OSCILLATING AIRFOIL**

M. J. STANEK and M. R. VISBAL (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (AIAA PAPER 89-0554)

The laminar wake structure of an airfoil which pitches about the quarter chord in forced sinusoidal motion is numerical simulated. The unsteady flow is simulated by solving the full two-dimensional compressible Navier-Stokes equations with an implicit approximate factorization algorithm utilizing a moving grid. The numerical results are compared with time-averaged wake velocity profile measurements and experimental flow visualization. For a NACA 0012 airfoil, reasonable qualitative agreement is obtained between computed and experimental results. Better gualitative agreement is obtained for the case with a complex double vortex wake structure with an elliptical airfoil/0-grid combination than with a NACA 0012 airfoil/C-grid combination. The computed airfoil wake structure is quite sensitive to the frequency and amplitude of the oscillation waveform. Author

A89-25446*# North Carolina State Univ., Raleigh. A ONE EQUATION TURBULENCE MODEL FOR TRANSONIC **AIRFOIL FLOWS**

R. A. MITCHELTREE, H. A. HASSAN (North Carolina State University, Raleigh), and M. D. SALAS (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. Research supported by USAF and U.S. Navy. refs (Contract NCC1-22; NAGW-1022; NAGW-1331)

(AIAA PAPER 89-0557)

A one-equation turbulence model has been developed from available experimental observations on both attached and separated turbulence flows, and numerical results are presented for flows about NACA 0012 and RAE 2822 airfoils. The model is shown to duplicate the accurate results of the Baldwin-Lomax (1978) algebraic model for the case of attached flow. For cases of separated flow, the model is found to predict shock location and strength closer to the experimentally observed values than both the algebraic and the g-omega two-equation models.

A89-25447*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PREDICTION OF SEPARATED TRANSONIC WING FLOWS WITH A NON-EQUILIBRIUM ALGEBRAIC MODEL

RIDHA ABID, VEER N. VATSA (NASA, Langley Research Center, Hampton, VA), DENNIS A. JOHNSON (NASA, Ames Research Center, Moffett Field, CA), and BRUCE W. WEDAN (Vigyan Research Associates, Inc., Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs (AIAA PAPER 89-0558)

A nonequilibrium algebraic turbulence model, which is based on the turbulence closure scheme of Johnson and King (1985), is proposed to predict separated transonic wing flows. The influence of history effects are modeled by solving a partial differential equation for the maximum total Revnolds shear stress, which is then used to scale the eddy viscosity of an algebraic model. The turbulence model is implemented in a three-dimensional, Reynolds-averaged Navier-Stokes code. Comparisons with experimental data are presented which show clearly that the nonequilibrium type of turbulence model is essential for accurate prediction of transonic separated flows. Author

A89-25448#

COMPARISON OF TWO DIFFERENT NAVIER-STOKES METHODS FOR THE SIMULATION OF 3-D TRANSONIC FLOWS WITH SEPARATION

W. KORDULLA, B. MUELLER, and H. VOLLMERS (DFVLR, Goettingen, Federal Republic of Germany) AIAA. Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs (Contract DFG-RU-334/1-6; DFG-DA-183/1-5) (AIAA PAPER 89-0559)

Previous numerical simulations of the transonic flow past a hemisphere-cylinder configuration, based on the bidiagonal implicit predictor-corrector finite-volume method of MacCormack, have indicated that the investigated flow fields are unsteady and exhibit a highly granular flow structure. To determine whether these laminar flow results are due to numerical reasons or not, a semiimplicit finite-difference method of Beam-and-Warming type has been employed using the same grids as in the finite-volume approach. The former results are essentially confirmed. Author

A89-25451#

ESSENTIALLY NON-OSCILLATORY SCHEMES FOR THE EULER EQUATIONS AND ITS APPLICATION TO COMPLEX **AERODYNAMIC FLOWS**

J. Y. YANG (National Taiwan University, Taipei, Republic of China), S. Y. HSU, T. S. CHANG, and C. A. HSU AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. Sponsorship: National Science Council of the Republic of China. refs

(Contract NSC-77-0210-D002-03; NSC-77-0210-D002-04) (AIAA PAPER 89-0562)

Essentially nonoscillatory schemes for the Euler equation in a general coordinate system are considered which are based on both the modified flux and modified eigenvalue approaches. Two-dimensional transonic airfoil flow at various angles of attack and with supersonic inlet flow has been simulated along with a two-dimensional time-dependent shock reflection by an ellipse. Both formulations considered provide clean shock representations. RR

A89-25452*# Planning Research Corp., Hampton, VA. INTEGRAL EQUATION SOLUTION OF THE FULL POTENTIAL EQUATION FOR TRANSONIC FLOWS

LI-CHUAN CHU (Planning Research Corp., Hampton, VA), E. CARSON YATES, JR. (NASA, Langley Research Center, Hampton, VA), and OSAMA A. KANDIL (Old Dominion University, Norfolk, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan, 9-12, 1989. 14 p. refs (Contract NAS1-18000)

(AIAA PAPER 89-0563)

An integral equation method for solving the full potential equation has been developed for arbitrary configurations in twoor three-dimensional transonic flows. This method is capable of capturing shocks using Murman-Cole type of finite difference scheme and is capable of predicting accurate and force-free wake shape as well. A rectangular grid combined with a technique of local grid refinement greatly improved the computational efficiency. Author

A89-25453#

VORTEX GENERATOR JETS - A MEANS FOR PASSIVE AND ACTIVE CONTROL OF BOUNDARY LAYER SEPARATION

JAMES P. JOHNSTON (Stanford University, CA) and MICHIHIRO NISHI (Kyushu Institute of Technology, Tobata, Japan) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 p. Research supported by USAF. refs

(AIAA PAPER 89-0564)

Stalled regions (zones of detached or separated flow sometimes followed by reattachment) in a turbulent boundary layer may be eliminated by a technique called the vortex-generator-jet (VGJ) method. The method employs spanwise arrays of small, skewed and pitched jets from holes in the surface. Low-speed, air-flow experiments are described which (1) demonstrate that the VGJ method creates longitudinal (streamwise) vortices in the boundary layer downstream of the jet holes, like the vortices behind solid vortex generators, and (2) show that the cross-stream mixing associated with these vortices is effective in reduction and elimination of stalled regions. Author

A89-25454*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CONTROL OF LAMINAR SEPARATION OVER AIRFOILS BY ACOUSTIC EXCITATION

K. B. M. Q. ZAMAN and D. J. MCKINZIE (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. Previously announced in STAR as N89-12552. refs

(AIAA PAPER 89-0565)

The effect of acoustic excitation in reducing laminar separation over two-dimensional airfoils at low angles of attack is investigated experimentally. Airfoils of two different cross sections, each with two different chord lengths, are studied in the chord Reynolds number range of 25,000 is less than R sub c is less than 100,000. While keeping the amplitude of the excitation induced velocity perturbation a constant, it is found that the most effective frequency scales as U (sup 3/2) (sub infinity). The parameter St/R (sup 1/2)(sub c), corresponding to the most effective f sub p for all the cases studied, falls in the range of 0.02 to 0.03, St being the Strouhal number based on the chord. Author

A89-25458#

BOUNDARY LAYER MEASUREMENTS ON AN AIRFOIL AT LOW REYNOLDS NUMBERS IN AN ACCELERATING FLOW FROM A NONZERO BASE VELOCITY

R. H. ELLSWORTH and T. J. MUELLER (Notre Dame, University, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(Contract N00014-83-K-0239)

(AIAA PAPER 89-0569)

A quantitative experimental study of the effects on transitional separation bubble characteristics of an accelerating freestream from a nonzero base velocity has confirmed previous oscillating freestream results. It is found that as a result of freestream acceleration, the separation bubble position shifts in the direction opposite to the chordwise direction it would move for a quasi-steady velocity change. The transition location was found to be more responsive to the acceleration than was the separation position.

A89-25485*# Georgia Inst. of Tech., Atlanta. EVALUATION OF THREE TURBULENCE MODELS FOR THE PREDICTION OF STEADY AND UNSTEADY AIRLOADS

JIUNN-CHI WU, L. N. SANKAR (Georgia Institute of Technology, Atlanta), and DENNIS L. HUFF (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. Research supported by McDonnell Douglas Helicopter Co. Previously announced in STAR as N89-12555. refs

(Contract NAG3-768)

(AIAA PAPER 89-0609)

Two dimensional quasi-three dimensional Navier-Stokes solvers were used to predict the static and dynamic airload characteristics of airfoils. The following three turbulence models were used: the Baldwin-Lomax algebraic model, the Johnson-King ODE model for maximum turbulent shear stress, and a two equation k-e model with law-of-the-wall boundary conditions. It was found that in attached flow the three models have good agreement with experimental data. In unsteady separated flows, these models give only a fair correlation with experimental data. Author

A89-25492#

COMBINED TANGENTIAL-NORMAL INJECTION INTO A SUPERSONIC FLOW

P. S. KING, R. H. THOMAS, J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg, VA), and F. S. BILLIG (Johns Hopkins University, Laurel, MD) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs (AIAA PAPER 89-0622)

A combination of tangential and normal air injection into a Mach 3 airflow was experimentally tested. A rearward facing slot producing tangential injection at a nominal Mach number 1.7 was operated at several different total pressures. An array of transverse tubes of height equal to the slot height and placed just downstream of the slot was operated at two dynamic pressure ratios as well as at Mach 1 and 2.2. Mean flow measurements of static and total pressures were taken up to 20 slot heights downstream from which Mach number, density, velocity and entrainment rates were calculated. Various dimensions of the mixing regions and spreading angles were measured directly from nanoshadowgraphs and schlieren photographs. For some cases heated air was injected through the normal tubes and the total temperature decay was measured downstream. It can be seen from the data as a whole that the mixing rate can be significantly increased by the combined tangential-normal injection design over tangential slot injection Author alone.

A89-25505#

MODELING OF SUBSONIC FLOW THROUGH A COMPACT OFFSET INLET DIFFUSER

RICHARD C. JENKINS and ALBERT L. LOEFFLER, JR. (Grumman Corporate Research Center, Bethpage, NY) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (AIAA PAPER 89-0639)

A comparison between computational and experimental results is presented for a study of flow through a compact, highly offset diffuser. The experiment was conducted to evaluate the use of a thin-layer Navier-Stokes code, ARC3D (Pulliam, 1984) to predict the effects of diffuser shape and inlet flow properties on pressure recovery and exit flow quality. It is found that the ARC3D code provides a good representation of the flow in most regions, although the Baldwin-Lomax algebraic turbulence model in the code does not adequately represent the flow in regions of separated flow. Preliminary results from computations made with a one-half equation turbulence model are presented. It is suggested that a more complex turbulence model is needed to properly treat the extensive region of flow separation in compact, offset diffusers.

R.B.

A89-25507#

DIRECT SOLUTION OF UNSTEADY TRANSONIC FLOW EQUATIONS IN FREQUENCY DOMAIN

C. E. LAN (Kansas, University, Lawrence) and HORNG-REN HWANG AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 19 p. refs

(AIAA PAPER 89-0641)

A novel method of unsteady transonics based on considerations in the freqency domain is developed for computing the unsteady flow field about oscillating airfoils using the two-dimensional full-potential equation. The unsteady equations can be solved with a steady-flow solver without the assumption of time-linearization. The present formulation for solving unsteady transonic flow equations in the frequency domain is a good alternative to time-domain integration for harmonic motions. K.K.

A89-25514*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

CHĂRÁCTERISTICS OF THE GROUND VORTEX FORMED BY A JET MOVING OVER A FIXED GROUND PLANE

G. T. KEMMERLY (NASA, Langley Research Center, Hampton, VA) and V. R. STEWART AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (AIAA PAPER 89-0650)

This paper discusses an experimental study conducted in the Langley Vortex Facility to investigate the effects on the ground vortex of the jet passing over a fixed ground board. A jet impacting the ground can form a vortex which may materially affect the aerodynamic characteristics of a STOL airplane operating near the ground. Several studies have been done with a stationary jet exiting near and perpendicular to fixed ground board. The resulting ground effects have been documented in terms of ground vortex and aerodynamic characteristics. The ground boundary layer created in a wind tunnel facility, however is thought to affect the extent of the ground vortex. This paper reports on an investigation utilizing an isolated moving jet to eliminate the ground boundary layer. The results are compared to the existing data base and show a 30 percent decrease in the vortex penetration shown by the stationary jet conditions. Author

A89-25517*# Tennessee Univ., Knoxville. PROGRESS ON A TAYLOR WEAK STATEMENT FINITE ELEMENT ALGORITHM FOR HIGH-SPEED AERODYNAMIC FLOWS

A. J. BAKER (Tennessee, University, Knoxville) and J. D. FREELS AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 20 p. Research supported by the University of Tennessee. refs

(Contract NAS2-12568; F04704-87-C-0100)

(AIAA PAPER 89-0654)

A new finite element numerical Computational Fluid Dynamics (CFD) algorithm has matured to the point of efficiently solving two-dimensional high speed real-gas compressible flow problems in generalized coordinates on modern vector computer systems. The algorithm employs a Taylor Weak Statement classical Galerkin formulation, a variably implicit Newton iteration, and a tensor matrix product factorization of the linear algebra Jacobian under a generalized coordinate transformation. Allowing for a general two-dimensional conservation law system, the algorithm has been exercised on the Euler and laminar forms of the Navier-Stokes equations. Real-gas fluid properties are admitted, and numerical results verify solution accuracy, efficiency, and stability over a range of test problem parameters.

A89-25521*# Planning Research Corp., Hampton, VA. A THREE-DIMENSIONAL UPWIND FINITE ELEMENT POINT IMPLICIT UNSTRUCTURED GRID EULER SOLVER

RAJIV R. THAREJA (Planning Research Corp., Hampton, VA), KEN MORGAN, JAIME PERAIRE, and JOAQUIN PEIRO (Swansea, University College, Wales) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. refs (Contract NAS1-18000; NAGW-478)

(AIAA PAPER 89-0658)

A three-dimensional upwind finite element technique that uses cell-centered quantities and implicit and/or explicit time marching was developed for computing hypersonic inviscid flows using adaptive unstructured grids. This technique was used to predict shock interference on a swept cylinder. An attempt was made to determine the flowfield and, in particular, the pressure augmentation caused by an impinging shock on the swept leading edge of a cowl lip of an engine inlet. K.K.

A89-25530#

SIMPLE TURBULENCE MODELS FOR SUPERSONIC AND HYPERSONIC FLOWS - BODIES AT INCIDENCE AND COMPRESSION CORNERS

SIAMACK A. SHIRAZI and C. RANDALL TRUMAN (New Mexico, University, Albuquerque) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. Research supported by Sandia National Laboratories. refs

(AIAA PAPER 89-0669)

Parabolized Navier-Stokes predictions of turbulent flows at supersonic and hypersonic speeds past two sphere-cones and a cone-cylinder-flare are used to evaluate simple turbulence models. Modifications to an algebraic turbulence model are proposed to improve predictions for flow on bodies at incidence. Predictions using a simple modification for the length scale and a model based upon Bradshaw's extra-strain-rate hypothesis are compared with measurements of supersonic and hypersonic flows at incidence. The modifications lead to significant improvements in predicted wall shear stress for a supersonic flow at incidence.

Author

A89-25532#

ON THE SOLUTION OF NONEQUILIBRIUM HYPERSONIC INVISCID STEADY FLOWS

M. ONOFRI, B. FAVINI (Roma I, Universita, Rome, Italy), and M. VALORANI AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. Research supported by Avions Marcel Dassault Breguet Aviation and CIRA. refs

(AIAA PAPER 89-0671)

The effects of finite-rate chemical reactions on inviscid hypersonic flows are investigated theoretically by means of numerical simulations using a shock-fitting technique. The theoretical basis of the method, which treats the finite-rate reaction as a singular-perturbation problem, is discussed in detail; the formulations for shock waves in nonequilibrium flows and the chemical and gasdynamic operators are derived; and the relaxation strategy for the global model is explained. Typical results demonstrating the efficiency and accuracy of the present method are presented in extensive graphs and briefly characterized. T.K.

A89-25534#

NUMERICAL SOLUTIONS TO THREE-DIMENSIONAL SHOCK WAVE/VORTEX INTERACTION AT HYPERSONIC SPEEDS

GRIFFIN CORPENING (Johns Hopkins University, Laurel, MD) and JOHN D. ANDERSON, JR. (Maryland, University, College Park) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs

(AIAA PAPER 89-0674)

Euler solutions to three-dimensional shock wave/vortex interactions at Mach numbers of 2.28 and 5.00 are studied. First, a numerical model capable of simulating the flowfield is presented and then, an input vortex is developed which can be fed into the upstream boundary of the computational domain. Areas of flow reversal around the outside of the post-shock vortex were seen at both Mach numbers.

A89-25602#

DRAGONFLY UNSTEADY AERODYNAMICS - THE ROLE OF THE WING PHASE RELATIONS IN CONTROLLING THE PRODUCED FLOWS

DANIEL SAHARON and MARVIN W. LUTTGES (Colorado, University, Boulder) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 20 p. refs

(Contract F49620-84-C-0065; N00014-85-K-0053)

(AIAA PAPER 89-0832)

Visualizations of three-dimensional unsteady separated flow produced by a mechanically driven dragonfly wing kinematics model were collected and analyzed. Tandem wing effects were evaluted by comparison with effects produced by fore and aft wings tested individually. The effects of wing kinematics were studied with an emphasis on changes in the phase relations between fore and aft wings. Vortex structures produced by the mechanical model were quite similar to those elicited from tethered dragonflies in wind tunnel tests. The eight kinematic elements of the model wing beat were short-lived such that each yielded a specific transitional flow structure. Fore and aft wing phase differences produced flow structures that interacted, one with another, in differing ways. Flow interactions were either constructive or destructive and yielded different wing - flow interactions. Constructive flow interactions were evalutaed in terms of integrating and fusing of vortex structures. Destructive flow interactions were evaluated in terms of vortex disruption, splitting and deflecting. The net results of these interactions were to enhance lift and thrust as seen in downwash and downstream flow structures. Author

A89-25603#

MEASUREMENT OF TRANSIENT VORTEX-SURFACE INTERACTION PHENOMENA

S. G. LIOU, N. M. KOMERATH, and H. M. MCMAHON (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract DAAG29-82-K-0084)

(AIAA PAPER 89-0833)

The transient, periodic interaction of a helical vortex with a

02 AERODYNAMICS

circular cylinder is experimentally studied. Close approach of the primary vortex causes stagnation and flow reversal near the surface. Regions of negative vorticity are created under the primary vortex when it is still well above the surface. Later, such a region appears above the vortex and moves rapidly downstream. As the primary structure impacts the surface, its lower part disappears. A secondary structure simultaneously appears downstream. This structure moves rapidly downstream and dissipates. The surface pressure variation corresponds to the structure of the tip vortex until the vortex impinges on the surface. Thereafter, the pressure is dominated by the secondary vortex structure. Simultaneous peaks in velocity and surface pressure are seen, due to the high stagnation pressure in the tip vortex. Vortex deformations and induced velocities do not agree quantitatively with two-dimensional potential theory at the top of the airframe. C.D.

A89-25606#

A SELF-ADAPTIVE COMPUTATIONAL METHOD APPLIED TO TRANSONIC TURBULENT PROJECTILE AERODYNAMICS

W. D. NEWBOLD and M. H. LEE AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (AIAA PAPER 89-0837)

An adaptive grid generation code coupled with an axisymmetric thin-layer Navier-Stokes code has been investigated for self-adaptive computation fo transonic turbulent projectile aerodynamics. The governing equations for an adaptive grid are obtained by minimizing the integral which measures the smoothness, orthogonality, and adaptivity, while the thin-layer Navier-Stokes equations are approximated by a TVD scheme in which turbulence is simulated by the Baldwin-Lomax algebraic eddy viscosity model. Two illustrative flow problems involving Mach 0.96 and 1.20 flow past a secant-ogive-cylinder-boattail projectile with base flow region and at zero angle of attack are considered.

C.D.

A89-25611#

FLOW VISUALIZATION INVESTIGATION OF DYNAMIC STALL ON A PITCHING AIRFOIL

K. F. TCHON AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs

(AIAA PAPER 89-0842)

The dynamic stall on a pitching airfoil is studied using chronophotography techniques. The study was based on a 16-mm film taken at 50 frames/sec during water tunnel flow visualizations using colored dye injections on a NACA 0018 airfoil undergoing damped pitching oscillations about an axis located at 30 percent chord, for a Reynolds number of 10,000 and a reduced frequency of 0.550. Stall occurred during the downstroke of the airfoil, and an almost simultaneous double separation of the boundary layer. Informations regarding the trajectory, convection velocity, growth, effective viscosity, roll-up, and approximate initial circulation of the shed vortices are also evaluated.

A89-25615#

ELEVATOR DEFLECTION EFFECTS ON THE ICING PROCESS RANDALL K. BRITTON (Texas A & M University, College Station) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(AIAA PAPER 89-0846)

A computer code has been developed to calculate the performance degradation due to ice accretion on a NACA 0012 airfoil. The results indicate that the icing process is dependent on elevator deflection and affects the flowfield about the airfoil by adding camber to the horizontal stabilizer system. The results are presented in terms of total collection efficiency and impingement limits as functions of angle of attack and elevator deflection angle. Author

A89-25856

NUMERICAL SIMULATION OF THE TRANSONIC DFVLR-F5 WING EXPERIMENT; PROCEEDINGS OF THE INTERNATIONAL WORKSHOP ON NUMERICAL SIMULATION OF COMPRESSIBLE VISCOUS-FLOW AERODYNAMICS, GOETTINGEN, FEDERAL REPUBLIC OF GERMANY, SEPT. 30-OCT. 2, 1987

WILHELM KORDULLA, ED. (DFVLR, Institut fuer theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) Workshop supported by DFVLR. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn (Notes on Numerical Fluid Mechanics. Volume 22), 1988, 314 p. For individual items see A89-25857 to A89-25867.

Papers are presented on the DFVLR-F5 test wing experiment for computational aerodynamics, advances in numerical grid generation, and boundary layer transition and turbulence modeling of three-dimensional flow. Also considered are turbulence modeling for compressible flows, a Navier-Stokes simulation of transonic wing flow fields using a zonal grid approach, and the numerical simulation of viscous transonic flow over a DFVLR-F5 wing. Other topics include three-dimensional viscous flow simulations using an implicit relaxation scheme, and Navier-Stokes calculations for the DFVLR-F5 wing in a wind tunnel using a Runge-Kutta time-stepping scheme. R.R.

A89-25857

DFVLR-F5 TEST WING EXPERIMENT FOR COMPUTATIONAL AERODYNAMICS

H. SOBIECZKY (DFVLR, Institut fuer theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany), G. HEFER (DFVLR, Institut fuer experimentelle Stroemungsmechanik, Goettingen, Federal Republic of Germany), and S. TUSCHE (DFVLR, Goettingen, Federal Republic of Germany) IN: Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn, 1988, p. 4-22. refs

This paper describes the design and the experimental investigation of a test wing configuration for the validation of aerodynamic computer codes. Half model technology is used with a controlled splitter plate flow. The main objective of the work was to produce a well defined boundary value problem for the transonic flow past a wing mounted onto a wall, as can be derived from geometrical and measured flow data. Author

A89-25858

DFVLR-F5 TEST WING CONFIGURATION - THE BOUNDARY VALUE PROBLEM

H. SOBIECZKY (DFVLR, Institut fuer theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) IN: Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn, 1988, p. 27-37.

Experimental results for the configuration geometry and control volume of a 20-deg DFVLR-F5 swept wing were obtained, and the boundary conditions on the control surface have been observed. The obtained data can be used to develop numerical analysis codes. The flow boundary conditions are modeled by simple analytical functions.

A89-25862* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NAVIER-STOKES SIMULATION OF TRANSONIC WING FLOW FIELDS USING A ZONAL GRID APPROACH

NEAL M. CHADERJIAN (NASA, Ames Research Center, Moffett Field, CA) IN: Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn, 1988, p. 159-183. Previously announced in STAR as N89-10022. refs

The transonic Navier-Stokes code was used to simulate flow fields about isolated wings for workshop wind-tunnel and free-air cases using the thin-layer Reynolds-averaged Navier-Stokes equations. An implicit finite-difference scheme based on a diagonal version of the Beam-Warming algorithm was used to integrate the governing equations. A zonal grid approach was used to allow efficient grid refinement near the wing surface. The flow field was sensitive to the turbulent transition model, and flow unsteadiness was observed for a wind-tunnel case but not for the corresponding free-air case. The specification of experimental pressure at the wind-tunnel exit plane is the primary reason for the difference of these two numerical solutions. Author

A89-25863

NUMERICAL SIMULATION OF VISCOUS TRANSONIC FLOW OVER THE DFVLR F5 WING

TONY LINDEBERG, ARTHUR RIZZI, and BERNHARD MUELLER (Flygtekniska Forsoksanstalten, Bromma, Sweden) IN: Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn, 1988, p. 184-199. Research supported by the Styrelsen for Teknisk Utveckling. refs

An algebraic code for studying turbulent flow over quadrilateral wings is used to generate three-dimensional meshes for a large-aspect-ratio DFVLR F5 wing. The Reynolds-averaged compressible Navier-Stokes equations are used to model the behavior of the fluid. Results are presented for the cases of the wing in a square wind tunnel and the wing alone. R.R.

A89-25864* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NAVIER-STOKES SIMULATION OF WIND-TUNNEL FLOW USING LU-ADI FACTORIZATION ALGORITHM

SHIGERU OBAYASHI, KOZO FUJII (NASA, Ames Research Center, Moffett Field, CA), and SHARAD GAVALI (Amdahl Corp., Sunnyvale, CA) IN: Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn, 1988, p. 200-225. Previously announced in STAR as N88-17584. refs

The three dimensional Navier-Stokes solution code using the LU-ADI factorization algorithm was employed to simulate the workshop test cases of transonic flow past a wing model in a wind tunnel and in free air. The effect of the tunnel walls is well demonstrated by the present simulations. An Amdahl 1200 supercomputer having 128 Mbytes main memory was used for these computations. Author

A89-25865

THREE-DIMENSIONAL VISCOUS FLOW SIMULATIONS USING AN IMPLICIT RELAXATION SCHEME

M. A. SCHMATZ (Messerschmitt-Boelkow-Blohm GmbH, Munich, Federal Republic of Germany) IN: Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn, 1988, p. 226-243. refs

A Navier-Stokes solver using characteristic flux extrapolation is used to numerically simulate a DFVLR-F5 test wing in a wind tunnel experiment. The code involves a Godunov-type averaging procedure by means of which the inviscid fluxes are evaluated at the finite-volume faces. Results are presented for transonic flow with an angle of attack of 2 degrees. Problems due to mesh distortion at the wing-body junction and in the wind tunnel corners are discussed. R.R.

A89-25866

SIMULATION OF THE DFVLR-F5 WING EXPERIMENT USING A BLOCK STRUCTURED EXPLICIT NAVIER-STOKES METHOD

D. SCHWAMBORN (DFVLR, Institut fuer theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) IN: Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn, 1988, p. 244-268. refs

A block structured solver for the numerical integration of the time-dependent form of the Navier-Stokes equations is presented. The method, which allows for high flexibility, is based on an explicit finite volume approach. The solver is applied to the flow about the DFVLR-F5 wing at M = .82 and Rex = 10 to the 7th/m at two angles of attack (0 deg, 2 deg). Results are obtained for the wing alone and for the wing in the wind tunnel. A comparison with experiments is made, and the influence of the computational grid is discussed.

A89-25867* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NAVIER-STOKES CALCULATIONS FOR DFVLR F5-WING IN WIND TUNNEL USING RUNGE-KUTTA TIME-STEPPING SCHEME

V. N. VATSA (NASA, Langley Research Center, Hampton, VA) and B. W. WEDAN (Vigyan Research Associates, Inc., Hampton, VA) IN: Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn, 1988, p. 269-305. refs

A three-dimensional Navier-Stokes code using an explicit multistage Runge-Kutta type of time-stepping scheme is used for solving the transonic flow past a finite wing mounted inside a wind tunnel. Flow past the same wing in free air was also computed to assess the effect of wind-tunnel walls on such flows. Numerical efficiency is enhanced through vectorization of the computer code. A Cyber 205 computer with 32 million words of internal memory was used for these computations. Author

A89-25929#

A NUMERICAL METHOD FOR UNSTEADY TRANSONIC FLOW ABOUT TAPERED WINGS

JIANBAI ZHANG (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 389-399. refs

A numerical method is presented for predicting steady and unsteady transonic aerodynamic flow about aircraft wing configuration. A special designed coordinate transformation is employed in the method. The numerical procedure solves the unsteady transonic modified three-dimensional small perturbation equation by time-accurate alternating direction, implicit finite difference algorithm. Numerical results are presented for an F-5 fighter wing and compared with experimental data for transonic flight conditions. Author

A89-25930#

APPLICATIONS OF AN EFFICIENT ALGORITHM TO TRANSONIC CONSERVATIVE FULL-POTENTIAL FLOW PAST 3-D WINGS

MINGKE HUANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 401-408. In Chinese, with abstract in English. refs

A computer program for analyzing three-dimensional transonic flow past wings has been developed using Holst's algorithm for the finite difference method. A fast conformal mapping technique

02 AERODYNAMICS

is utilized to form a two-dimensional O-type grid, which is then used to generate the three-dimensional body-fitted grid. This leads to a great saving of CPU time in grid generation. For transonic flow computation, the same iteration scheme as used in the TWING code is applied. The resulting computer program has been applied not only to thick wings with moderate sweep angle but also to highly swept and tapered thin wings. The difficult case for this method is the computation of delta wings with tip cut. C.D.

A89-25931#

COMPUTATION FOR SUPERSONIC AND TURBULENT SEPARATED FLOW OVER A COMPRESSION CORNER

GIPENG CAO (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 409-415. In Chinese, with abstract in English. refs

A unified levyless transformation and direct/inverse method is used to obtain a numerical solution for supersonic and turbulent separated flow over a compression corner. A direction method is applied with given pressure distributions obtained by the unified supersonic/hypersonic small disturbance theory over a wedge. The turbulent model adopted is the simple algebraic 'eddy viscosity' model. An inverse method is used for the separated flow region in which the displacement-thickness is prescribed with pressure treated as the unknown parameter. The turbulent model adopted is the algebraic relaxation model. The Keller box scheme is used to solve the boundary layer equations. The computation well predicts the separated point, reattachment point, wall pressure, and the skin friction stress distribution. C.D.

A89-25932#

A PREDICTION OF THE STALLING OF THE MULTIELEMENT AIRFOILS

BAOQIN ZHANG and ZHILIANG LU (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 416-425. In Chinese, with abstract in English. refs

A multicomponent airfoil program which computes stall characteristics has been developed. A higher-order singularity panel method is used for the potential flow solution. The vorticity and sources distribution in each panel is assumed linear with respect to the arc length of the panel. A separated wake model is used when the separation occurs at the trailing edges of the elements of the multielement airfoils. The final viscous solution is obtained by representing the boundary layer displacement thickness with an appropriate source distribution and by a viscous-potential iteration technique. The calculated pressure distribution and the lift for angles of attack up to the stall are in good agreement with experimental results. C.D.

A89-25938#

EXPERIMENTAL RESEARCH OF FLOW SEPARATION, HEAT TRANSFER AND ABLATION ON FLAT PLATE-WEDGES IN SUPERSONIC, TURBULENT FLOW

SUPERSONIC, TURBULENT FLOW YINDA HAN (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 463-471. In Chinese, with abstract in English. refs

A ground test capability for simulating heating and pressure fields around the control wing of controllable lifting vehicles is developed in order to study ablation phenomena on heatshield surfaces. An experimental method based on an arc heater is introduced, and major results are shown for flow separation, heat transfer, and ablation on a model of a control wing for supersonic, turbulent flow across a flat plate. The results show that with a transverse seam in front of the wing angle, the effects of flow separation are weakened, leading to the minimum wing angle that produces increased flow separation. Because of the effects of flow separation the pressures and heat fluxes increase and the ablation velocities increase significantly in the regions on and around the wing. Correlating formulas are presented. C.D.

A89-25939#

TESTING ON TWO DIMENSIONAL VERTICAL MODELS IN A CONVENTIONAL WIND TUNNEL

YIXIN LIU (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 472-479. In Chinese, with abstract in English. refs

This paper recommends a method of testing two-dimensional vertical models in a conventional wind tunnel. Up to now, up to 10 two-dimensional models have been tested using this method in the CARDC 4 x 3 wind tunnel, including the model of the NASA GA(W)-1 airfoil section, which was tested as a calibration model. The results were compared with data from NASA and good agreement was obtained. The tests were conducted over an angle-of-attack from -10 deg to 24 deg and up to a Reynolds number of 4.69 x 10 to the 6th. Tufts were attached for flow visualization. A head rake of 39 Venturi tubes was used to obtain the drag profile.

A89-25940#

APPLICATIONS OF AF3 EFFICIENT ITERATION SCHEME TO TRANSONIC NONCONSERVATIVE FULL-POTENTIAL FLOW PAST AIRFOILS

HANJIE LI and MINGKE HUANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 480-484. In Chinese, with abstract in English. refs

The finite difference method proposed by Jameson (1975) for computation of transonic, nonconservative full-potential flow past airfoils is improved in convergence speed by the use of Baker's (1988) AF3 efficient iteration scheme. A computer program is developed accordingly. Test examples show that computations on a mesh of 128x32 require only several decade iterations in most cases for convergence and that the results obtained agree very well with those by Jameson's original method. Author

A89-25941#

A NUMERICAL METHOD FOR CALCULATING THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF THE STRAKE-WING CONFIGURATIONS

YANSUN XIANG (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 485-490. In Chinese, with abstract in English. refs

The equivalent concentrated vortex method is used for strake-wing configuration aerodynamic characteristics calculations. When the so-called mixed flow pattern concept is adopted, flow over a strake-wing is characterized by the leading-edge separated vortex flow of the strake and the attached flow of the basic main wing. Similar treatment for a slender wing can be used for the strake and a conventional vortex lattice method can be used for the basic main wing. Calculations were performed to estimate the aerodynamic characteristics of several strake-wing configurations. The results show good agreement with experimental data. C.D.

A89-25942#

AN INTEGRAL METHOD FOR CALCULATING TURBULENT BOUNDARY LAYER FLOW ON PRACTICAL WINGS

HANLING BAO (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 491-496. In Chinese, with abstract in English. refs

In this paper an entrainment method for 3-D compressible turbulent boundary layer on arbitrary wings is presented. The method can be applied to cases of boundary layer with potential or nonpotential external flow fields. The calculating results of this method for the C-5A aircraft wing are fairly close to that of the implicit finite-difference method using Cebecis algebraic turbulent model. An example of viscosity effect on the wing lift and the aerodynamic focus location in a subsonic Mach number using this method is also presented in the paper. Author

DERIVATION OF AN INTEGRAL EQUATION FOR LARGE DISTURBING TRANSONIC FLOW AND ITS NUMERICAL METHOD OF UNDERCRITICAL FLOW

WUFAN CHEN (National University of Defence Technology, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 501-505. In Chinese, with abstract in English.

In this paper, a new approximate procedure is presented to simplify the potential equation of large-disturbing transonic flow in two-dimensions. An integral equation corresponding to the potential equation has been mathematically derived in which the conditions of boundaries and shock waves are treated in small-disturbing theorem. Author

A89-25946#

AN EFFECTIVE MODELING METHOD OF UNSTEADY **AERODYNAMICS FOR STATE-SPACE AEROELASTIC MODELS**

QING CHEN (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 512-516. In Chinese, with abstract in English. refs

This paper presents an effective method for linearizing Karpel's nonlinear model and combining the advantage of Roger's (1977) approximate method, which can get high accuracy by solving elements of a same coefficient matrix independently. The method simplifies the fitting calculation and improves the accuracy of results. Also it has the property of Karpel's minimum number of argumented states. Numerical results are given for the twodimensional case and the three-dimensional case. Author

A89-26011

UNSTEADY SEPARATION WAVE IN A SUPERSONIC BOUNDARY LAYER (NESTATSIONARNAIA VOLNA OTRYVA V POGRANICHNOM SLOE PRI SVERKHZVUKOVOM OBTEKANII] V. I. ZHUK and S. P. POPOV (AN SSSR, Vychislitel'nyi Tsentr, Akademiia Nauk SSSR, Doklady (ISSN Moscow, USSR) 0002-3264), vol. 303, no. 4, 1988, p. 822-824. In Russian. refs

Theoretical results are presented on a number of unsteady inviscid flows characterized by the presence of separation zones with closed streamlines propagating upstream along the boundary layer. A numerical solution is obtained to the Burgers equation with inhomogenous terms. It is shown that a shock wave incident on the boundary layer or steady injection creates favorable conditions for the appearance of broad separation zones propagating upstream. B.J.

A89-26163

ASYMPTOTICS OF STATIONARY SEPARATED FLOW PAST A BODY AT LARGE REYNOLDS NUMBERS (ASIMPTOTIKA STATSIONARNOGO OTRYVNOGO OBTEKANIJA TELA PRI BOL'SHIKH CHISLAKH REINOL'DSA]

S. I. CHERNYSHENKO Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 52, Nov.-Dec. 1988, p. 958-966. In Russian. refs

An asymptotic theory is developed for stationary separated flow past bodies at large Re numbers. It is shown that the length and the width of the separation zone are proportional to Re and the drag coefficient is proportional to 1/Re. On the body scale, the flow tends to a Kirchhoff flow satisfying the Brillouin condition with a velocity at a free flow line of the order of Re exp -1/2. V.L.

A89-26368#

NONEQUILIBRIUM VISCOUS HYPERSONIC FLOWS OVER **ABLATING TEFLON SURFACES**

BILAL A. BHUTTA, DONG JOO SONG, and CLARK H. LEWIS (VRA, Inc., Blacksburg, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 16 p. refs (Contract F04704-86-C-0031)

(AIAA PAPER 89-0314)

A three-dimensional nonequilibrium parabolized Navier-Stokes (PNS) scheme was developed which can accurately predict the effects of Teflon ablation into air under hypersonic flight conditions. This PNS scheme, which uses a general curvilinear coordinate system, is inherently stable in the subsonic as well as the supersonic flow regions and, thus, does not require any sublaver approximation. Two test cases are presented for the nonequilibrium flow over a sphere-cone configuration with Teflon ablation at the wall, which demonstrate this new PNS scheme under zero and nonzero angle-of-attack conditions, showing the accuracy, efficiency, and stability of the scheme. 15

A89-26369*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL INVESTIGATION OF TRANSONIC OSCILLATING CASCADE AERODYNAMICS

DANIEL H. BUFFUM (NASA, Lewis Research Center, Cleveland, OH) and SANFORD FLEETER (Purdue University, West Lafavette, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 14 p. refs

(AIAA PAPER 89-0321)

Fundamental experiments are performed in the NASA Lewis Transonic Oscillating Cascade Facility to investigate the subsonic and transonic aerodynamics of cascaded airfoils executing torsion mode oscillations at realistic values of reduced frequency. In particular, an unsteady aerodynamic influence coefficient technique is developed and utilized. In this technique, only one airfoil in the cascade is oscillated at a time, with the resulting airfoil surface unsteady pressure distribution measured on one dynamicallyinstrumented reference airfoil. The unsteady aerodynamics of an equivalent cascade with all airfoils oscillating at any specified interblade phase angle are then determined through a vector summation of these data. Author

A89-26371*# PRC Systems Services Co., Hampton, VA. AN EULER ANALYSIS OF LEADING-EDGE VORTEX FLOWS ON A FOREBODY-STRAKE AT SUPERSONIC SPEEDS

O. J. ROSE (PRC Systems Services, Hampton, VA) and JAMES L. PITTMAN (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 19 p. refs (AIAA PAPER 89-0343)

The flowfield, surface pressure, and integrated forces and moments for a fighter-type forebody with sharp leading-edge strakes have been obtained by numerical solution of the Euler equations. The method is found to correctly predict the leading-edge vortices and embedded shocks which arise at higher angles of attack. Results are presented for the effects of crossflow grid density, artificial viscosity, angle of attack, streamwise station, and camber on the flow characteristics. R.R.

A89-26373*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

LASER VELOCIMETER MEASUREMENTS OF THE FLOWFIELD GENERATED BY AN ADVANCED COUNTERROTATING PROPELLER

GARY G. PODBOY and MARTIN J. KRUPAR (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 33 p. Previously announced in STAR as N89-13409. refs (AIAA PAPER 89-0434)

Results are presented of an 0.72 regime, with the advance ratio of each rotor set at 2.80. The measured data indicate only a slight influence of the potential field of each front rotor blade on the flowfield upstream of the rotor. The data measured downstream of the front rotor characterize the tip vortices, vortex sheets and potential field nonuniformities generated by the front rotor. The unsteadiness of the flow in the rotating frame of reference of the aft rotor is also illustrated. Author

A89-26374#

PRELIMINARY RESULTS IN THE DEVELOPMENT OF A METHOD TO CORRECT PROPELLER INFLOW FOR IMPROVED UNSTEADY FORCE CALCULATIONS

T. S. MAUTNER (U.S. Navy, Naval Ocean Systems Center, San

Diego, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 29 p. Research supported by the U.S. Navy. refs

(AIAA PAPER 89-0436)

An existing propeller design method was modified and used to calculate the spatial variation of propeller performance and velocity components for use in determining unsteady forces. The calculations showed only small changes in the magnitude of the various velocity components when compared to typical counterrotating propeller design results, and Fourier analysis of the axial velocity data revealed the introduction of the 6th and 18th harmonics which were previously zero. Sign changes in the Fourier coefficients were obtained, and there was approximate agreement between the (absolute) magnitude of both the harmonic coefficients and unsteady forces obtained using the axial velocity and the measured wake (axial and radial components). However, the unsteady force distributions associated with the calculated axial velocity, which includes propeller effects, showed an increase in magnitude at the inner radii with minimal change in the shape of Author the radial distributions.

A89-26689

LOW SPEED AERODYNAMICS OF CANARD CONFIGURATIONS

G. BANDYOPADHYAY (Indian Institute of Technology, Kharagpur, India) Aeronautical Journal (ISSN 0001-9240), vol. 93, Jan. 1989, p. 22-28. Research supported by the Ministry of Defence of India. refs

Numerical methods treating both attached and separated flow over canard surfaces in incompressible, inviscid conditions have been developed for the prediction of aerodynamic characteristics in aircraft of this configuration, assuming that flow over the main wing surface remains attached. Attention is presently given to a comparison of these numerical results with those of a wind tunnel investigation that yielded pressure distributions as well as overall forces and moments. Good agreement is obtained to approximately 16-deg incidence. O.C.

A89-26946

FINITE ELEMENT SIMULATION OF 3D TURBULENT FREE SHEAR FLOWS

DOMINIQUE PELLETIER and RICARDO CAMAREO (Montreal, Ecole Polytechnique, Montreal, Canada) (FIDAP Users Conference, 1st, Evanston, IL, Sept. 13-15, 1987) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 8, Dec. 1988, p. 1563-1586. refs

This paper reviews past and current efforts in developing a simple but robust turbulence model for free shear flows. Much of this work has been published previously and this paper is a rearrangement aimed at the conference. The model is presented and is interfaced with FIDAP to solve three-dimensional flows and a pusher-prop configuration. The eight-node brick, the penalty formulation and the Broyden method are used to solve the Navier-Stokes equations. The propeller is modeled as an actuator disk and the direct simulation of a given propeller is considered in detail. Good results are obtained for the square jet. For propeller exceeding the velocity and pressure for flows of this complexity.

A89-27384

EVOLUTION OF PERTURBATIONS NEAR A SURFACE IN SUPERSONIC FLOW [RAZVITIE VOZMUSHCHENII VBLIZI POVERKHNOSTI, OBTEKAEMOI SVERKHZVUKOVYM POTOKOM]

S. A. GAPONOV and V. I. LYSENKO PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), Nov.-Dec. 1988, p. 70-76. In Russian. refs

The stability of a supersonic boundary layer near a surface is investigated analytically. It is found that, for different flow parameters, such as longitudinal velocity, temperature, and pressure, the perturbation growth rates are different and that these relations are strongly dependent on the Mach number. The results are compared with experimental data obtained by using hot-wire anemometers on the surface of models. V.L.

A89-27706#

TURBULENCE MEASUREMENTS IN A RADIAL UPWASH

BARRY GILBERT (Grumman Corporate Research Center, Bethpage, NY) AIAA Journal (ISSN 0001-1452), vol. 27, Jan. 1989, p. 44-51. Previously cited in issue 18, p. 2809, Accession no. A87-42455. refs (Contract F49620-85-C-0111)

A89-27716#

DIAGONAL IMPLICIT MULTIGRID CALCULATION OF INLET

D. A. CAUGHEY and R. K. IYER (Cornell University, Ithaca, NY) AIAA Journal (ISSN 0001-1452), vol. 27, Jan. 1989, p. 110-112. refs

The Caughey (1988) diagonal implicit multigrid algorithm for solving the Euler equations of two-dimensional transonic flow is presently extended in order to compute the supersonic flow past, and that within, a two-dimensional planar inlet. The inlet studied has a 10-deg ramp and a 20-deg wedge cowl, and is subjected to a Mach 2 freestream velocity; because the farfield flow is supersonic, all flow variables are specified at points on the inflow boundary, while all flow variables are extrapolated from the interior of the domain at points on the outflow boundary. O.C.

A89-27728#

SUPERSONIC, TRANSVERSE JET FROM A ROTATING OGIVE CYLINDER IN A HYPERSONIC FLOW

D. L. MCMASTER, J. S. SHANG (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), and W. C. GOLBITZ (DNA, Washington, DC) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 26, Jan.-Feb. 1989, p. 24-30. Previously cited in issue 18, p. 2810, Accession no. A87-42459. refs

A89-27742*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EFFECT OF SIDEWALL BOUNDARY LAYER ON A WING IN A WIND TUNNEL

V. N. VATSA (NASA, Langley Research Center, Hampton, VA) and B. W. WEDAN (Vigyan Research Associates, Inc., Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 157-161. Previously cited in issue 07, p. 927, Accession no. A88-22073. refs

A89-27746#

TURBULENCE MODELING IN SEPARATED FLOW BEHIND STRONG SHOCKS

DON W. KINSEY (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and F. E. EASTEP (Dayton, University, OH) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 185, 186. Previously cited in issue 07, p. 941, Accession no. A88-22531. refs

A89-27748#

INVESTIGATION OF INTERNAL SINGULARITY METHODS FOR MULTIELEMENT AIRFOILS

M. J. SHEU (National Tsing Hua University, Hsinchu, Republic of China) and D. R. CHEN Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 189-192. refs

The present flat-element method, which is based on linear distributions of vorticity and sources along the mean-camber line of the airfoil elements, is noted to constitute a useful approach to the solution of general potential flow problems. The method obviates the leaving of a gap between the leading edge and the element on the mean-camber line that is closest to the leading edge, in order to avoid the instability of the numerical solutions. Good agreement is obtained between flat-element method and curved-element method pressure distributions. O.C.

A89-28074

EULER FLOW SOLUTIONS FOR TRANSONIC SHOCK WAVE-BOUNDARY LAYER INTERACTION

BARRY KOREN (Centrum voor Wiskunde en Informatica, International Journal for Numerical Amsterdam, Netherlands) Methods in Fluids (ISSN 0271-2091), vol. 9, Jan. 1989, p. 59-73. Research supported by Stichting voor de Technische Wetenschappen. refs

Steady two-dimensional Euler flow computations have been performed for a wind tunnel section, designed for research on transonic shock wave-boundary layer interaction. For the discretization of the steady Euler equations, an upwind finite volume technique has been applied. The solution method used is collective. symmetric point Gauss-Seidel relaxation, accelerated by nonlinear multigrid. Initial finest grid solutions have been obtained by nested iteration. Automatic grid adaptation has been applied for obtaining sharp shocks. An indication is given of the mathematical quality of four different boundary conditions for the outlet flow. Two transonic flow solutions with shock are presented: a choked and a non-choked flow. Both flow solutions show good shock capturing. A comparison is made with experimental results. Author

A89-28203* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

LOW-SPEED VORTICAL FLOW OVER A 5-DEGREE CONE WITH TIP GEOMETRY VARIATIONS

J. CHU, R. M. HALL, and S. O. KJELGAARD (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 9 p. refs

(SAE PAPER 881422)

Experimental results on the surface pressures and sectional side forces on a 5-deg cone were obtained for the cases of three different nose tips. The sectional side force data for both the sharp cone and the blunt nose cone configurations showed a dependence on roll orientation. The blunt nose configurations were found to be effective in reducing the sectional side force for angles of attack up to 25 deg. Ř.R.

A89-28218* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

LDV SURVEYS OVER A FIGHTER MODEL AT MODERATE TO HIGH ANGLES OF ATTACK

WILLIAM L. SELLERS, III, JAMES F. MEYERS (NASA, Langley Research Center, Hampton, VA), and TIMOTHY E. HEPNER (U.S. Army, Aviation Research and Development Command, Hampton, SAE, Aerospace Technology Conference and Exposition, VA) Anaheim, CA, Oct. 3-6, 1988. 14 p. refs (SAE PAPER 881448)

The vortex flowfield over an advanced twin-tailed fighter configuration has been studied in a low-speed wind tunnel at two angles of attack using LDV, along with laser light sheet and surface flow visualizations. At 15 deg angles of attack, the vortices generated by the wing leading edge extension (LEX) were found to be unburst over the model and to pass outboard of the vertical tail. At 25 deg angle of attack, the vortices were shown to burst in the vicinity of the wing-LEX intersection and to impact directly on the vertical tails. R.R.

A89-28229* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THEORETICAL INVESTIGATION FOR THE EFFECTS OF SWEEP, LEADING-EDGE GEOMETRY, AND SPANWISE PRESSURE GRADIENTS ON TRANSITION AND WAVE DRAG TRANSONIC, AND SUPERSONIC SPEED WITH **EXPERIMENTAL CORRELATIONS**

S. H. GORADIA and P. J. BOBBITT (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 26 p. refs (Contract NAS1-17919) (SAE PAPER 881484)

A89-28251*# Vigyan Research Associates, Inc., Hampton, VA. **VISCOUS SHOCK-LAYER SOLUTIONS FOR THE** LOW-DENSITY HYPERSONIC FLOW PAST LONG SLENDER BODIES

R. N. GUPTA (Vigyan Research Associates, Inc., Hampton, VA), J. N. MOSS, E. V. ZOBY (NASA, Langley Research Center, Hampton, VA), S. N. TIWARI (Old Dominion University, Norfolk, VA), and K. P. LEE AIAA, Aerospace Sciences Meeting, 26th, Reno, NV, Jan. 11-14, 1988. 16 p. refs (AIAA PAPER 88-0460)

Results are obtained for the surface pressure, drag, heat-transfer, and skin-friction coefficients for hyperboloids and sphere cones. Body half angles from 5 to 22.5 degrees are considered for various low-density flow conditions. Recently obtained surface-slip and shock-slip equations are employed to account for the low-density effects. The method of solution employed for the viscous shock-layer (VSL) equations is a partially coupled spatial-marching implicit finite-difference technique. The flow cases analyzed include highly cooled long slender bodies in high Mach number flows. The present perfect-gas VSL calculations compare quite well with available experimental data. Results have also been obtained from the steady-state Navier-Stokes (NS) equations by successive approximations. Comparison between the NS and VSL results indicates that VSL equations even with body and shock-slip boundary conditions may not be adequate in the stagnation region at altitudes greater than about 75 km for the cases analyzed here.

A89-28341*# Massachusetts Inst. of Tech., Cambridge. ACTIVE SUPPRESSION OF AERODYNAMIC INSTABILITIES IN TURBOMACHINES

A. H. EPSTEIN, J. E. FFOWCS WILLIAMS, and E. M. GREITZER (MIT. Cambridge, MA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Mar.-Apr. 1989, p. 204-211. Previously cited in issue 22, p. 3219, Accession no. A86-45410, refs (Contract NSG-3208)

A89-28404*# High Technology Corp., Hampton, VA. FLOW MEASUREMENT ON THE FUSELAGE OF A BOEING 737 AIRPLANE

A. BERTELRUD (High Technology Corp., Hampton, VA), R. D. WATSON, and C. B. MCGINLEY (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 23 p. refs

(AIAA PAPER 89-0209)

Results are presented on flow measurements on the fuselage of a Boeing 737 aircraft, carried out during flight tests. The instruments used to measure static pressure, local skin friction, boundary layer characteristics, turbulence properties, and pressure fluctuations are described together with the computational methods used. Boundary layer thicknesses were found to be typically 6-8 inches at Reynolds numbers based on the momentum thickness of 60-180,000, depending on flight conditions and location along the fuselage. LS

A89-28406*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

UNSTEADY EULER CASCADE ANALYSIS

JONG-SHANG LIU (NASA, Lewis Research Center, Cleveland, OH; Textron Lycoming, Stratford, CT) and PETER M. SOCKOL (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 8 p. refs (AIAA PAPER 89-0322)

The results of an investigation of the rotor-stator interaction phenomena in turbomachines are presented. Numerical study was carried out by solving the unsteady Euler equations in the blade-to-blade direction for a variety of cascade geometries. The problem of uneven rotor and stator blades is addressed by adopting the tilted time domain technique. Computed solutions are presented and discussed for a NACA 0012 type cascade and the first stage fuel turbopump of the Space Shuttle Main Engine (SSME).

Author

Author

A89-28407*# Case Western Reserve Univ., Cleveland, OH. EXPERIMENTAL AND NUMERICAL INVESTIGATION OF AN OBLIQUE SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTION WITH CONTINUOUS SUCTION

DRISS BENHACHMI, ISAAC GREBER (Case Western Reserve University, Cleveland, OH), and WARREN R. HINGST (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 14 p. refs

(Contract NAG3-61) (AIAA PAPER 89-0357)

An numerical and experimental investigation has been conducted into the interaction of an incident oblique shock wave with a turbulent boundary layer, for the cases of a rough plate and a porous plate with suction, at a nominal Mach number of 2.5 and flow deflection angles of 0, 4, 6, and 8 deg. Attention is given to the pitot pressure profiles, wall static pressures, and porous plate local bleed distributions measured for the two plates. Suction is found to increase the strength of the incident shock required to separate the boundary layer; for all shock strengths tested, separation is completely eliminated. O.C.

A89-28413*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NUMERICAL ANALYSIS OF FLOW THROUGH OSCILLATING CASCADE SECTIONS

DENNIS L. HUFF (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 24 p. Previously announced in STAR as N89-14220. refs

(AIAA PAPER 89-0437)

The design of turbomachinery blades requires the prevention of flutter for all operating conditions. However, flow field predictions used for aeroelastic analysis are not well understood for all flow regimes. The present research focuses on numerical solutions of the Euler and Navier-Stokes equations using an ADI procedure to model two-dimensional, transonic flow through oscillating cascades. The model prescribes harmonic pitching motions for the blade sections for both zero and nonzero interblade phase angles. The code introduces the use of a deforming grid technique for convenient specification of the perioidic boundary conditions. Approximate nonreflecting boundary conditons were coded for the inlet and exit boundary conditions. Sample unsteady solutions were performed for an oscillating cascade and compared to experimental data. Also, test cases were run for a flat plate cascade to compare with the unsteady, small-perturbation, subsonic analysis. The predictions for oscillating cascades with nonzero interblade phase angle cases, which were near a resonant condition, differ from the experiment and theory. The zero degree interblade phase angle cases, which were near a resonant condition, differ from the experiment and theory. Studies on reflecting versus nonreflecting inlet and exit boundary conditions show that the treatment of the boundary can have a significant effect on the first harmonic, unsteady pressure distribution for certain flow conditions. Author

A89-28428*# Analytical Services and Materials, Inc., Hampton, VA.

OPTIMIZATION OF NATURAL LAMINAR FLOW AIRFOILS FOR HIGH SECTION LIFT-TO-DRAG RATIOS IN THE LOWER REYNOLDS NUMBER RANGE

WERNER PFENNINGER and CHANDRA S. VEMURU (Analytical Services and Materials, Inc., Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 17 p. refs (Contract NAS1-18235; NAS1-18599)

(AIAA PAPER 89-0539)

Relatively thin natural-laminar-flow airfoils were arranged optimally for different design lift coefficients in the wing chord Reynolds number ranges of 200,000-600,00 and 0.875 x 10 to the 6th to 2 x 10 to the 6th. The 9.5 percent thick airfoil ASM-LRN-010, the 7.9 percent thick airfoil ASM-LRN-012, the 10.4 percent thick airfoil ASM-LRN-015, and the 8.2 percent thick airfoil ASM-LRN-017 were designed for high lift-to-drag ratios using Drela's design and analysis.

A89-28434# THE EFFECTS OF ASPECT RATIO ON THE STALL OF A FINITE WING

ALLEN E. WINKELMANN (Maryland, University, College Park) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 17 p. refs

(AIAA PAPER 89-0570)

Results of the first phase of a study of the stall characteristics of high-aspect-ratio plane rectangular wings are presented. The oil flow visualization tests on a wing AR = 9 have indicated the existence of three and then four mushroom-shaped stall cells as the angle of attack has increased toward full stall. The effects of yawing a high-aspect-ratio plane rectangular wing are such that discrete mushroom stall cells do not occur. K.K.

A89-28442#

TRANSONIC STORE SEPARATION USING A THREE-DIMENSIONAL CHIMERA GRID SCHEME

F. CARROLL DOUGHERTY and JYH-HORNG KUAN (Colorado, University, Boulder) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs

(AIAA PAPER 89-0637)

This paper describes the development of a numerical simulation capability, using finite difference techniques, for flows around aircraft carrying stores. A multiple overset mesh approach, called the chimera scheme, is used in order to avoid the difficulties associated with generating a single global mesh around this complex configuration. In the chimera scheme, the configuration is mapped with a global mesh about the main component (the wing), and minor overset meshes are generated about each additional component (the stores). The minor meshes can be freely moved with respect to the global mesh, so that a time-accurate simulation of a moving store beneath a wing is possible without regridding the configuration. An implicit approximate factorization code for inviscid calculations is used here to solve time-dependent Euler equations to simulate flows about separating stores. It is shown that the time accuracy is adequately maintained, and the automatic bookkeeping routines are capable of tracking the moving SAV. arids in three dimensions.

A89-28443*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE FREE-WAKE PREDICTION OF ROTOR HOVER

PERFORMANCE USING A VORTEX EMBEDDING METHOD

K. RAMACHANDRAN (Flow Analysis, Inc., Mountain View, CA), C. TUNG, and F. X. CARADONNA (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs

(AIAA PAPER 89-0638)

A method is developed to predict the rotor hover performance. This method solves the compressible mass conservation equation much like current full potential codes and can therefore predict the transonic flows on a rotor. However, the newly developed approach also allows for the free convection of shed vorticity and permits the computation of the entire hover wake system. The method uses a vortex embedding scheme in potential flow and has been implemented in a computer code, HELIX -I. To predict power we implement a simple boundary layer and two different induced-drag integration schemes. The induced-drag is obtained from surface pressure integration and an energy flux integral. Comparisons between computations and experiment show good agreement for the prediction of power polars, surface pressure distribution, and tip vortex geometry.

A89-28444#

F-14 FLOW FIELD SIMULATION

K. Y. SZEMA, S. R. CHAKRAVARTHY, and B. L. BIHARI (Rockwell International Science Center, Thousand Oaks, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p.

(AIAA PAPER 89-0642)

The computer code EMTAC-MZ has been applied to investigate

the flow field over a variety of very complex three-dimensional configurations for supersonic flow with large subsonic pockets. In the code, a finite volume, multizone implementation of high accuracy, total variation diminishing formulation is used to solve the unsteady Euler equations. In the supersonic regions of the flow, an 'infinitely large' time step and a space-marching scheme is employed. A finite time step and a relaxation of three-dimensional approximate factorization method is used in subsonic flow regions. The multizone technique allows very complicated configurations to be modeled without geometry modifications, and can easily handle combined yaw and angle of attack cases. The F-14 flow field was investigated at subsonic and high angle of attack conditions by using the EMTAC-MZ code. Numerical results are obtained and are in very good agreement with available experimental data. Author

A89-28453*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN EXPERIMENTAL INVESTIGATION OF MULTI-ELEMENT AIRFOIL ICE ACCRETION AND RESULTING PERFORMANCE DEGRADATION

MARK G. POTAPCZUK (NASA, Lewis Research Center, Cleveland, OH) and BRIAN M. BERKOWITZ (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 39 p. Previously announced in STAR as N89-15084. refs (AIAA 89-0752)

An investigation of the ice accretion pattern and performance characteristics of a multi-element airfoil was undertaken in the NASA Lewis 6- by 9-Foot Icing Research Tunnel. Several configurations of main airfoil, slat, and flaps were employed to examine the effects of ice accretion and provide further experimental information for code validation purposes. The text matrix consisted of glaze, rime, and mixed icing conditions. Airflow and icing cloud conditions were set to correspond to those typical of the operating environment anticipated for a commercial transport vehicle. Results obtained included ice profile tracings, photographs of the ice accretions, and force balance measurements obtained both during the accretion process and in a past-accretion evaluation over a range of angles of attack. The tracings and photographs indicated significant accretions on the slat leading edge, in gaps between slat or flaps and the main wing, on the flap leading-edge surfaces, and on flap lower surfaces. Force measurements indicate the possibility of severe performance degradation, especially near C sub Lmax, for both light and heavy ice accretion and performance analysis codes presently in use. The LEWICE code was used to evaluate the ice accretion shape developed during one of the rime ice tests. The actual ice shape was then evaluated, using a Navier-Strokes code, for changes in performance characteristics. These predicted results were compared to the measured results and indicate very good agreement. Author

N89-16726# Continuum Dynamics, Inc., Princeton, NJ. VORTEX DYNAMICS FOR ROTORCRAFT INTERACTIONAL AERODYNAMICS

TODD R. QUACKENBUSH and DONALD B. BLISS (Duke Univ., Durham, NC.) Mar. 1988 65 p Prepared in cooperation with Duke University, Durham, NC

(Contract DAAL03-87-C-0013)

(AD-A200128; ARO-25093.1-EG-SBI) Avail: NTIS HC A04/MF A01 CSCL 01A

Promising results were obtained that indicate that new techniques in the analysis of vortex dynamics could be used as the foundation of a general analysis of rotor/airframe interactions. Prediction of the velocity field downstream of helicopter rotors was addressed first. Using a novel, full-span rotor wake representation constructed of curved vortex elements, accurate qualitative and quantitative predictions of wake velocity data were achieved for rotors in both low- and high-speed forward flight. The flow field predictions illustrated the radical changes that take place in the wake velocity field as speed increases and demonstrated the success of this approach in capturing these variations. New methods for analyzing close interactions between

vortices and fixed surfaces were developed. The basis of this new approach is the inclusion of the special treatment of the vortex velocity field for close interactions with paneled surfaces which obviates the need for high local panel density. Model problems were solved featuring vortices in close proximity to flat surfaces and cylinders that amply illustrate the accuracy and efficiency of the new method. GRA

N89-16728# Naval Postgraduate School, Monterey, CA. AERODYNAMIC PERFORMANCE OF WINGS OF ARBITRARY PLANFORM IN INVISCID, INCOMPRESSIBLE, IRROTATIONAL FLOW M.S. Thesis

CHRIS L. HOLM Sep. 1988 200 p

(AD-A200436) Avail: NTIS HC A09/MF A01 CSCL 01A

This thesis contains discussion, theory and program code for a computational fluid dynamics (CFD) model of a wing of arbitrary planform. The mathematical model assumes incompressible, inviscid, irrotational flow. The program computes forces acting on the wing by modeling the flow with a set of horseshoe vortex elements. It models the flow over an arbitrary wing using two solutions. One solution is the ideal lift, associated with a cambered and twisted wing. The other solution is the additional lift associated with a flat wing. The program computes wing camber and twist using an elliptic loading distribution. The thesis includes the FORTRAN source code, a separable user's manual for the VORTEX program, discussion of the theory applied in the model, and instructions for operating the program. It shows a sample wing planform with tabular and graphic results. Two other CFD models are also discussed, based on circulation and pressure difference, along with some of the problems and solutions in grid generation. Computer programs. Theses. (edc) GRA

N89-16730ESDU International Ltd., London (England).ESTIMATION OF DRAG ARISING FROM ASYMMETRY INTHRUST OR AIRFRAME CONFIGURATIONDec. 198840 p

(ESDU-88006; ISBN-0-85679-638-7; ISSN-0141-4054) Avail: ESDU

This data item 88006, an addition to the Sub-series on Aircraft Performance, gives a simple method, based on a correlation of established for a range of propeller and turbo-jet and turbo-fan powered aircraft, for predicting approximately the drag increment in flight with one or more engines inoperative (including the drag of the failed engine(s)). The derivation of the parameters used in that non-dimensional presentation is also considered and methods of estimating asymmetric flight is also considered and methods of estimating some of them are provided together with a list of sources of data for the others. The force and moment equations used to determine equilibrium flight conditions are given for use with either estimated or wind-tunnel aerodynamic data and an example of their application to a transport aeroplane is included. There is also a detailed discussion of alternative ways in which an aircraft may be flown in steady straight flight with thrust or other airframe asymmetries. ESDU

N89-16731 ESDU International Ltd., London (England). ROLLING MOMENT DERIVATIVE LXI, FOR PLAIN AILERONS AT SUBSONIC SPEEDS

Aug. 1988 18 p Supersedes ESDU Aero C.06.01.01 (ESDU-88013; ISBN-0-85679-645-X; ISSN-0141-397X) Avail: ESDU

This Data Item 88013, an addition to the Sub-series on Aerodynamics, presents a semi-empirical method that improves the traditional approach based on Weissinger's simplified lifting-surface theory which drew parallels with the dihedral contribution to the rolling moment due to sideslip. The method relies on ESDU 74011 to estimate the lift increment due to control deflection (in conjunction with the wing lift-curve slope from ESDU 70011), assumes that it acts at the mid-span of the aileron, and corrects the rolling moment so derived by an empirical factor that allows for the aileron effectiveness. The ranges of wing and control geometry for which the method is validated are given, and it is found to predict the derivative to within 20 percent for values up to -0.15 and to within 0.03 for numerically higher values. FSDU

N89-16732 ESDU International Ltd., London (England). DERIVATION OF PRIMARY AIR-DATA PARAMETERS FOR HYPERSONIC FLIGHT

Dec. 1988 48 p

(ESDU-88025; ISBN-0-85679-657-3; ISSN-0141-4054) Avail: ÈSDU

This Data Item 88025, an addition to the Sub-series on Aircraft Performance, gives data and methods of analysis for deriving true airspeed, Mach number, pressure height and ambient air temperature from registered values of total pressure and temperature, and static pressure. The methods apply for Mach numbers between approximately 4 and 10 and for heights up to 65 km (210,000 ft). Such air data are of particular importance where they are used to control an air-breathing propulsion unit. The assuptions and limitations of the methods are clearly stated and explaned, and a worked example illustrates the use of graphs and tables for the properties of equilibrium air behind a normal shock which are then used with the Rankine-Hugoniot relationships FSDU to devise the required data.

N89-16734 ESDU International Ltd., London (England). YAWING MOMENT COEFFICIENT FOR PLAIN AILERONS AT SUBONIC SPEEDS

Dec. 1988 16 p

(ESDU-88029; ISBN-0-85679-661-1; ISSN-0141-397X) Avail: ESDU

This data item 88029, an addition to the Sub-series on Aerodynamics, predicts the adverse yawing moment accompanying aileron deflection as two components, an induced drag contribution due to the differential setting and a profile drag component. For the first component a semi-empirical correlation procedure is developed while for the second the method of ESDU 87024, which deals with the profile drag due to deflection of plain flaps, is used. The method applies to sealed controls (or controls with small gaps) and allows for differential operation and flap deployment. The experimental data drawn from the literature (with some unpublished wind-tunnel measurements) covered a wide range of wing and aileron geometry which is specified. The method predicted the change of yawing moment coefficient per unit control deflection to within 0.003/rad at zero lift and without deployed FSDU flaps.

N89-16735 ESDU International Ltd., London (England). BOUNDARIES OF LINEAR CHARACTERISTICS OF CAMBERED AND TWISTED WINGS AT SUBCRITICAL MACH NUMBERS 43 p

Nov. 1988

(ESDU-88030; ISBN-0-85679-662-X; ISSN-0141-397X) Avail: **FSDU**

This Data Item 88030, an addition to the Sub-series on Aerodynamics, estimates the onset of non-linear aerodynamic characteristics by giving an empirical method for predicting the incidence and corresponding lift coefficient for either initial leadingor trailing-edge separation. The method developed treats the incidence as contributed to by three components: one from a datum plane wing, and one each from the superimposed aerodynamically smooth wings provided that the local effective twist does not exceed 10 degrees and will not apply when the ranges of planform and flow conditions are covered by the method (including aspect ratios from 1.4 to 13 and leading-edge sweeps from zero to 62 degrees). The method applies to any camber line slope, which may vary spanwise, as may the thickness chord ratio, and comparisons are shown between predicted lift coefficient for the onset of separation for both leading- and trailing-edge types which show it is predicted to within 15 percent. Comprehensive practical worked examples illustrate the use of the method, and a calculation summary sheet guides the user step-by-step through the procedure. ESDU

N89-16736 ESDU International Ltd., London (England). LIFT AND LONGITUDINAL FORCES ON PROPELLER/NACELLE/WING/FLAP SYSTEMS Dec. 1988 41 p

(ESDU-88031; ISBN-0-85679-663-8; ISSN-0141-397X) Avail: ESDU

This Data Item 88031, an addition to the Sub-series on Aerodynamics, provides a simple semi-empirical method for estimating the free air low-speed values of these forces for an unswept wing/flap system submerged in the slipstream from multiple propellers. It provides for the separate estimation of forces on the propeller and on the nacelle/wing/flap and requires a knowledge of the geometry and of the power-off lift and drag for the nacelle/wing/flap. There is a basic method, developed using simple momentum theory, which applies to flaps continuous across the slipstream, circular section nacelles of diameter equal to that of the spinner, and propellers that do not overlap. Guidance is then provided on the effect of flap cut-out, nacelle size and propeller overlap. The wing may be fitted with any of a wide range of single- or multi-element flaps, provided the flow is fully attached. Estimates are provided over the full range of thrust coefficients (based on slipstream kinetic pressure and propeller disc area) from zero to unity and predictions of the lift and longitudinal force on the nacelle/wing/flap system are within 10 and 15 percent respectively. ESDU

N89-16738# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

INTAKE AERODYNAMICS, VOLUME 1

1988 333 p Lecture series held in Rhode-Saint-Genese, Belgium, 22-26 Feb. 1988

(VKI-LS-1988-04-VOL-1; ISSN-0377-8312; ETN-89-93592) Avail: NTIS HC A15/MF A01

Tactical fighter inlets; inlet-engine compatibility; intake swirl and simplified methods for dynamic pressure distortion assessment; Jaguar/Tornado intake design; intake-airframe integration; intakes for high angle of attack; transonic cowl design; and intake drag were discussed.

ESA

N89-16739# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

INTRODUCTION TO INTAKE AERODYNAMICS

1988 J. SEDDON In its Intake Aerodynamics, Volume 1 28 p Avail: NTIS HC A15/MF A01

Pressure recovery in axial flow engines, with subsonic or supersonic inlets; boundary layers around inlets; inlet drag; and variable geometry inlets are introduced. ESA

N89-16740# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH. Flight Dynamics Lab.

TACTICAL FIGHTER INLETS

LEWIS E. SURBER and KEITH E. NUMBERS In VKI, Intake Aerodynamics, Volume 1 34 p Avail: NTIS HC A15/MF A01 1988

It is shown that the design of a tactical fighter air intake results from a compromise of performance and stability against complexity and weight, driven by overall aircraft mission requirements. Intake design requires thorough understanding of the various facets of inlet performance and the flow field phenomena which affect them. The basic measures of performance and the primary flow field phenomena which must be controlled are introduced. Design considerations involved in maximizing pressure recovery, minimizing drag, and controlling the flow for improved uniformity and steadiness are discussed. Given the design techniques available and their implementation in current aircraft it is shown that the inlet configuration itself can reveal much about the intended aircraft mission application and the overall system design philosophy. **ESA**
Messerschmitt-Boelkow-Blohm G.m.b.H., Munich N89-16742# (Germany, F.R.). Military Aircraft Div.

INTAKE SWIRL AND SIMPLIFIED METHODS FOR DYNAMIC PRESSURE DISTORTION ASSESSMENT

F. AULEHLA and D. M. SCHMITZ In VKI, Intake Aerodynamics, Volume 1 58 p 1988

Avail: NTIS HC A15/MF A01

It is shown that all supersonic intakes of present combat aircraft produce essentially two types of swirl components of varying magnitude, i.e., bulk and twin swirl. Depending on the sensitivity of the engine towards such disturbances serious engine/intake compatibility problems may arise, for example engine surge and fan vibration. The remedial measures to overcome this problem are described and the solution of fenced intakes selected for Tornado is discussed. A similar problem solution for the Airbus A300 is also presented. The relevance of dynamic total pressure distortion as the prime compatibility parameter for engines without inlet guide vanes is questioned and a proposal for an improved intake disturbance simulation in engine bench tests is made. It is suggested that fully dynamic distortion measurements can be replaced by simplified methods at least in the early stage of a project. **FSA**

N89-16743# British Aerospace Aircraft Group, Preston (England). Military Aircraft Div.

JAGUAR/TORNADO INTAKE DESIGN

D. C. LEYLAND In VKI, Intake Aerodynamics, Volume 1 25 p 1988

Avail: NTIS HC A15/MF A01

The assessment of aerodynamic features that led to the chosen intake configurations and particular aspects that had to be taken into account in overall design of the Jaguar and Tornado intakes are summarized. Intake sizing and profiles; pressure recovery; boundary layers; intake control; supersonic characteristics; and vortex-incidence aspects are discussed. ESA

N89-16747# British Aerospace Aircraft Group, Preston (England). Military Aircraft Div.

INTAKE DRAG

D. C. LEYLAND In VKI, Intake Aerodynamics, Volume 28 p 1988

Avail: NTIS HC A15/MF A01

Intake drag associated with location and external geometry at full mass flow and that due to reduction in entry flow from the maximum or datum value, the engine throttle dependent term, is discussed. General methods for estimating intake spillage drag are given but there is considerable installation geometry dependence and it is preferable to use test data for a similar configuration. The need for a correct understanding of the origin of propulsion related forces and of the requirements for proper book keeping of thrust and drag terms is emphasized. The use of part models in propulsion installation analysis is reviewed, and it is suggested that distinction needs to be made between the contributions to axial force from potential flow and real flow, only the latter part being strictly drag and contributing to overall aircraft drag. The use of data from part models is indicated, in support of the usual book keeping arrangement for throttle dependent terms to be taken into the engine installation account. ESA

N89-16748# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belaium).

INTAKE AERODYNAMICS, VOLUME 2

1988 302 p Lecture series held in Rhode-Saint-Genese, Belgium, 22-26 Feb. 1988

(VKI-LS-1988-04-VOL-2; ISSN-0377-8312; ETN-89-93593) Avail: NTIS HC A14/MF A01

Transport aircraft intake design; missile intakes; wind tunnel air intake test techniques; computational methods for inlet airframe integration; computational fluid dynamics (CFD) application to subsonic inlet airframe integration; and CFD application to supersonic/hypersonic inlet airframe integration were discussed.

ESA

N89-16751# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

WIND TUNNEL AIR INTAKE TEST TECHNIQUES

JACKY LEYNAERT In VKI, Intake Aerodynamics, Volume 2 30 p 1988

Avail: NTIS HC A14/MF A01

The general concept and validation of wind tunnel intake test setups are reviewed. The main intake test parameters are defined. Test rigs adapted to subsonic transport intakes, and to supersonic or combat aircraft intakes at supersonic Mach number, at transonic, and low speed are discussed. Devices for unsteady flow analysis, and for detailed inner flow probing are mentioned. **ESA**

N89-16753*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CFD APPLICATION TO SUBSONIC INLET AIRFRAME INTEGRATION

BERNHARD H. ANDERSON In VKI, Intake Aerodynamics, Volume 2 59 p 1988

Avail: NTIS HC A14/MF A01

The fluid dynamics of curved diffuser duct flows of military aircraft is discussed. Three-dimensional parabolized Navier-Stokes analysis, and experiment techniques are reviewed. Flow measurements and pressure distributions are shown. Velocity vectors, and the effects of vortex generators are considered. ESA.

National Aeronautics and Space Administration. N89-16754*# Lewis Research Center, Cleveland, OH.

CFD APPLICATION TO SUPERSONIC/HYPERSONIC INLET **AIRFRAME INTEGRATION**

THOMAS J. BENSON In VKI, Intake Aerodynamics, Volume 2 1988 62 p

Avail: NTIS HC A14/MF A01

Supersonic external compression inlets are introduced, and the computational fluid dynamics (CFD) codes and tests needed to study flow associated with these inlets are outlined. Normal shock wave turbulent boundary layer interaction is discussed. Boundary layer control is considered. Glancing sidewall shock interaction is treated. The CFD validation of hypersonic inlet configurations is explained. Scramjet inlet modules are shown. **FSA**

N89-16756# Centre Aeroporte de Toulouse (France) STUDY OF THE AERODYNAMIC SITUATION ALONG THE C 160 AIRCRAFT IN PARACHUTING CONFIGURATION (ETUDE DE LA SITUATION AERODYNAMIQUE LE LONG DU C 160 EN **CONFIGURATION DE PARACHUTAGE**]

M. CAROL May 1988 97 p In FRENCH (DAT-88-06; ETN-89-93610) Avail: NTIS HC A05/MF A01 Wind tunnel tests and flight tests were carried out to characterize the aerodynamic flow along and behind the C 160 aircraft when proceeding to a parachuting operation. The study gives indications to improve the aircraft design and the understanding of parachute behavior after leaving the aircraft. The test results, associated to a theoretical analysis show that the aerodynamical effect on the torsion of a parachute in automatic operation is negligible. **FSA**

N89-16757# National Aeronautical Lab., Bangalore (India). Fluid Mechanics Div.

NUMERICAL SOLUTION OF FLOW FIELDS AROUND DELTA WINGS USING EULER EQUATIONS METHOD

ANAND KUMAR and A. DAS (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) Jan. 1987 15 p Presented at the International Vortex Flow Symposium on Euler Code Validation, Stockholm, Sweden, 1-3 Oct. 1986

(NAL-TM-FM-8701) Avail: NTIS HC A03/MF A01

Flow over cropped delta wings having a leading edge sweep of 65 deg and an aspect ratio of 1.38 are computed using the DFVLR Euler code. Both sharp and round leading edges are considered. Calculations are performed for angles of incidence of 10, 20 and 24 deg for free-stream Mach number of 0.85, and for angles of incidence of 2, 10, to 30 deg (5 deg) for free-stream Mach number of 0.4. Influence of grid refinement and surface pressure evaluation on the solution are also studied. Author

N89-16758*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.

AN EXPERIMENTAL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF SLANTED BASE OGIVE CYLINDERS USING MAGNETIC SUSPENSION TECHNOLOGY Progress Report, 1 Apr. - 30 Sep. 1988

CHARLES W. ALCORN and COLIN BRITCHER Aug. 1988 90 p (Contract NAG1-716)

(NASA-CR-184624; NAS 1.26:184624) Avail: NTIS HC A05/MF A01 CSCL 01A

An experimental investigation is reported on slanted base ogive cylinders at zero incidence. The Mach number range is 0.05 to 0.3. All flow disturbances associated with wind tunnel supports are eliminated in this investigation by magnetically suspending the wind tunnel models. The sudden and drastic changes in the lift, pitching moment, and drag for a slight change in base slant angle are reported. Flow visualization with liquid crystals and oils is used to observe base flow patterns, which are responsible for the sudden changes in aerodynamic characteristics. Hysteretic effects in base flow pattern changes are present in this investigation and are reported. The effects of a wire support attachment on the zero degree slanted base model is studied. Computational drag and transition location results using VSAERO and SANDRAG are presented and compared with experimental results. Base pressure measurements over the slanted bases are made with an onboard pressure transducer using remote data telemetry. Author

N89-16760# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel. REYNOLDS NUMBER EFFECTS IN TRANSONIC FLOW

A. ELSENAAR, T. W. BINION, JR., E. STANEWSKY, and H. C. HORNUNG, ed. (California Inst. of Tech., Pasadena.) Mar. 1989 92 p

(AGARD-AG-303) Avail: NTIS HC A05/MF A01

Reynolds number effects in transonic flow are critically reviewed. A discussion is presented of the viscous effects observed on realistic configurations. The following geometries are considered: Airfoils and high aspect ratio wings typical of transport aircraft, fighter-type low aspect ratio delta wings, two- and three-dimensional bodies characteristic of missiles and combat aircraft fuselages, and afterbodies. Pseudo-Reynolds number effects are identified which may arise, for instance due to the influence of the Reynolds number on the wind tunnel environment and in turn affect the flow about a model. As an introduction, a brief retrospect of the history of Reynolds number effect is presented. Author

N89-16761*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.

DEVELOPMENT OF DIRECT-INVERSE 3-D METHODS FOR APPLIED TRANSONIC AERODYNAMIC WING DESIGN AND ANALYSIS Semiannual Progress Report, 1 Jul. - 31 Dec. 1988 LELAND A. CARLSON Feb. 1989 85 p (Contract NAG1-619)

(NASA-CR-184788; NAS 1.26:184788; TAMRF-5373-89-01)

Avail: NTIS HC A05/MF A01 CSCL 01A

Progress in the direct-inverse wing design method in curvilinear coordinates has been made. This includes the remedying of a spanwise oscillation problem and the assessment of grid skewness, viscous interaction, and the initial airfoil section on the final design. It was found that, in response to the spanwise oscillation problem that designing at every other spanwise station produced the best results for the cases presented, a smoothly varying grid is especially needed for the accurate design at the wing tip, the boundary layer displacement thicknesses must be included in a successful wing design, the design of high and medium aspect ratio wings is possible with this code, and the final airfoil section designed is fairly independent of the initial section. Author N89-16847*# Army Aviation Systems Command, Moffett Field, CA.

A CRITICAL ASSESSMENT OF WIND TUNNEL RESULTS FOR THE NACA 0012 AIRFOIL

W. J. MCCROSKEY In AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 21 p Jul. 1988 Previously announced as N88-11636 Avail: NTIS HC A22/MF A01 CSCL 01A

A large body of experimental results, obtained in more than 40 wind tunnels on a single, well known two-dimensional configuration, was critically examined and correlated. An assessment of some of the possible sources of error was made for each facility, and data which are suspect were identified. It was found that no single experiment provided a complete set of reliable data, although an investigation stands out as superior in many respects. However, from the aggregate of data the representative properties of the NACA 0012 airfoil can be identified with reasonable confidence over wide range of Mach numbers, Reynolds number, and angles of attack. This synthesized information can now be used to assess and validate existing and future wind tunnel results and to evaluate advanced Computational Fluid Dynamics codes.

N89-16849# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

COMPARISON OF THE RESULTS OF TESTS ON A300 AIRCRAFT IN THE RAE 5 METRE AND THE ONERA F1 WIND TUNNELS

C. QUEMARD and P. B. EARNSHAW (Royal Aircraft Establishment, Farnborough, England) *In* AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 16 p Jul. 1988

Avail: NTIS HC A22/MF A01

Studies of the A300 Airbus were carried out in the pressurized low speed wind tunnel at RAE and ONERA. Initially comparison of the results from the same model mounted on an identical three strut support, showed discrepancies which in the case of lift coefficient amounted to about 2.5 pct. A systematic comparison was made of the measurement techniques together with the methods used in the reduction of the resulting data. The production of uncorrected aerodynamic coefficients required the measurement of loads by means of underfloor balances and of the reference pressure. Checks were carried out on the balance calibrations confirming their accuracy after which an attempt was made in both facilities to assess and refine the accuracy of the reference pressure measurement. As a result, corrections were applied to the measurements made in both wind tunnels which reduced but did not eliminate the differences between the two sets of results. The data reduction relies on corrections to be applied for tunnel wall interference as well as that from the strut support system.

Author

N89-16858# Office National d'Etudes et de Recherches Aerospatiales, Modane (France).

PRECISION IMPROVEMENT OF TRANSPORT AIRCRAFT DRAG MEASUREMENTS (AMELIORATION DE LA PRECISION DE LA MESURE DE LA TRAINEE D'UN AVION DE TRANSPORT)

C. ARMAND and C. PUJOL (Societe Nationale Industrielle Aerospatiale, Toulouse, France) *In* AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 14 p Jul. 1988 In FRENCH Previously announced in IAA as A88-22597

Avail: NTIS HC A22/MF A01

Methods used in the ONERA S1MA and S2MA wind tunnels for attaining the desired absolute precision of 0.0002 in drag measurements of Airbus type transport aircraft are discussed. Factors considered include the quality of the balances, the precision of the incidence measurements, and the effects of friction and extreme temperatures. It is also noted that in order to obtain accurate drag measurements the airfoil geometry and the pressure distribution on the airfoil must be known to a high degree of precision. The results are corrected for the pressure fields in the test section and for the effects of the wall and the sting. E.R.

N89-16869# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

SOME DIFFICULTIES IN THE WIND TUNNEL PREDICTION OF MODERN CIVIL AIRCRAFT BUFFETING: PROPOSED REMEDIES

R. DESTUYNDER, V. SCHMITT, J. BERGER, and R. BARREAU (Societe Nationale Industrielle Aerospatiale, Toulouse, France) In AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 14 p Jul. 1988 In FRENCH; ENGLISH summary

Avail: NTIS HC A22/MF A01

The prediction of transport aircraft buffet response still remains a challenge despite recent progress in understanding of the phenomenon. The prediction is up to now inaccessible to a purely theoretical approach and so is mainly based on wind tunnel investigations. After a review of experimental methods currently used to determine model buffeting and a short description of full scale application techniques, the simulation problems that appear are presented. The next point deals with a number of improvements concerning models and experimental methodology with the final objective to provide more reliable buffeting predictions on large transport aircrafts. Author

N89-17566 Old Dominion Univ., Norfolk, VA. FULL-POTENTIAL INTEGRAL SOLUTIONS FOR STEADY AND UNSTEADY TRANSONIC AIRFOILS WITH AND WITHOUT EMBEDDED EULER DOMAINS Ph.D. Thesis HONG HU 1988 173 p

Avail: Univ. Microfilms Order No. DA8813660

The integral equation solution of the full potential equation is presented for steady and unsteady transonic airfoil flow problems. The method is also coupled with an embedded Euler domain solution to treat flows with strong shocks for steady flows. For steady transonic flows, three integral equation schemes are well developed. The three schemes are applied to different airfoils over a wide range of Mach numbers, and the results are in good agreement with the experimental data and other computational results. For unsteady transonic flows, the full-potential equation formulation in the moving frame of reference was used. The steady Integral Equation with Shock Capturing (IE-SC) scheme was extended to treat airfoils undergoing time-dependent motions, and the unsteady IE-SC scheme was thus developed. The resulting unsteady scheme was applied to a NACA 0012 airfoil undergoing a pitching oscillation around the quarter chord length. The numerical results are compared with the results of an implicit approximately-factored Euler scheme. Dissert. Abstr.

N89-17568*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. NASA SC(2)-0714 AIRFOIL DATA CORRECTED FOR

NASA SC(2)-0714 AIRFOIL DATA CORRECTED FOR SIDEWALL BOUNDARY-LAYER EFFECTS IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL RENALDO V. JENKINS Washington, DC Mar. 1989 58 p

RENALDO V. JENKINS Washington, DC Mar. 1989 58 p (NASA-TP-2890; L-16385; NAS 1.60:2890) Avail: NTIS HC A04/MF A01 CSCL 01A

This report presents the corrected aerodynamic data for A NASA SC(2)-0714 airfoil tested in the Langley 0.3-Meter Transonic Cryogenic Tunnel. This test was another in the series of tests involved in the joint NASA/U.S. industry Advanced Technology Airfoil Tests program. This 14 percent thick critical airfoil was tested at Mach numbers from 0.6 to 0.76 and angles of attack from -2.0 to 6.0 deg. The test Reynolds numbers were 4 million, 6 million, 10 million, 15 million, 30 million, 40 million, and 45 million. Corrections for the effects of the sidewall boundary layer have been made. The uncorrected data were previously published in NASA Technical Memorandum 4044.

N89-17569 Texas Univ., Arlington. AN EXPERIMENTAL INVESTIGATION OF THE PERPENDICULAR VORTEX-AIRFOIL INTERACTION AT TRANSONIC SPEEDS Ph.D. Thesis IRAJ MASBOOGHI KAI KHORAN 1987 178 p

IRAJ MASBOOGHI KALKHORAN 1987 178 p Avail: Univ. Microfilms Order No. DA8812828

Extensive studies were conducted in the UTA High Reynolds Number Transonic Wind Tunnel facility. The tests included a complete calibration of the wind tunnel over a wide range of transonic Mach numbers and at Reynolds numbers representing the normal operating condition of interest to aerospace vehicles. Experimental tests of the compressible trailing vortex system were performed by means of a thorough probing of the viscous core of the vortex system. Detailed flow field measurements and contour plots of the total pressure field in the neighborhood of the vortex core are presented. Thorough tests were conducted to investigate the pressure distribution on a C-141 and a NACA airfoil sections for a range of transonic flow conditions. The results obtained from these experiments indicate a substantial change in the pressure distribution of the downstream airfoil, a spanwise drift of the vortex core after interacting with the airfoil, and a high degree of unsteadiness in the vicinity of the vortex viscous core.

Dissert. Abstr.

N89-17577*# Johnson Aeronautics, Palo Alto, CA. WAKE MODEL FOR HELICOPTER ROTORS IN HIGH SPEED FLIGHT

WAYNE R. JOHNSON Nov. 1988 305 p

(Contract NAS2-12767)

(NASA-CR-177507; UŚAVSCOM-TR-88-A-008; NAS 1.26:177507) Avail: NTIS HC A14/MF A01 CSCL 01A

Two alternative approaches are developed to calculate blade-vortex interaction airloads on helicopter rotors: second order lifting-line theory, and a lifting surface theory correction. The common approach of using a larger vortex core radius to account for lifting-surface effects is quantified. The second order lifting-line theory also improves the modeling of yawed flow and swept tips. Calculated results are compared with wind tunnel measurements of lateral flapping, and with flight test measurements of blade section lift on SA349/2 and H-34 helicopter rotors. The tip vortex core radius required for good correlation with the flight test data is about 20 percent chord, which is within the range of measured viscous core sizes for helicopter rotors. Author

N89-17578*# McDonnell-Douglas Helicopter Co., Mesa, AZ. APPLICATION OF A COMPREHENSIVE ANALYTICAL MODEL OF ROTOR AERODYNAMICS AND DYNAMICS (CAMRAD) TO THE MCDONNELL DOUGLAS AH-64A HELICOPTER Final Report

CYNTHIA B. CALLAHAN and DUANE E. BASSETT Nov. 1988 62 p

(Contract NASA ORDER A-63622-C)

(NASA-CR-177455; NAS 1.26:177455) Avail: NTIS HC A04/MF A01 CSCL 01A

A model of the AH-64A helicopter was generated in a Comprehensive Analytical Model of Rotorcraft Aerodynamics and Dynamics (CAMRAD) in an effort to validate its analytical capabilities for modeling a current advanced Army helicopter. The initial phase of the effort involved the generation of CAMRAD input files necessary for the complete aerodynamic, structural, and dynamic definition of the production AH-64A helicopter. The input files were checked by making comparisons of CAMRAD full helicopter trim and main rotor blade natural frequency predictions with those of full helicopter trim program, Blade Element Trim (BETRIM), and dynamic analysis code, Dynamic Analysis Research Tool (DART), respectively. The main thrust concerned the application of the AH-64A CAMRAD model thus developed and verified for main rotor blade structural loads predictions and comparison with DART analytical results. The investigation provided insight not only into the usefulness of CAMRAD for the AH-64A performance and dynamics prediction, but also into the limitations of the program for modeling advanced rotor and fuselage systems. The model development effort is discussed, the results of the

CAMRAD correlation studies presented, and some general conclusions are offered on the applicability of CAMRAD for rotor aeroelastic loads prediction for current and future rotorcraft Author configurations.

National Aeronautics and Space Administration. N89-17579*# Ames Research Center, Moffett Field, CA. TIP AERODYNAMICS AND ACOUSTICS TEST: A REPORT

AND DATA SURVEY

JEFFREY L. CROSS and MICHAEL E. WATTS Dec. 1988 463 p (NASA-RP-1179; A-87128; NAS 1.61:1179) Avail: NTIS HC A20/MF A01 CSCL 01A

In a continuing effort to understand helicopter rotor tip aerodynamics and acoustics, a flight test was conducted by NASA Ames Research Center. The test was performed using the NASA White Cobra and a set of highly instrumented blades. All aspects of the flight test instrumentation and test procedures are explained. Additionally, complete data sets for selected test points are presented and analyzed. Because of the high volume of data acquired, only selected data points are presented. However, access to the entire data set is available to the researcher on request.

Author

Tokyo Univ. (Japan). Inst. of Space and N89-17580# Astronautical Science.

A NUMERICAL SIMULATION OF FLOWS ABOUT TWO-DIMENSIONAL BODIES OF PARACHUTE-LIKE CONFIGURATION

TORU SHIMADA Jun. 1988 15 p (ISAS-629; ISSN-0285-6808) Avail: NTIS HC A03/MF A01

Transient aerodynamic characteristics of the flows around bodies of parachute-like configuration are numerically analyzed from the solution of the Navier-Stokes equations. The computational method is mainly based upon the combination of effective and efficient techniques recently developed in the field of computational fluid mechanics. The results show that the flow behavior around a mouth plays a key role in determining the maximum peak drag acting on the parachute-like body in the starting period from the rest and also a vent is effective in Author controlling the starting peak of the drag.

N89-17582# Naval Surface Weapons Center, Silver Spring, MD. NOTES ON A THEORETICAL PARACHUTE OPENING FORCE ANALYSIS APPLIED TO A GENERAL TRAJECTORY Final Report, 1987 - 1988

WILLIAM P. LUDTKE 28 May 1988 72 p

(AD-A201050; NSWC-TR-88-6) Avail: NTIS HC A04/MF A01 CSCL 01C

The report presents a method for calculating the inflation reference time and opening shock forces of the solid-cloth family of parachutes when deployed at an arbitrary trajectory angle to the horizontal. The method is extended to other types of parachutes, but it is limited in that the inflation reference times are not calculated as part of the deployment process. Particular inflation times must be provided as input data to the furnished computer program. The variation of opening shock force versus inflation reference time may be surveyed by providing several values or using actual field test data. Examples are used to demonstrate the effects of canopy cloth rate of airflow, altitude, and trajectory deployment angle for constant velocity and constant dynamic pressure altitude profiles. GRA

AIR TRANSPORTATION AND SAFETY

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

A89-25545#

ON DESIGN AND PROJECTED USE OF DOPPLER RADAR AND LOW-LEVEL WINDSHEAR ALERT SYSTEMS IN AIRCRAFT TERMINAL OPERATIONS

EDWIN KESSLER (Oklahoma, University, Norman) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 7 p. refs

(AIAA PAPER 89-0704)

The path of development envisioned by the FAA for a prospective Doppler radar which may be useful in warning against low-altitude windshear near airports is presently questioned, on the grounds that while the system contemplated will yield high-quality operation in the high plains and desert regions of the U.S., windshear-related accidents in such regions are rare. By contrast, the major accidents involving windshear in the Mississippi region and eastward to the Atlantic coast have been associated with heavy precipitation; since precipitation-detection would then control aircraft guidance, windshear-detection capabilities would O.C. be redundant.

A89-25547#

WEATHER ACCIDENT PREVENTION USING THE TOOLS THAT WE HAVE

DENNIS W. NEWTON (Boeing Commercial Airplanes, Seattle, AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. WA) 9-12, 1989. 7 p. refs

(AIAA PAPER 89-0707)

This paper points out devices and methods which have the potential to increase safety in hazardous weather situations. The methods are available, or could be made available quickly and at reasonable cost. Some instances of effective use of existing tools Author are cited by way of example.

A89-25553*# Continuum Dynamics, Inc., Princeton, NJ. PROBLEMS IN UNDERSTANDING AIRCRAFT ICING **DYNAMICS**

ALAN J. BILANIN (Continuum Dynamics, Inc., Princeton, NJ) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. Research supported by NASA. refs

(AIAA PAPER 89-0735)

A general discussion of the nonthermodynamic mechanisms present during ice accretion on nonrotatig and rotating/flexing aerodynamic surfaces is undertaken. It is shown that competing physical effects do not in general allow a rigorous scaling methodology to be formulated, but suggestions are made which may result in an acceptable approxiamte scaling scheme. A test program is described which may provide data from which these approximate scaling schemes may be validated. Author

A89-25555#

ENROUTE CONVECTIVE TURBULENCE DEVIATION CONSIDERATIONS ON SHORT SEGMENTS

JEFFREY L. DICKINSON (Southwest Airlines Co., Dallas, TX) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 6 p.

(AIAA PAPER 89-0738)

This paper deals with the subject of enroute turbulence and weather avoidance as seen from a line pilot's point of view. The policies, procedures and techniques used enroute at both high and low altitude for weather avoidance or when encountering unsuspected hazardous weather are included. These procedures and techniques are generic to all carriers utilizing high performance, Author swept wing commercial aircraft.

A89-25556#

ENROUTE TURBULENCE AVOIDANCE PROCEDURES

ARCHIE TRAMMELL (AJT, Inc., Trinidad, TX) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 5 p. (AIAA PAPER 89-0739)

Case studies are analyzed which illustrate the possibilities for weather disturbance avoidance through greater reliance on airliner crews' more perspicacious use of airborne radar data that are already available in contemporary cockpits. The major considerations involved in the anticipation of possible weather problems during flight encompass a dewpoint greater than 50 F, a temperature/dewpoint spread greater than 30 F, and a turbulent weather feature movement that is greater than 10 knots. Attention is given to the possible consequences of these conditions over time. O.C.

A89-25557#

THE EFFECTS OF ENROUTE TURBULENCE REPORTS ON AIR CARRIER FLIGHT OPERATIONS

W. S. DOBBS (American Airlines, Inc., Dallas, TX) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p.

(AIAA PAPER 89-0741)

The science of meteorology has been continually improved through the development of many new tools and techniques. The resultant effects on airline flight planning have aided dramatically in reducing the discomforts and potential hazards of enroute encounters with turbulence. While forecasting the large scale dynamics of the upper air environment is now being done more accurately than ever before, the immensity of this environment allows many small scale anomalies to exist undetected except through firsthand experience. By requiring immediate reports on time, altitude, location and type from those pilots who experience such anomalous turbulence, it may be possible to prevent similar encounters by subsequent flights, and to add to a body of knowledge intended to further improve forecasting. Author

A89-25558#

DO PILOTS LET AIRCRAFT OPERATIONS SCHEDULES INFLUENCE ENROUTE TURBULENCE AVOIDANCE PROCEDURES?

E. B. MCCRARY (SimuFlite Training International, Dallas, TX) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 4 p.

(AIAA PAPER 89-0743)

An account is given of the factors responsible for the degree to which pilots allow scheduling considerations to influence their reactions to the detection of atmospheric turbulence conditions and the selection of appropriate turbulence-avoidance procedures. Attention is given to the fixation on time-schedules that may be brought to commercial airline operations by pilots with extensive experience in military flying. It is noted that insufficient consciousness of the turbulence-avoidance problem may delay necessary political action on behalf of regulatory improvement of procedures. O.C.

A89-25560*# Ohio State Univ., Columbus. EFFECT OF SIMULATED GLAZE ICE ON A RECTANGULAR WING

M. B. BRAGG and A. KHODADOUST (Ohio State University, Columbus) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. Research supported by NASA. refs (AIAA PAPER 89-0750)

Experimental measurements of the effect of simulated glaze ice on a three-dimensional wing are presented. A semispan wing of effective aspect ratio five was mounted from a splitter plate in the OSU subsonic wind tunnel. The model has a straight, untwisted rectangular platform, and uses a NACA 0012 airfoil section. Surface pressures were measured at 5 semispan locations and a total-pressure wake-survey probe was used on the model centerline. The section lift and drag data from the model centerline compared well to earlier two-dimensional data. These data show a large drag and maximum lift penalty due to the simulated glaze ice. Three-dimensional span-load data compare well to computational results. Author

A89-25561*# United Technologies Corp., Windsor Locks, CT. PROP-FAN AIRFOIL ICING CHARACTERISTICS

J. A. PIKE, H. S. WAINAUSKI, and L. S. BOYD (United Technologies Corp., Windsor Locks, CT) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 32 p. Research supported by NASA. refs

(AIAA PAPER 89-0753)

An icing test program was carried out during the 1986-87 and 1987-88 icing seasons at the Fluidyne lcing Tunnel. The testing consisted of evaluating the icing characteristics and aerodynamic performance characteristics of two thin, two-dimensional airfoil sections. The two airfoils were a NACA Series 16-203 and a Hamilton Standard PF1-304, 3 and 4 percent thickness-to-chord ratio airfoils, respectively. These airfoils are representative of the thin airfoils currently being evaluated for Prop-Fan propulsion systems. The tests were conducted over a wide range of icing conditions, angles-of-attack, and Mach numbers (0.3 to 0.8).

Author

A89-25563#

SELECTION OF THE CRITICAL ICING/FLIGHT CASE FOR AN UNPROTECTED AIRFOIL

KENNETH E. YEOMAN (Key Industries Corp., San Antonio, TX) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs

(AIAA PAPER 89-0757)

A method for determining the critical icing conditions for an aircraft is discussed. The method defines trends caused by variations in the geometry, flight, and icing parameters. It is suggested that the trend method uses less computer time than the method which determines the finite values of collection efficiency. Methods for determining trends in the effects of altitude, temperature, airspeed, and aircraft operation are given. R.B.

A89-25564# ELECTROMAGNETIC EMISSIONS FROM A MODULAR LOW VOLTAGE EIDI SYSTEM

PETER ZIEVE, BRENT HUFFER, and JAMES NG (Electroimpact, Inc., Seattle, WA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. Research sponsored by FAA. refs

(AIAA PAPER 89-0758)

An important consideration in the certification of Electro-Impulse Deicing (EIDI) systems for aircraft ice protection is electromagnetic interference (EMI). The Low Voltage Electro-Impulse De-Icing system is unique in that the capacitor bank is mounted adjacent to the coil thereby eliminating most of the cables. Electromagnetic emissions from this system would then be primarily from the coil. The performed tests investigate the EMI environment inside and outside of both a composite and an aluminum wing. Measurements of the radiated electric field indicate that emissions from the aluminum wing were well within the standards. Some tests with the composite wing were within standards while others were not. It was found that the composite wing could be brought back into compliance through the addition of thin metallic shielding.

Author

A89-25566#

INFRARED TECHNIQUE TO MEASURE THE SKIN TEMPERATURE ON AN ELECTROTHERMAL DE-ICER -COMPARISON WITH NUMERICAL SIMULATIONS

ROBERT C. HENRY and DIDIER P. GUFFOND (ONERA, Chatillon-sous-Bagneux, France) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs (AIAA PAPER 89-0760)

Helicopters are developed and certified under icing conditions using models capable of simulating the behavior of electrothermal deicers. An electrothermal deicer has been modeled by the finite difference method. To validate the code, the blade temperatures during the deicing process must be known. As the skin temperature is difficult to measure by sensors, in particular during a deicing sequence, the infrared technique has been used. Deicing code results are compared with measured temperature, and further developments are presented. Author

A89-25567#

DROPLET IMPACTION ON A SUPERSONIC WEDGE -CONSIDERATION OF SIMILITUDE

L. J. FORNEY (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(AIAA PAPER 89-0763)

The theoretical collection efficiency has been determined for water droplets impinging on a two-dimensional supersonic wedge with an attached shock. By defining a moving coordinate system such that the gas is stationary behind the shock and scaling the droplet Stokes number with a shock-to-wedge distance, a similarity parameter has been defined which properly accounts for the effects of freestream Mach number, wedge angle and large droplet Reynolds number. The effective Stokes number, which represents the ratio of the droplet stopping distance in the moving frame to the appropriate shock-to-wedge length, is shown to correlate both the total collection efficiency and local impingement rate. Author

A89-25584#

IMPACT OF SEVERE WEATHER ON AVIATION - AN NWS PERSPECTIVE

CHARLES H. SPRINKLE, JR. (NOAA, National Weather Service, Silver Spring, MD) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 p. refs

(AIAA PAPER 89-0795)

Methods for providing the aviation community with weather information are reviewed, focusing on techniques used by the National Weather Service for weather observation, storm detection, and forecast formulation. Several aviation weather systems are described, including the Automated Surface Observing System, the Next Generation Weather Radar, the Terminal Doppler Weather Radar, thermodynamic and wind atmospheric profilers, the Aircraft to Satellite Data Relay, and the Aeronautical Radio Incorporated Communications Addressing and Reporting System. The use of satellite remote sensing of the atmosphere, surface-based lightning detection systems, the Advanced Weather Interactive Processing System, and the work done at the National Severe Storms Forecast Center are examined. The prospects for future aviation weather dissemination systems are considered. R.B.

A89-25585#

THE EFFECTS OF INCLEMENT WEATHER ON AIRLINE OPERATIONS

JAMES F. SULLIVAN (USAir, Pittsburgh, PA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 4 p. (AIAA PAPER 89-0797)

The operation of airline dispatch offices is discussed, focusing on the way in which they handle inclement weather conditions. The use of weather information from the FAA, the National Weather Service, and contract sources on flight planning is examined. The effects of several types of inclement weather are considered, including snow, clear air turbulence, wind, and freezing rain.

R.B.

A89-25592#

WEATHER DATA DISSEMINATION TO AIRCRAFT

RICHARD H. MCFARLAND and CRAIG B. PARKER (Ohio University, Athens) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(AIAA PAPER 89-0809)

The requirements for the transmission of weather data products from the ground to aircraft by data uplink are determined. It is shown that the Mode S Beacon System (Orlando and Drouilhet, 1982) does not have sufficient data link capability to provide service to all aircraft. An alternative system is proposed which uses hybrid modulation techniques to transmit data on an existing aeronautical VHF voice communication channel. Results are presented from a computer analysis which demonstrates the capability of this hybrid modulation technique. R.B.

A89-26231

ELECTRIC CHARGE ACQUIRED BY AIRPLANES PENETRATING THUNDERSTORMS

J. J. JONES (New Mexico Institute of Mining and Technology, Socorro) IN: International Conference on Atmospheric Electricity, 8th, Uppsala, Sweden, June 13-16, 1988, Proceedings. Uppsala, Sweden, Institute of High Voltage Research, 1988, p. 560-565. refs

(Contract NSF ATM-82-05468; NSF ATM-82-18621; NSF ATM-86-00526)

Three airplanes - a sailplane, a piston-powered sailplane, and a twin turboprop - have been instrumented to measure electric fields inside thunderstorms. A method is presented for determining the net electric charge on the airplanes. For small amounts of charge on the airplane the engine exhaust acts to discharge the airplane, while for larger charges corona emission becomes the predominant mechanism of discharge. In unelectrified clouds the powered airplanes become negatively charged in the presence of liquid cloud water droplets. In thunderstorm electric fields there are at least two charging mechanisms. One involves the liquid water droplets of the cloud and the other shedding of polarization charge in strong fields. For both charging processes the sign of the acquired charge depends on the sign of the electric field component along the direction of flight.

A89-27249

PROBLEMS OF ENSURING CIVIL-AIRCRAFT FIRE SAFETY

V. K. LUZHETSKII (Gosudarstvennyi Nauchno-Issledovatel'skii Institut Grazhdanskoi Aviatsii, Moscow, USSR) ICAO Bulletin (ISSN 0018-8778), vol. 43, Oct. 1988, p. 26-29.

Experimental and theoretical research by Soviet scientist to study airborne fire-protection systems is examined. The ways in which fires start and spread are reviewed. The development of fire-warning systems for future aircraft is discussed, including the functional requirements, structure, flight tests, and specific procedures such as landing and smoke removal. In addition, the psychological aspects of a crew's actions during an in-flight fire are considered. R.B.

A89-27739*# Massachusetts Inst. of Tech., Cambridge. INVESTIGATION OF SURFACE WATER BEHAVIOR DURING GLAZE ICE ACCRETION

R. JOHN HANSMAN, JR. and STEPHEN R. TURNOCK (MIT, Cambridge, MA) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 140-147. Research supported by FAA. Previously cited in issue 07, p. 943, Accession no. A88-22079. refs (Contract NAG3-666; NGL-22-009-640)

A89-28187

RESULTS OF THE AIA/ATA/FAA DYNAMIC SEAT TESTING PROGRAM

JAMES L. WEBSTER, SR., JEAN A. MCGREW, and WILLIAM H. SHOOK (Douglas Aircraft Co., Long Beach, CA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 7 p.

(SAE PAPER 881375)

Dynamic tests were conducted in 1986 with airline passenger triple-seat assemblies to gain experience in testing methods and to gather data on airline seat performance in the dynamic environment of an emergency landing. The test series investigated acceleration levels, impact velocity, longitudinal and vertical impacts, multiple-row effects, and floor deformation. The test conditions remained below the point of total seat assembly failure so that the performance of the seat assemblies could be evaluated for structural integrity, reaction loads of the seat legs with the floor structure, and the loads experienced by the instrumented dummy occupant. Author

A89-28188 MEASUREMENT OF DYNAMIC REACTIONS IN PASSENGER SEAT LEGS

VAN GOWDY and RICHARD F. CHANDLER (FAA, Civil Aeromedical Institute, Oklahoma City, OK) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 9 p. refs

(SAE PAPER 881376)

A procedure is described for measuring the dynamic forces acting between seats and the floor of an aircraft during an impact. The procedure involves a series of sled tests using strain gages on the seat legs to measure the impact, and the calibration of the strain gage output in terms of forces transmitted to the floor of a rigid test fixture during the test of each seat. The instrumentation, the acquired data, and the analysis of the results of calibration procedure results are presented.

A89-28189

TRANSPORT AIRPLANE FUSELAGE SECTION LONGITUDINAL IMPACT TEST

RICHARD JOHNSON, STEVE SOLTIS (FAA, Washington, DC), JIM BLAKER, and BARRY WADE (Ohio, Transportation Research Center, East Liberty) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 18 p. refs (SAE PAPER 881377)

A transport airplane fuselage section with a full complement of cabin seats and anthropomorphic test dummies was longitudinally impact-tested at a condition that approached the ultimate strength of the airframe protective shell structure. Airframe structural responses, seat/floor reaction loads, and the interactive effects of secondary impacts between multiple cabin seat rows were investigated. The scope and conduct of the test are presented together with some preliminary analyses of the test results.

Author

A89-28190

DISCUSSION OF TRANSPORT PASSENGER SEAT PERFORMANCE CHARACTERISTICS

S. P. DESJARDINS, MARK R. CANNON, and S. JOSEPH SHANE (Simula, Inc., Phoenix, AZ) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 11 p. refs

(SAE PAPER 881378)

The performance requirements for the seats of a transport aircraft are summarized. It is emphasized that, in order to minimize the severity of injury to the passenger while providing sufficient opportunity to egress, the seat must have the following characteristics: (1) it must carry the inertial loads of the occupant and the seat and to limit the floor reaction loads to magnitudes not above the floor strength, (2) must minimize the hazard associated with the secondary impact of the accupants with the seat in front, and (3) must not leave the occupant in a position or orientation that would impede egress. Some of the factors that must be considered in designing such a seat are discussed. LS.

A89-28191

EFFECTS OF AIRCRAFT SIZE ON CABIN FLOOR DYNAMIC PULSES

CAESAR A. CAIAFA and LAWRENCE M. NERI (FAA, Technical Center, Atlantic City, NJ) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 17 p. refs (SAE PAPER 881379)

The experiments performed during the Federal Aviation Administration sponsored tests on the effect of the aircraft size on cabin-floor dynamic pulses are described. The results of narrow-body- and wide-body-section tests are reviewed, together with the results of a supporting analytical model, and the relationships between the parameters which influence the dynamic response of aircraft structure are defined. The aircraft-size-effect trend curves for the cabin floor dynamic pulses are developed in terms of triangular pulse acceleration magnitude, velocity change, and pulse duration. Data on the effects of aircraft size on the cabin-floor dynamic pulses are presented for several types of aircraft, including the commuter aircraft, general-aviation aircraft, and narrow-body and wide-body transport aircraft. 1.5

A89-28192* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN OVERVIEW OF THE CURRENT NASA PROGRAM ON AIRCRAFT ICING RESEARCH

RICHARD J. RANAUDO, ANDREW L. REEHORST, and MARK G. POTAPCZUK (NASA, Lewis Research Center, Cleveland, OH) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 20 p. refs (SAE PAPER 881386)

The NASA Lewis Research Center is presently conducting an aircraft icing research program, the major thrust of which is to advance technologies that improve our ability to model the icing phenomenon and its effect on aircraft. The approach employs three interrelated elements: analysis; wind tunnel experiments; and, considerable flight testing in natural icing clouds. This paper presents a brief overview of this program with emphasis on recent accomplishments. Author

A89-28294#

WAYS TO SOLVE CURRENT FLIGHT-SAFETY PROBLEMS WEGE ZUR LOESUNG DER AKTUELLEN PROBLEME DER FLUGSICHERUNG1

Ortung und Navigation (ISSN 0474-7550), vol. 29, no. 3, 1988, p. 343-362. In German.

The current status of flight-safety systems in the FRG and of European cooperation in this field is surveyed, and policy alternatives for solving outstanding and foreseeable problems are suggested, in a report presented by FRG administration officials to the budget committee of the Bundestag. Topics addressed include the continuing rapid growth of European air traffic volume, the sudden and unpredicted 15-20-percent increase during 1987, the potential impact of EEC integration plans for 1992, the geographically and militarily central position of the FRG, and personnel shortages in the FRG ATC agencies. Consideration is then given to short-term and long-term planning strategies, international negotiations and the role of Eurocontrol, and specific measures for possible inclusion in the 1989 FRG budget. тκ

A89-28448#

ANALYSIS OF ARROW AIR DC-8-63 ACCIDENT GANDER, **NEWFOUNDLAND ON 12 DECEMBER 1985**

JAMES K. LUERS and MARK A. DIETENBERGER (Dayton, University, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 23 p. Research sponsored by the Canadian Aviation Safety Board.

(AIAA PAPER 89-0706)

A two-part performance analysis of the Arrow Air DC-8-63 takeoff accident which occurred at Gander, Newfoundland on December 12, 1985 is presented. Takeoff sensitivity analysis was performed using a digital, fixed stick, simulation program to establish the relative performance degradation resulting from several candidate causes. The accident trajectory was reconstructed by solving the airplane equations of motion using flight recorder data as input. Consistent results are achieved by the two approaches. C.D.

A89-28451*# Massachusetts Inst. of Tech., Cambridge. MODELING OF SURFACE ROUGHNESS EFFECTS ON GLAZE **ICE ACCRETION**

R. JOHN HANSMAN, JR., KEIKO YAMAGUCHI (MIT, Cambridge, MA). BRIAN BERKOWITZ (Sverdrup Technology, Inc., Middleburg Heights, OH), and M. POTAPCZUK (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs

(Contract NAG3-666; NGL-22-009-640)

(AIAA 89-0734)

The cause and effects of roughness on accreting glaze ice surfaces were studied with microvideo observations. Distinct zones of surface water behavior were observed, including a smooth wet

03 AIR TRANSPORTATION AND SAFETY

zone in the stagnation region with a uniform water film, a rough zone where surface tension effects caused coalescence of surface water into stationary beads, and a zone where roughness elements grow into horn shapes. In addition, a zone where surface water ran back as rivulets and a dry zone where rime feathers formed were observed. The locations and behaviors of these zones are discussed. A simple multizone modification to the glaze ice accretion model is proposed to include spatial variability in surface roughness. Two test cases using the multizone model showed significant improvements for the prediction of glaze ice shapes.

R.B.

A89-28464*# Rice Univ., Houston, TX. OVERVIEW OF OPTIMAL TRAJECTORIES FOR FLIGHT IN A WINDSHEAR

A. MIELE, T. WANG (Rice University, Houston, TX), W. W. MELVIN (Delta Air Lines, Inc., Atlanta, GA), and H. WANG AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 41 p. Research supported by Boeing Commercial Airplane Co. and Air Line Pilots Association. refs

(Contract NAG1-516)

(AIAA 89-0812)

Optimal flight trajectories for the B-727, B-737, and B-747 aircraft in the presence of wind shear are studied. The takeoff problem and the abort landing problem are considered with reference to flight in a vertical plane. In the former, optimal trajectories are computed by minimizing the peak deviation of the absolute path inclination from a reference value; in the latter, optimal trajectories are computed by minimizing the peak value of the altitude drop. Numerical computations show that, for both the problems under consideration, the optimal trajectories of the three aircraft show the same qualitative behavior. Hence, it appears that the near-optimal guidance schemes developed for the B-727 can be extended to the other two aircraft, albeit with some guantitative modification.

A89-28486

KINEMATICS OF U.S. ARMY HELICOPTER CRASHES - 1979-85

DENNIS F. SHANAHAN and MAUREEN O. SHANAHAN (U.S. Armed Forces Institute of Pathology, Washington, DC) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 60, Feb. 1989, p. 112-121. refs

All records of U.S. Army Class A and B mishaps of four types of helicopters occurring from Oct. 1, 1979, through Sept. 30, 1985, were reviewed for terrain impact kinematic parameters. During this 6-year period, there were 298 mishaps involving 303 aircraft. Approximately 88 percent of these crashes were considered survivable. Mean and 95th percentile vertical velocity changes at the most severe terrain impact were similar for all aircraft types except the UH-60, which experienced significantly higher impact velocities. Overall 95th percentile vertical and horizontal velocity changes at the most severe terrain impact were 11.2 m/s and 25.5 m/s, respectively. Both these values are substantially different from values cited in current design standards. Roll, pitch, and yaw attitudes at impact were similar for all aircraft and agreed with the values in current design standards, except that the distribution of roll angles was considerably wider. The importance of using current kinematic parameters for crashworthiness design standards and crash injury prevention is stressed. Recommendations are made to improve crashworthiness Author design standards.

N89-16766# Sandia National Labs., Albuquerque, NM. Systems Engineering Div.

AVIATION SECURITY: A SYSTEM'S PERSPECTIVE

JAMES P. MARTIN 1988 35 p Presented at the 5th FAA International Civil Aviation Security Conference, Washington, DC, 24 Oct. 1988

(Contract DE-AC04-76DP-00789)

(DE89-002020; SAND-88-2629C; CONF-8810219-1) Avail: NTIS HC A03/MF A01

For many years the aviation industry and airports operated

with security methods and equipment common to most other large industrial complexes. At that time, the security systems primarily provided asset and property protection. However, soon after the first aircraft hijacking the focus of security shifted to emphasize the security requirements necessary for protecting the traveling public and the one feature of the aviation industry that makes it unique---the airplane. The airplane and its operation offered attractive opportunities for the homesick refugee, the mentally unstable person and the terrorist wanting to make a political statement. The airport and its aircraft were the prime targets requiring enhanced security against this escalated threat. In response, the FAA, airport operators and air carriers began to develop plans for increasing security and assigning responsibilities for implementation.

N89-16768# National Transportation Safety Board, Washington, DC.

AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORT, TRAVIS AIR FORCE BASE, CALIFORNIA, 8 APRIL 1987 31 Dec. 1988 16 p

(PB88-910414; NTSB-AAR-88-03-SUM) Avail: NTIS HC A03/MF A01 CSCL 01C

This report is a summary of an aircraft accident investigated by the National Transportation Safety Board. The accident location and date is Travis Air Force Base, California, April 8, 1987. Author

N89-17584*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DESIGN OF AUTOMATION TOOLS FOR MANAGEMENT OF DESCENT TRAFFIC

HEINZ ERZBERGER and WILLIAM NEDELL Dec. 1988 35 p (NASA-TM-101078; A-89058; NAS 1.15:101078) Avail: NTIS HC A03/MF A01 CSCL 01C

The design of an automated air traffic control system based on a hierarchy of advisory tools for controllers is described. Compatibility of the tools with the human controller, a key objective of the design, is achieved by a judicious selection of tasks to be automated and careful attention to the design of the controller system interface. The design comprises three interconnected subsystems referred to as the Traffic Management Advisor, the Descent Advisor, and the Final Approach Spacing Tool. Each of these subsystems provides a collection of tools for specific controller positions and tasks. This paper focuses primarily on the Descent Advisor which provides automation tools for managing descent traffic. The algorithms, automation modes, and graphical interfaces incorporated in the design are described. Information generated by the Descent Advisor tools is integrated into a plan view traffic display consisting of a high-resolution color monitor. Estimated arrival times of aircraft are presented graphically on a time line, which is also used interactively in combination with a mouse input device to select and schedule arrival times. Other graphical markers indicate the location of the fuel-optimum top-of-descent point and the predicted separation distances of aircraft at a designated time-control point. Computer generated advisories provide speed and descent clearances which the controller can issue to aircraft to help them arrive at the feeder gate at the scheduled times or with specified separation distances. Two types of horizontal guidance modes, selectable by the controller, provide markers for managing the horizontal flightpaths of aircraft under various conditions. The entire system consisting of descent advisor algorithm, a library of aircraft performance models, national airspace system data bases, and interactive display software has been implemented on a workstation made by Sun Microsystems, Inc. It is planned to use this configuration Author in operational evaluations at an en route center.

N89-17585# Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.

DEVELOPMENT OF NEW REDUNDANT FLIGHT SAFETY SYSTEM USING INERTIAL SENSORS SHIGEKI TSUKAMOTO Oct. 1988 18 p

(ISAS-634; ISSN-0285-6808) Avail: NTIS HC A03/MF A01

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

A Flight Safety System requires high reliability in its operation because of the crucial duty to decide to destroy a flying vehicle or not, etc., in a state of emergency. A new Flight Safety System, one totally independent of the old one, which depends on radar information, is based on the principle of inertial navigation in calculating a real-time trajectory and impact points on earth by online PCM-telemetry data. This backup system has been applied to practical missions such as Halley and Ginga, with good success. An efficient, redundant system was created by connecting an ordinary personal computer to the line for speedy calculation in order to construct a transfer matrix for a single pole representation of altitude. Author

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A89-26708#

LABORATORY AND FLIGHT EVALUATION OF THE INTEGRATED INERTIAL SENSOR ASSEMBLY (IISA)

JACK JANKOVITZ (U.S. Navy, Naval Air Development Center, Warminster, PA) and JOHN PERDZOCK (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 126-133.

Two complete sets of the Integrated Inertial Sensor Assembly (IISA) have been built, one set for laboratory evaluation and the other for flight test evaluation. The flight test evaluation was performed at Edwards Air Force Base on an F-15 aircraft. The authors provide an overview of the laboratory and flight test evaluations conducted by the Navy and Air Force. It is concluded that the IISA program has shown that it is feasible to use dispersed skewed inertial navigation quality sensors for redundant flight control sensors, navigation, cockpit displays and sensor stabilization. It is further concluded that the IISA concept is viable as a navigation and flight control reference. I.E.

A89-26724

VERDICT - A PLAN FOR GRAVITY COMPENSATION OF INERTIAL NAVIGATION SYSTEMS

MARVIN MAY, JAMES A. LOWREY, III, and MIKIE AIKAWA (U.S. Navy, Naval Air Development Center, Warminster; Rockwell International Corp., Pittsburgh, PA) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 280-287.

The effect of gravitational disturbances prior and subsequent to compensation with preprepared maps for advanced tactical fighter application is quantified. The avionics issues associated with implementation of vertical deflection compensation are addressed. It is shown that a unique implementation concept designated the VERDICT (vertical deflection inertial compensation terminal) can provide the required compensation and is adaptable to a wide variety of inertial navigators. The authors document the validation of the VERDICT concept and present an approach to the hardware design of VERDICT. It is concluded that the combination of advanced mass storage and digital processing electronics, and the availability of large gravity databases from satellite altimetry make the VERDICT concept feasible for near-term implementation. I.E.

A89-26725

CORRECTION FOR DEFLECTIONS OF THE VERTICAL AT THE RUNUP SITE

PALMER O. HANSON (Honeywell, Inc., Military Avionics Div.,

Minneapolis, MN) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 288-296. Research supported by USAF. refs

The effects of unmodeled deflections of the vertical on aircraft inertial navigation system performance are considered. It is argued that, with few exceptions, the work on the area to date has ignored an important aspect, the correlated effects of deflections of the vertical at the runup site interacting with the system's self-alignment algorithm. The author reviews statistical analysis and flight test results, examines the effects of self-alignment on navigation errors, and describes a methodology that applies appropriate corrections during self-alignment and static navigation testing, and removes those corrections during flight. An implementation that substantially reduced the resulting errors for navigation times of one or two Schuler cycles was successfully demonstrated during flight test of the Mini-GEANS (Gimbaled Electrostatic Gyro Aircraft Navigation System).

A89-26726

PRECISION TRAJECTORY RECONSTRUCTION

WANG TANG and NEWTON JOHNSON (General Dynamics Corp., Convair Div., San Diego, CA) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 297-302.

A precision trajectory reconstruction technique based on photoscoring has been developed to evaluate the airborne accuracy performance of guidance and navigation systems. The sensors include a reference inertial navigation system (INS) and a motion picture camera. The camera is mounted in the aircraft at a known position and attitude with respect to the inertial system and is used to photograph marker panels placed at precisely surveyed locations on the gound. The camera includes a time display device which is driven by a clock associated with the inertial data. The image data from the camera are processed with a modern Kalman filter/smoother to estimate the inertial system errors. The trajectory is then reconstructed by correcting the inertial system data with the estimated errors. It is shown using covariance analysis that the precision photoscoring technique can be used to reconstruct the flight trajectory with a position error of 0.4 m under baseline conditions. In addition, flight tests were used to evaluate the accuracy of the photoscoring process. I.E.

A89-26733

AIR TRAFFIC CONTROL AUTOMATION CONCEPTS TO OPTIMIZE FLIGHT MANAGEMENT SYSTEM UTILIZATION

SATISH C. MOHLEJI (Mitre Corp., McLean, VA) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 341-346. refs (Contract DOT-FA01-84-C-00001)

The author defines the requirements and design philosophy for developing ground-based automation planning and control advisory concepts to best serve the aircraft with FMS (flight management system) capabilities. Analytical results are presented, based on comparison of operational data with the user-preferred trajectories to identify flying-time variabilities in various segments of arriving flights. En route descents, terminal maneuvering areas, and the final approaches are considered to determine the impact of aircraft and environmental factors on flying times essential for traffic planning. Simple time-estimation algorithms based on FMS-defined speed schedules and prevailing winds are presented for estimating flying times during en route descents. Automation planning and control concepts are developed which utilize flexible route structures and a speed-control strategy to permit the aircraft maximum use of FMS and onboard avionics in all operating conditions. LE.

A89-26734

THE REALIZATION OF MICROWAVE LANDING SYSTEM BENEFITS

AGAM N. SINHA (Mitre Corp., McLean, VA) IN: PLANS '88 -

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 347-352. refs (Contract DOT-FA01-84-C-00001)

The operational benefits derived from the use of MLS (microwave landing system) attributes are classified in five general categories: (1) use of curved/segmented approaches, (2) use of back azimuth guidance, (3) use of higher glide slopes/reduced siting problems, (4) relief of frequency congestion, and (5) other benefits (e.g., reliability and maintainability). Each of these categories is discussed, with specific examples. The requirements necessary to achieve the benefits are described. I.E.

A89-26735

CAUSAL PROBABILITY MODEL FOR TRANSOCEANIC TRACK SEPARATIONS WITH APPLICATIONS TO AUTOMATIC DEPENDENT SURVEILLANCE

JAMES H. ROME and VENKATARAMA KRISHNAN (Lowell, University, MA) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 353-365. Research supported by DOT. refs

With the advent of automatic dependent surveillance (ADS), a detailed model of aircraft crosstrack deviations is required to determine the impact of ADS. The authors present a suitable probability model which is amenable to extrapolation. Normal navigation, degradation, pilot blunders, and failures are characterized by Gaussian density functions with associated standard deviations defined by the physics of the event. The overall model is a weighted sum of these Gaussian error probabilities. Overlap and encroachment probabilities are derived, and the impact of ADS on this model determined. It is shown that, by using the simplest form of ADS, the separation standards can be reduced and in addition, by transmitting a figure of merit (FOM) providing information on failures and degradations, the separation standards can be further reduced. The results suggest an improvement by a factor of two over current separation standards.

A89-26740

A KALMAN FILTER FOR AN INTEGRATED DOPPLER/GPS NAVIGATION SYSTEM

ALAN M. SCHNEIDER (California, University, La Jolla) and JAMES L. MAIDA (Teledyne Ryan Electronics, San Diego, CA) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 408-415.

A Kalman filter has been designed to integrate a Doppler radar navigation system with a GPS (Global Positioning System) system. The filter uses eight states for flights over land, and ten over water. Simulation data shows navigation errors of 1 m or less on each axis under good operating conditions. The performance is equivalent in position error to the standard standalone GPS filter in straight and level flight, and superior in maneuvering flight under dynamic conditions. The filter implementation was also designed to provide additional improvement in the performance of a Doppler navigation system. The results demonstrate that this capability was achieved. I.E.

A89-26741

THE HONEYWELL/DND HELICOPTER INTEGRATED NAVIGATION SYSTEM (HINS)

G. WEST-VUKOVICH, J. ZYWIEL, B. SCHERZINGER (Honeywell, Ltd., Advanced Technology Centre, Markham, Canada), H. RUSSELL, and S. BURKE (DND, Ottawa, Canada) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 416-425.

HINS, a prototype of a high-performance, fault tolerant navigation system is currently being developed for Canada's antisubmarine warfare helicopter. HINS consists of three primary navigation subsystems (an F3 INS (inertial navigation system), a five channel P-code GPS (Global Positioning System), and a Doppler velocity sensor) and three secondary sensors (a strapdown magnetometer, a vertical gyro, and an air data system). The system is designed to blend the complementary strengths of component sensors, and to provide graceful degradation of performance in the event of failure or slow deterioration of these sensors. During normal operation, the Doppler and secondary sensors are calibrated to enhance performance during degraded mode operation. A multilevel failure detection and isolation scheme monitors sensor health and identifies faulty system components. I.E.

A89-28183

THE EMERGENCE OF SATELLITE COMMUNICATION FOR COMMERCIAL AIRCRAFT

GEORGE A. COBLEY (Rockwell International Corp., Avionics Group, Cedar Rapids, IA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 9 p. refs (SAE PAPER 881370)

A view of the emerging aeronautical use of geosynchronous relay satellites is presented. This brings to commercial aircraft the first new communications system in over forty years. The new system will provide reliable long range communications to support the needs of airlines, flight crews, air traffic control, and passengers. The various implementations will be explored along with their parameters and operating characteristics. The potential for spectrum saturation will also be examined. Author

A89-28292#

THE INTEGRATION OF EUROPEAN FLIGHT-SAFETY SYSTEMS [ZUR INTEGRATION EUROPAEISCHER FLUGSICHERUNGSSYSTEME]

HANSJUERGEN VON VILLIEZ (Eurocontrol, Maastricht, Netherlands) Ortung und Navigation (ISSN 0474-7550), vol. 29, no. 3, 1988, p. 317-329. In German.

Ongoing efforts to increase the efficiency of European ATC services by improving international coordination and cooperation are reviewed, with a focus on technological aspects of an experimental project being undertaken by the FRG, the Benelux countries, and the European agency Eurocontrol. The problems posed by continually increasing air traffic are discussed; the radar network for the experimental system and the scheme devised to exchange radar data are described; and a number of typical control screens and messages are displayed. Also stressed is the need for more and better-qualified ATC personnel. T.K.

A89-28293#

LIRAS - A PROPOSAL FOR AN AIRPORT TRAFFIC SAFETY SYSTEM [LIRAS - EIN VORSCHLAG FUER EIN FLUGPLATZ-VERKEHRS-SICHERUNGS-SYSTEM]

WOLFGANG KOERNER (AEG AG, Ulm, Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), vol. 29, no. 3, 1988, p. 331-342. In German.

The design concept and operation of LIRAS, a linear radar system for monitoring aircraft and service-vehicle traffic on airport runways, are discussed and illustrated with extensive drawings, diagrams, and photographs. Consideration is given to the AVES-type (60-GHz CW) surveillance radar sensors and their placement, the 80-GHz FM/CW vehicle-separation radars, takeoff-runway security procedures, the ground-traffic control center and its computer systems, and vehicle identification methods.

T.K.

A89-28296#

GPS ANTENNAS FOR CIVIL AVIATION [GPS-ANTENNEN FUER DIE ZIVILE LUFTFAHRT]

H. FUELBER (Deutsche Lufthansa, Hamburg, Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), vol. 29, no. 3, 1988, p. 421-430. In German.

The design and performance of Navstar-GPS receivers for use in civil transport aircraft are discussed, with a focus on antennas. Topics addressed include the hybrid system proposed for the B737, B747, B757, and B767 aircraft; stand-alone GPS receivers; mechanical criteria for antenna designs; and nominal performance requirements. The requirements call for gains of over -1, -2.5,

-4.5, and -7.5 dBiC at elevation angles over 15, over 10, over 5, and zero degrees, respectively. Diagrams, drawings, and flow charts are provided.

A89-28297#

GPS ANTENNA PROBLEMS FOR MILITARY AIRCRAFT PROBLEMATIK DER GPS-ANTENNEN AN MILITAERISCHEN FLUGZEUGEN

NORBERT BRIESSMANN (Wehrtechnische Dienststelle fuer Luftfahrzeuge, Manching, Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), vol. 29, no. 3, 1988, p. 431-433. In German.

The design and performance requirements imposed on GPS antennas for military aircraft use are discussed. Consideration is given to aircraft dynamics, simultaneous reception of two frequencies, and available antenna locations. It is concluded that a military GPS antenna should (1) obtain zero points with more than 25 dB of damping, even under dynamic conditions and while receiving up to five interference signals; (2) track zero points with at least 300 deg/sec about each rotation axis; (3) track even when interference amplitude varies rapidly; (4) perform beam steering toward the satellite; and (5) have small physical surface area and thickness. ТΚ

A89-28298#

AN ANTENNA FOR THE GPS INSTALLATION AT DFVLR [ANTENNE FUER DIE GPS-ANLAGE DER DFVLR]

S. HODABBAR (DFVLR, Oberpfaffenhofen, Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), vol. 29, no. 3, 1988, p. 442-447. In German.

The design concept, realization, and performance of the GPS receiver antenna installed at DFVLR Oberpfaffenhofen are presented in extensive drawings and diagrams and briefly characterized. The antenna comprises a disk of diameter 2/3 lambda, six conducting rods, a double-Archimedean-spiral radiator of diameter 2 lambda, and a resonance cavity. The maximal antenna-pattern expansion obtainable with this configuration is half-width 140 deg, with right circular polarization, low reflection and spurious radiation, horizontal radiation level -6 dB below maximum, and gain 0 dB. For a typical satellite passage, reception begins as the satellite is about 18 deg above one horizon and continues until it is 25 deg above the other horizon. T.K.

A89-28299#

A GPS RECEIVER ANTENNA WITH INTEGRATED DOWN-MIXER [EINE GPS-EMPFANGSANTENNE MIT INTEGRIERTEM ABWAERTSMISCHER]

KLAUS LOHSE (FUBA, Hans Kolbe und Co., Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), vol. 29, no. 3, 1988, p. 448-454. In German.

The design and performance of a prototype GPS receiver unit comprising antenna, preamplifier, mixer, and IF section are described and illustrated with diagrams and graphs. The antenna is a conical double logarithmic spiral, and the preamplifier is equipped with a band-pass filter especially designed to eliminate interference from a nearby Inmarsat antenna. The prototype receiver has been successfully tested in stationary installations and in land vehicles, ships, and aircraft; a significantly more compact version with a planar antenna is under development.

ТΚ

N89-17586 Bundesanstalt fuer Flugsicherung, Frankfurt am Main (Germany, F.R.).

ACTIVITIES REPORT IN AIR TRAFFIC CONTROL Annual Report, 1987 [JAHRESBERICHT 1987]

Jul. 1988 52 p In GERMAN

(ETN-89-93513) Avail: Fachinformationszentrum Karlsruhe, 7514 Eggenstein-Leopoldshafen 2, Federal Republic of Germany

Measures taken to improve to safety and regularity of air traffic in West Germany are outlined. Navigation and radiotelephone techniques; information transmission techniques; radar techniques, information techniques; and maintenance of data processing systems are discussed. ESA

N89-17587# Sandia National Labs., Albuquerque, NM. ADVANCED FIGHTER TECHNOLOGY INTEGRATION/SANDIA **INERTIAL TERRAIN-AIDED NAVIGATION (AFTI/SITAN) Final** Report

J. RICK FELLERHOFF Nov. 1988 250 p (Contract DE-AC04-76DP-00789)

(DE89-004000; SAND-88-1325) Avail: NTIS HC A07/MF A01 Sandia Inertial Terrain-Aided Navigation (SITAN) provides continuous position fixes to an Inertial Navigation System (INS) by real-time comparison of radar altimeter ground clearance measurements with stored digital terrain elevation data (DTED). This is accomplished by using an extended Kalman filter algorithm to estimate the errors in the reference trajectory provided by an INS. In this report, Sandia National Laboratories documents the results of a reimbursable effort funded by the Air Force Wright Aeronautical Laboratories (AFWAL) Avionics Laboratory to flight test SITAN as implemented onboard the Advanced Fighter Technology Integration (AFTI)F-16. DOE

N89-17588# Naval Postgraduate School, Monterey, CA. AN EVALUATION OF AUTOMATING CARRIER AIR TRAFFIC CONTROL CENTER (CATCC) STATUS BOARDS UTILIZING VOICE RECOGNITION INPUT M.S. Thesis

ROBERT D. JENSEN and JOHN J. SPEGELE Jun. 1988 177 p. (AD-A200626) Avail: NTIS HC A09/MF A01 CSCL 25D

Conducting safe flight operations from aircraft carriers requires accurate and timely dissemination of aircraft status information from the Carrier Air Traffic Control Center (CATCC). Presently, the information is manually displayed on status boards throughout the ship by a network of sailors communicating via sound-powered microphones. A prototype, connected speech-based system, developed by the Naval Ocean Systems Command (NOSC), was evaluated. Specific evaluation criteria were the hardware, software and the man-machine interface. The use of connected speech as an input modality across varying noise and syntactic conditions was experimentally tested. The result of this research was the proposal of guidelines for designing connected speech syntaxes and specific recommendations for future prototype development efforts. GRA

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A89-24919

NUMERICAL AND EXPERIMENTAL STUDY OF THE CRASH BEHAVIOR OF HELICOPTERS AND FIXED-WING AIRCRAFT ETUDE NUMERIQUE ET EXPERIMENTALE DU COMPORTEMENT AU CRASH DES HELICOPTERES ET DES **AVIONS**

F. DUPRIEZ, P. GEOFFROY, J.-L. PETITNIOT, and T. VOHY (ONERA, Lille, France) (NATO, AGARD, Meeting on Aircraft Structural Crash Worthiness, Luxembourg, May 2-5, 1988) L'Aeronautique et l'Astronautique (ISSN 0001-9275), no. 133, 1988, p. 54-72. In French. refs

The crash behavior of helicopters and fixed-wing aircraft has been studied numerically by the FEM and experimentally using representative models. Experimental results obtained with a falling autorating helicopter model have been compared with full-scale testing results. An experimental study of the landing of a light aircraft on soft ground is discussed. Elastoplastic bending results and data on the crushing of metallic structures have been applied to the numerical study of a commercial aircraft substructure.

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

A89-25009#

SCISSOR WING - AN ALTERNATIVE TO VARIABLE SWEEP

KAMRAN ROKHSAZ and BRUCE P. SELBERG (Missouri-Rolla, University, Rolla) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 p. refs

(AIAA PAPER 89-0013)

A scissor wing geometry is introduced as an alternative to variable sweep and oblique wing designs. It is shown that this configuration offers certain enhancements to the stability and control of the aircraft, in additon to aerodynamic advantages. It is shown that a scissor wing configuration can maintain a constant static margin throughout its flight Mach numbers. The dependence of the motion of the aircraft neutral point on the sweep angle is shown as a function of the chord and span ratios. It is also demonstrated that with the use of wing mounted elevons, additional pitch and attitude control can be obtained over a range of sweep angles. Author

A89-25041#

LATERAL OSCILLATIONS OF STING-MOUNTED MODELS AT HIGH ALPHA

L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs

(AIAA PAPER 89-0047)

An analysis is performed showing that, in a static test of a model of a high performance aircraft or missile, lateral oscillations can occur, resulting in static, time-average measurements of the asymmetric loads that are close to zero. In contrast, the loads needed for analysis of full scale aircraft or missile maneuvers are the maximum possible instantaneous asymmetric loads. In contrast to the in-plane oscillations due to sting plunging, corrections for the lateral oscillations cannot be made. The only remedy is to perform the subscale test with a support system that can provide coning and/or rolling motions, as in the case of a rotary rig.

Author

A89-25081#

CFD IN DESIGN - AN AIRFRAME PERSPECTIVE

MARK I. GOLDHAMMER and PAUL E. RUBBERT (Boeing Commercial Airplanes, Seattle, WA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs (AIAA PAPER 89-0092)

CFD has provided a dramatic change in the techniques used for the aerodynamic design of airframes. This paper discusses the impact CFD has had at Boeing on aerodynamic design, testing, and evaluation of commercial aircraft. The evolution of CFD methods, from mathematical formulations to practical engineering tools, is also discussed. Examples of recent CFD implementation at Boeing are shown. The impact of CFD on testing is analyzed. Finally, the future direction of CFD research is discussed. Author

A89-25106*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A PATCHED-GRID ALGORITHM FOR COMPLEX CONFIGURATIONS DIRECTED TOWARDS THE F-18 AIRCRAFT

JAMES L. THOMAS, ROBERT P. WESTON, JAMES M. LUCKRING (NASA, Langley Research Center, Hampton, VA), ROBERT W. WALTERS, TAEKYU REU (Virginia Polytechnic Institute and State University, Blacksburg), and FARHAD GHAFFARI (Vigyan Research Associates, Inc., Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 18 p. refs (Contract NAG1-866; NAS1-17919)

(AIAA PAPER 89-0121)

A patched-grid algorithm for the analysis of complex configurations with an implicit, upwind-biased Navier-Stokes solver is presented. Results from both a spatial-flux and a time-flux conservation approach to patching across zonal boundaries are presented. A generalized coordinate transformation with a biquadratic geometric element is used at the zonal interface in order to treat highly stretched viscous grids and arbitrarily-shaped zonal boundaries. Applications are made to the F-18 forebody-strake configuration at subsonic, high-alpha conditions. Computed surface flow patterns compare well with ground-based and flight-test results; the large effect of Reynolds number on the forebody flowfield is shown.

A89-25158#

THERMAL-ENERGY MANAGEMENT FOR AIR BREATHING HYPER-VELOCITY VEHICLES

L. J. COULTER, R. W. BASS (United Technologies Research Center, East Hartford, CT), and R. C. ERNST (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs

(AIAA PAPER 89-0183)

Air-breathing hyper-velocity vehicles require integration of all systems to a greater than any previous aircraft. The thermal-energy management system, relatively simple in existing aircraft, will have to tolerate high heat loads, high heat fluxes and high temperatures and at the same time utilize the fuel as the heat sink for all vehicle waste heat. A methodology is presented which examines the tradeoffs necessary to define a thermal-energy management system which acts in concert with the propulsion system to provide a thermally balanced vehicle for the entire mission. The methodology permits consideration of both external and internal heat loads as well as thermal interface systems. The impact on engine thrust due to non-ideal fuel preheat is discussed as are the remedies available to the designer to modify the thermal-energy management system to ensure a thermally balanced vehicle. Finally, a six step procedure is given which summarizes the key Author elements of the methodology.

A89-25221*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

TRANAIR AND EULER COMPUTATIONS OF A GENERIC FIGHTER INCLUDING COMPARISONS WITH EXPERIMENTAL DATA

AGA M. GOODSELL, MICHAEL D. MADSON, and JOHN E. MELTON (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 26 p. refs

(AIÀA PAPER 89-0263)

The TranAir full-potential code and the FLO57 Euler code were used to calculate transonic flow solutions over two configurations of a generic fighter model. The results were computed at Mach numbers of 0.60 and 0.80 for angles of attack between 0 and 12 deg for TranAir and between 4 and 20 deg for FLO57. Due to the fact that TranAir solves the full-potential equations for transonic flow, TranAir is only accurate to about alpha = 8 deg, at which point the experimental results show the formation of a vortex at the leading edge. Euler results show good agreement with experimental results until vortex breakdown occurs in the solutions. K.K.

A89-25236*# Lockheed Missiles and Space Co., Huntsville, AL. COMPUTATION OF TURBULENT INCOMPRESSIBLE WING-BODY JUNCTION FLOW

R. W. BURKE (Lockheed Missiles and Space Co., Inc., Huntsville, AL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan.

9-12, 1989. 14 p. refs (Contract NAS8-37359)

(AIAA PAPER 89-0279)

A three-dimensional incompressible Reynolds-averaged Navier-Stokes solver is presently used in conjunction with a mixing-length turbulence model to characterize the flow around a wing that is mounted on a flat plate, in a wind tunnel, as well as the flow around a support strut within a turnaround duct. Good agreement is found between predicted and observed values of flat-plate static pressure, horseshoe vortex system size, and mean flow velocities in the case of the wing; the case of the strut in a duct is noted to exhibit many of the same overall flow features as the wing/plate. O.C.

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

A89-25320#

RECOVERABLE TEST VEHICLE, AN INNOVATIVE APPROACH TO A LOW COST COMPOSITE AIRFRAME FOR AEROSPACE APPLICATION

THOMAS W. SKELLY (Aerocet, Inc., Arlington, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 6 p. refs

(AIAA PAPER 89-0378)

The Recoverable Test Vehicle (RTV), which is being procured by the US Naval Weapons Center, is a low cost re-useable alternative to expensive flight test platforms that have historically been used for development of weapons delivery systems. An innovative approach using commercially available composite materials was developed to meet the requirements for vehicle ruggedness, re-useability and low cost. Although used for years in commercial products and noncritical aerospace applications, the RTV represents the first successful use of these materials as primary structure for a high speed flight test vehicle. This paper presents an overview of the RTV structural design which capitalizes on these composite materials. Also presented in this paper is an innovative approach to fabricating the RTV wing, fin and elevons. Author

A89-25429*# Purdue Univ., West Lafayette, IN. PROPELLER/WING INTERACTION

DAVID P. WITKOWSKI, ROBERT T. JOHNSTON, and JOHN P. SULLIVAN (Purdue University, West Lafayette, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs

(Contract NSG-3134)

(AIAA PAPER 89-0535)

The present experimental investigation of the steady-state and unsteady-state effects due to the interaction between a tractor propeller's wake and a wing employs, in the steady case, wind tunnel measurements at low subsonic speed; results are obtained which demonstrate wing performance response to variations in configuration geometry. Other steady-state results involve the propeller-hub lift and side-force due to the wing's influence on the propeller. The unsteady effects of interaction were studied through flow visualization of propeller-tip vortex distortion over a wing, again using a tractor-propeller configuration. O.C.

A89-25449#

A TRANSONIC COMPUTATIONAL METHOD FOR AN AFT-MOUNTED NACELLE/PYLON CONFIGURATION WITH PROPELLER POWER EFFECT

L. T. CHEN, K. C. YU, and T. Q. DANG (Douglas Aircraft Co., Aerodynamics Research and Technology Group, Long Beach, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs

(AIAA PAPER 89-0560)

A computation method for determining transonic flows about an aft-fuselage mounted capped-nacelle/pylon configuration with and without propeller power is presented. A hybrid conformal-mapping/transfinite-interpolation scheme is used to generate body conforming grid systems, and a multigrid line-relaxation scheme is used to solve the potential flowfield. Special attention is given to the importance of the fuselage boundary-layer effect on the pylon pressure distribution. Results compare well to available test data and to the solutions of a panel method. R.R.

A89-25506#

FEASIBILITY STUDY ON THE DESIGN OF A LAMINAR FLOW NACELLE

R. RADESPIEL, K. H. HORSTMANN, and G. REDEKER (DFVLR, Institut fuer Entwurfsaerodynamik, Brunswick, Federal Republic of Germany) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 12 p. refs

(AIAA PAPER 89-0640)

This paper describes the design of a laminar flow nacelle. By means of natural laminar flow, e.g., nacelle contouring, laminar boundary layers on the nacelle surface can be maintained up to 60 percent of the nacelle length at cruise flight conditions. As well at take-off and landing conditions the inlet flow and the outside flow is free of flow separation. The overall drag coefficient of an aircraft equipped with two laminar flow nacelles is estimated to be reduced at cruise flight by Delta c(D) of about 0.0011. Author

A89-25509*# West Virginia Univ., Morgantown. COMPUTATIONAL DESIGN OF LOW ASPECT RATIO WING-WINGLETS FOR TRANSONIC WIND-TUNNEL TESTING

JOHN M. KUHLMAN and CHRISTOPHER K. BROWN (West Virginia University, Morgantown) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. Previously announced in STAR as N88-24630. refs (Contract NAG1-625)

(AIAA PAPER 89-0644)

A computational design has been performed for three different low aspect ratio wing planforms fitted with nonplanar winglets; one of the three planforms has been selected to be constructed as a wind tunnel model for testing in the NASA LaRC 7 x 10 High Speed Wind Tunnel. A design point of M = 0.8, CL approx = 0.3 was selected, for wings of aspect ratio equal to 2.2, and leading edge sweep angles of 45 and 50 deg. Winglet length is 15 percent of the wing semispan, with a cant angle of 15 deg, and a leading edge sweep of 50 deg. Winglet total area equals 2.25 percent of the wing reference area. This report summarizes the design process and the predicted transonic performance for each configuration.

A89-25565*# Toledo Univ., OH. THERMAL ANALYSIS OF ENGINE INLET ANTI-ICING SYSTEMS

THEO G. KEITH, JR., KENNETH J. DE WITT (Toledo, University, OH), JAMES K. NATHMAN (Analytical Methods, Inc., Redmond, WA), DONALD A. DIETRICH (General Electric Co., Cincinnati, OH), and KAMEL M. AL-KHALIL AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. Research sponsored by the General Electric Co. and NASA. refs (AIAA PAPER 89-0759)

A hot air anti-icing system of a gas turbine engine inlet is analyzed numerically. A three-dimensional potential flow code, which accounts for compressibility effects, is used to determine the flowfield in and around the inlet. A particle trajectory code is developed using a local linearization technique. The trajectory code is used to calculate local water impingement rates. Energy balances are performed on both the surface runback water and the metallic skin to determine their temperature distributions. A variety of test cases are considered in order to validate the various numerical components of the process as well as to demonstrate the procedure. Author

A89-25571*# DISTRIBUTED ICE ACCRETION SENSOR FOR SMART AIRCRAFT STRUCTURES

J. J. GERARDI and G. A. HICKMAN (Innovative Dynamics, Ithaca, NY) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs

(Contract NAS3-25200)

(AIAA PAPER 89-0772)

A distributed ice accretion sensor is presented, based on the concept of smart structures. Ice accretion is determined using spectral techniques to process signals from piezoelectric sensors integral to the airfoil skin. Frequency shifts in the leading edge structural skin modes are correlated to ice thickness. It is suggested that this method may be used to detect ice over large areas with minimal hardware. Results are presented from preliminary tests to measure simulated ice growth. R.B.

A89-25572#

DEVELOPMENTS IN EXPULSIVE SEPARATION ICE PROTECTION BLANKETS

JOSHUA GOLDBERG and BENJAMIN LARDIERE, JR. (Data Products New England Aerospace, Wallingford, CT) AIAA,

Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 6 p. refs

(AIAA PAPER 89-0774)

The paper discusses two specific improvements to the expulsive blankets described in NASA's original patent. Quantitative discussion which suggests criteria for efficient expulsive blanket design are given. Wind tunnel and laboratory data are provided to substantiate the criteria given. A few speculations based on limited current data are offered on the mechanism of ice shedding in efficient blankets. Author

A89-25605#

THE EFFECTS OF AFT-LOADED AIRFOILS ON AIRCRAFT TRIM DRAG

ROBERT ENDE AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(AIAA PAPER 89-0836)

The effects of aft-loaded airfoils on aircraft trim drag were studied for a High-Altitude, Long-Endurance (HALE) vehicle. A family of high-lift airfoil drag polars with varying pitching moments were designed, and a computer program was developed to calculate the lift distribution between the wing and tail and the trim drag and total drag for a typical HALE configuration at various altitudes and velocities, allowing for changes in airfoil properties and static margin. It was found that aft-loading trim drag and total drag for the dash condition did not vary significantly over the range of pitching moment coefficients from -0.15 to -0.22, and actually reached minimum values at some point in that range, depending on static margin. Aft-loading also improved maximum dash speed.

A89-26950#

AIRCRAFT LANDING GEAR DESIGN: PRINCIPLES AND PRACTICES

NORMAN S. CURREY (Lockheed Aeronautical Systems Co., Marietta, GA) Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1988, 383 p. refs

The present guide to design practices in the field of aircraft landing gears considers the entire range of historical experience for all sizes and types of military and commercial aircraft. After discussing the design process and the various performance requirements that must be met by the different elements and functions of typical landing gears, Attention is given to the detailed design of shock absorbers, tires, braking and skid-control practices, and the kinematics of landing gears. Also discussed are steering systems, detailed mechanical design, weight estimation methods, airfield surface and dimension considerations, and unorthodox landing gear designs and their comparative performance. O.C.

A89-27613* Sparta, Inc., Laguna Hills, CA.

THE DEVELOPMENT OF AN AUTOMATED FLIGHT TEST MANAGEMENT SYSTEM FOR FLIGHT TEST PLANNING AND MONITORING

MARLE D. HEWETT, DAVID M. TARTT (Sparta, Inc., Laguna Hills, CA), EUGENE L. DUKE, ROBERT F. ANTONIEWICZ (NASA, Flight Research Center, Edwards, CA), RANDAL W. BRUMBAUGH (PRC Kentron, Inc., Edwards, CA) et al. IN: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 1. Tullahoma, TN, University of Tennessee, 1988, p. 324-333. refs

The development of an automated flight test management system (ATMS) as a component of a rapid-prototyping flight research facility for Al-based flight systems concepts is described. The rapid-prototyping facility includes real-time high-fidelity simulators, numeric and symbolic processors, and highperformance research aircraft modified to accept commands for a ground-based remotely augmented vehicle facility. The flight system configuration of the ATMS includes three computers: the TI explorer LX and two GOULD SEL 32/27s. K.K.

A89-27695*# Georgia Inst. of Tech., Atlanta. ANALYSIS OF STRUCTURES WITH ROTATING, FLEXIBLE SUBSTRUCTURES APPLIED TO ROTORCRAFT AEROELASTICITY

DEWEY H. HODGES (Gerorgia Institute of Technology, Atlanta), A. STEWART HOPKINS, and DONALD L. KUNZ (NASA, Ames Research Center, Moffett Field, CA) (Structures, Structural Dynamics and Materials Conference, 28th, Monterey, CA, Apr. 6-8, 1987 and AIAA Dynamics Specialists Conference, Monterey, CA, Apr. 9, 10, 1987, Technical Papers. Part 2B, p. 955-965) AIAA Journal (ISSN 0001-1452), vol. 27, Feb. 1989, p. 192-200. Research supported by Georgia Institute of Technology. Previously cited in issue 14, p. 2106, Accession no. A87-33748. refs

A89-27735#

WING ROCK GENERATED BY FOREBODY VORTICES

L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 110-116. Previously cited in issue 08, p. 1048, Accession no. A87-22523. refs (Contract F33615-87-C-3607)

A89-27738*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

UNSTEADY TRANSONIC ALGORITHM IMPROVEMENTS FOR REALISTIC AIRCRAFT APPLICATIONS

JOHN T. BATINA (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 131-139. Previously cited in issue 07, p. 946, Accession no. A88-22075. refs

A89-27740*# Pennsylvania State Univ., University Park. DESIGN AND EXPERIMENTAL RESULTS FOR A HIGH-ALTITUDE, LONG-ENDURANCE AIRFOIL

MARK D. MAUGHMER (Pennsylvania State University, University Park) and DAN M. SOMERS (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 148-153. Previously cited in issue 21, p. 3347, Accession no. A87-49105. refs

A89-27747#

SOME IMPLICATIONS OF WARPING RESTRAINT ON THE BEHAVIOR OF COMPOSITE ANISOTROPIC BEAMS

GABRIEL A. OYIBO (Polytechnic University, Farmingdale, NY) (Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2, p. 664-671) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 187-189. Previously cited in issue 18, p. 2611, Accession no. A86-38947. refs

(Contract F49620-85-C-0090; F49620-87-C-0046)

A89-27808

IMPROVED RELIABILITY AND MAINTAINABILITY FOR FIGHTER AIRCRAFT ENVIRONMENTAL CONTROL SYSTEMS

RICHARD R. DIECKMANN (McDonnell Aircraft Co., Saint Louis, MO) SAE, Intersociety Conference on Environmental Systems, 18th, San Francisco, CA, July 11-13, 1988. 11 p. Research sponsored by USAF. refs

(SAE PAPER 880999)

Environmental Control System (ECS) features to improve reliability and to reduce maintenance of fighter aircraft are presented. The features are intended to overcome supportability problems of current fighter aircraft ECS, and to reduce supportability requirements for ECS designs in future aircraft. They have the potential to achieve very significant reductions in failure rates, maintenance, and logistics support for fighter aircraft ECS. Two features offer the highest reliability and maintainability improvements. These are use of digital ECS controls integrated with an aircraft maintenance management system, and the use of more rugged bleed air components to reduce maintenance and logistic support. If these and other improvements are installed, ECS downtime can be reduced by 79 percent from that of the best in current fighter aircraft. Author

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

A89-27809

A DYNAMIC MODEL FOR VAPOR-CYCLE COOLING SYSTEMS JOHN F. DEFENBAUGH, WILLIAM S. HEGLUND, and ALBERT L. MARKUNAS (Sundstrand Corp., Sundstrand Advanced Technology Group, Rockford, IL) SAE, Intersociety Conference on Environmental Systems, 18th, San Francisco, CA, July 11-13, 1988. 12 p. refs (SAE PAPER 881001)

A dynamic simulation model has been developed for a vapor-cycle cooling system designed for aircraft environmental control applications. The dynamic models will reduce the risks associated with development and the costs associated with control development on the test stand. The heat exchanger is modeled using multiple-, lumped-parameter, fixed-length elements based on coupled thermal and mass storage effects, and flow equations that incorporate the effects of thermal expansion and contraction. The system requires the modeling of a two-phase binary refrigerant mixture heat exchange process using nonazeotropic refrigerants. The mathematical model for each heat exchange system component is implemented in a FORTRAN subroutine using pressure and enthalpy as the independent thermodynamic variables. The simulation is developed with modular components with causality defined to minimize connection states and, thus, execution time. S.A.V.

A89-27925

DESIGN OF AN ALL BORON/EPOXY DOUBLER REINFORCEMENT FOR THE F-111C WING PIVOT FITTING -STRUCTURAL ASPECTS

L. MOLENT, R. J. CALLINAN, and R. JONES (Department of Aeronautical Research Laboratories, Defence. Melbourne. Composite Structures (ISSN 0263-8223), vol. 11, no. Australia) 1, 1989, p. 57-83. refs

This paper presents an overview of the structural aspects of the design and development of a local reinforcement designed to lower the stresses in a region of the F-111C wing pivot fitting which is prone to cracking. The stress analysis, representative specimen testing, thermal analysis and aspects of the full-scale static testing of this design are summarized. Author

National Aeronautics and Space Administration. A89-28176* Langley Research Center, Hampton, VA.

FORE-AND-AFT STIFFNESS AND DAMPING

CHARACTERISTICS OF 30 X 11.5-14.5, TYPE VIII, BIAS-PLY AND RADIAL-BELTED AIRCRAFT TIRES

MERCEDES C. LOPEZ, PAMELA A. DAVIS, ROBERT B. YEATON (NASA, Langley Research Center, Hampton, VA), and WILLIAM A. VOGLER (PRC Systems Services, Hampton, VA) SAE. Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 8 p. refs (SAE PAPER 881357)

Measurements of footprint geometrical properties and fore and aft stiffness and damping characteristics were obtained on 30 x 11.5-14.5 bias-ply and radial-belted aircraft tires. Significant differences in stiffness and damping characteristics were found between the two design types. The results show that footprint aspect ratio effects may interfere with the improved hydroplaning potential associated with the radial-belted tire operating at higher inflation pressures. Ř.R.

A89-28177* Michigan Univ., Ann Arbor. PROPERTIES OF AIRCRAFT TIRE MATERIALS

RICHARD N. DODGE and SAMUEL K. CLARK (Michigan, University, Ann Arbor) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 8 p. (Contract NSG-1607)

(SAE PAPER 881358)

A summary is presented of measured elastomeric composite response suitable for linear structural and thermoelastic analysis in aircraft tires. Both real and loss properties are presented for a variety of operating conditions including the effects of temperature and frequency. Suitable micro-mechanics models are used for

predictions of these properties for other material combinations and the applicability of laminate theory is discussed relative to measured values. Author

A89-28178

COMPARATIVE TESTS OF AIRCRAFT RADIAL AND BIAS PLY TIRES

STEPHEN N. BOBO (DOT, Transportation Systems Center, Cambridge, MA), RICHARD A. JOHNSON (FAA, Technical Center, Atlantic City, NJ), and PAUL C. DURUP (Lockheed Corp., Burbank, CA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 12 p. (SAE PAPER 881359)

Laboratory dynamometer tests are being conducted to assess the difference in performance between radial and bias ply tires, both new and retreaded, of various sizes and manufacturers. Tire properties that affect the operation and safety of landing gear systems such as temperature performance, cornering power, dynamic loaded radius and wheel stresses are being compared. The tests are described along with some initial findings. Author

A89-28194

PERFORMANCE TESTING OF AN ELECTRICALLY ACTUATED AIRCRAFT BRAKING SYSTEM

DOUGLAS D. MOSELEY (Loral Corp., Loral Aircraft Braking Systems Div., Akron, OH) and THOMAS J. CARTER (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 34 p.

(SAE PAPER 881399)

The concept of utilizing an electrically actuated aircraft braking system could result is greater fire safety, the elimination of centralized hydraulics, and compatibility with an all-electric aircraft. Using the Air Force A-10 as a test bed, the first fully functional electric brake was laboratory tested, qualified, and installed on an aircraft for testing. On-aircraft testing was curtailed due to a dynamic instability between the brake and landing gear. An extensive laboratory dynamometer test program was substituted. The prototype electric brake demonstrated performance nearly equivalent to the production hydraulic brake with a potential for more accurate torque control. Author

A89-28206* Lockheed Aeronautical Systems Co., Burbank, CA. CONCEPTUAL DESIGN OF A STOVL FIGHTER/ATTACK AIRCRAFT

Y. T. CHIN (Lockheed Aeronautical Systems Co., Burbank, CA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 12 p. Research sponsored by NASA. refs (SAE PAPER 881431)

STOVL aircraft offer unique basing and operational advantages to improve the capabilities of military forces in future warfare. To develop a STOVL fighter design with supersonic capability requires the integration of an advanced propulsion system into the airframe design. A promising propulsion system for supersonic STOVL application is the relatively new Hybrid Fan Vectored Thrust (HFVT) concept. This advanced tandem fan concept incorporates a dual-cycle engine with front and rear fully vectorable nozzles of the three-poster type, to provide the required performance. In this paper, the HFVT STOVL design integration approaches for a conceptual fighter/attack aircraft, as well as some features of the resulting design, will be presented. Author

A89-28207

CONSIDERATIONS OF CONTROL AUTHORITY REQUIREMENTS IN STOVL PROPULSION SYSTEM SIZING

H. P. LEE, Y. T. CHIN, and G. L. HERSTINE (Lockheed Aeronautical Systems Co., Burbank, CA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 8 p. (SAE PAPER 881432)

The total control authority available to pilots of STOVL aircraft during very low speed and hovering flight must be sufficient to trim the aircraft, maneuver in all axes, suppress such external disturbances as winds and gusts, and counter such environmental changes as hot exhaust gas reingestion and suckdown. In addition, it must be possible to compensate for asymmetric weapons loading and furnish automatic stability augmentation when required. The effects of these requirements on the sizing of the reaction control system and the propulsion system will be illustrated for the case of a single-seat/single-engine STOVL military aircraft configuration with 42,000 lb TOGW. O.C.

A89-28208

THE CURRENT STATUS OF THE FLIGHT TEST OF THE ASKA NORIAKI OKADA, KAZUYA MASUI, HIROYUKI YAMATO (National Aerospace Laboratory, Gifu, Japan), MASAMICHI KURIYAMA, and YOSHINARI TOBINAGA (Kawasaki Heavy Industries, Ltd., Kagamigahara, Japan) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 17 p. refs (SAE PAPER 881433)

The design and current status of ASKA, a four-engine experimental STOL aircraft being developed by the Japanese National Aerospace Laboratory on the basis of the upper-surface blowing concept, are discussed. Data from flight tests on the landing performance are presented in extensive tables and graphs, and drawings and photographs are provided. Particular attention is given to airspeed and angle-of-attack measurements, lift/drag performance and powered-lift characteristics, the pitching moment of the powered-lift aircraft, the tail-load measurement system, and ground effects. T.K.

A89-28252#

SPANLOAD OPTIMIZATION FOR STRENGTH DESIGNED LIFTING SURFACES

ANTHONY P. CRAIG and J. DOUGLAS MCLEAN (Boeing Commercial Airplanes, Seattle, WA) AIAA, Applied Aerodynamics Conference, 6th, Williamsburg, VA, June 6-8, 1988. 8 p. refs (AIAA PAPER 88-2512)

A computer program has been developed that optimizes spanloads with structural weight taken into account. The program optimizes the twist distribution to minimize a combination of wing drag and weight. The wing drag is based on a Trefftz plane induced drag analysis and on an empirical profile drag estimation. The wing weight is based on a simple beam model where weight is based on bending strength design for a critical condition spanload. The program can be used to analyze multiple non-planer lifting surface configurations with realistic constraints such as trim and material limitations.

A89-28255

TOPICS OF AIRCRAFT THERMAL MANAGEMENT

JERRY E. BEAM (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 1-8. refs (SAE PAPER 881381)

Aircraft thermal management issues are reviewed in order to determine areas necessary for additional research. Particular topics discussed include the philosophy of traditional thermal control systems, the avionics cooling problem, and the application of heat pipes to aircraft systems. Avionics cooling includes a summary of current spacecraft cooling that is applicable. Analysis includes results for free convective cooling, forced convective cooling, and nucleate boiling heat transfer for low gravity applications as well as artificial gravity generation. Heat pipe applications are discussed with particular emphasis on the effects of high acceleration and nonuniform heat loads. Author

A89-28256

THE ALL ELECTRIC AIRPLANE REVISITED

MICHAEL J. CRONIN (Lockheed Aeronautical Systems Co., Burbank, CA) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 9-26. refs (SAE PAPER 881407) A development status evaluation is conducted for all-electric military and commercial aircraft power systems in which high-pressure hydraulics are entirely supplanted by electromechanical devices. A significant persistent difficulty is the unwillingness of designers to develop the increased-voltage/ frequency electrical power supplies that are critical to an all-electric system's optimization. Once electrical generators are directly integrated into advanced powerplants, as advocated by AFWAL, all power will be easily suppliable electrically. O.C.

A89-28269

X-29A SUBSYSTEMS INTEGRATION - AN EXAMPLE FOR FUTURE AIRCRAFT

EDWARD COLLINS (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 131-147. refs (SAE PAPER 881504)

An account is given of the method and results of the effort by the X-29A experimental aircraft's designers to integrate five subsystems: these were, respectively, hydraulics, electrical power, emergency power, accessory drive, and environmental controls. Laboratory tests were conducted prior to aircraft installation. Attention is given to the selection rationale used to arrive at the specific off-the-shelf subsystem components employed, the formulation of testing environment requirements, and the configuration of the completed integrated system. O.C.

A89-28350

THE CONTRIBUTION OF PLANFORM AREA TO THE PERFORMANCE OF THE BERP ROTOR

F. J. PERRY (Westland Helicopters, Ltd., Yeovil, England) American Helicopter Society, Journal (ISSN 0002-8711), vol. 34, Jan. 1989, p. 64, 65; Author's Closure, p. 66.

The aerodynamic characteristics of the British Experimental Rotor Programme (BERP) helicopter rotor blade are discussed on the basis of flight test data. Comparisons between the BERP blade and a related tapered blade are presented graphically and briefly characterized. It is shown that the blade planform shape plays a more significant role than the blade profile in the ability of the BERP rotor to sustain high angles of attack prior to stall. The need for a weighted solidity parameter to separate incidence and planform effects in analyzing blade performance is indicated.

T.K.

A89-28456#

ELECTRO-IMPULSE DE-ICING SYSTEMS - ISSUES AND CONCERNS FOR CERTIFICATION

CHARLES O. MASTERS (FAA Technical Center, Atlantic City, NJ) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs

(AIAA 89-0761)

This paper discusses issues and concerns associated with the design, implementation and utilization of an electroimpulse deicing (EIDI) system, as related to aviation safety standards. The guidance/criteria currently being formulated by the FAA for verification of EIDI system performance adequacy and, ultimately, a demonstration of compliance are examined. Also, both the normal voltage and low voltage EIDI ice protection systems for composite and metal airframes are discussed.

N89-16741# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH. Flight Dynamics Lab. **INLET-ENGINE COMPATIBILITY**

LEWIS E. SURBER and CLAY FUJIMARA In VKI, Intake Aerodynamics, Volume 1 32 p 1988

Avail: NTIS HC A15/MF A01

Inlet-engine compatibility is reviewed to show how inlet spatial flow distortion relates to the compatibility problem in turbine-engine powered supersonic fighter aicraft. It is shown that flow distortion is actually experienced as off-design flow incidence by compressor airfoils, but may be characterized and treated as flow field total pressure distortion in the development process. Axial compressor engines respond to time-variant spatial distortion up to the range of the blade passing frequency. Therefore, any accurate compatibility analysis must deal with dynamic distortion. Information is presented to show that accurate distortion parameter values and pressure distortion maps can be produced for low and moderate inlet turbulence levels with as few as eight turbulence measurements. Advanced fighter inlets with compact offset diffusers may experience turbulence levels in the 5 plus percent range where probe-to-probe signal coherence violates the basic premise of statistical analysis. In cases where highly accurate compatibility assessments are required for high turbulence inlet flows, deterministic methods are employed.

N89-16744# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH. Flight Dynamics Lab.

INTAKE-AIRFRAME INTEGRATION

LEWIS E. SURBER In VKI, Intake Aerodynamics, Volume 1 66 p 1988

Avail: NTIS HC A15/MF A01

Intake-airframe integration of tactical aircraft is reviewed. It is shown that the stream flow approaching a side-mounted inlet is substantially distorted by the presence of the fuselage in maneuvering flight. This flow distortion has a generally adverse effect on inlet total pressure recovery and inlet-engine compatibility. Supersonic maneuvering flight can lead to substantial performance degradation in a side-mounted leeward 2-D inlet due to flow separation at the inboard sideplate. Performance degradation in side-mounted half-axisymmetric inlets in supersonic maneuvers results from flow separation in the upper portion of the throat followed by choking of the rest of the throat. Flow field studies show dramatic potential performance advantages for shielding supersonic maneuvering inlets. Fuselage-shielding, however, is the only technique which retains all the advantages for 2-D inlets when alpha/Beta combinations were explored. Half-axisymmetric inlets show substantial performance advantages over 2-D inlets in supersonic wing-shielded flow fields when considering the entire maneuver envelope. Experiments demonstrate limited tailoting of top-mounted inlet flow fields through careful design of wing leading-edge strakes which control the vortex pattern over an aircraft's upper surface. Such designs may be able to facilitate an acceptable inlet environment for limited maneuver conditions.

ESA

N89-16745# British Aerospace Aircraft Group, Preston (England). Military Aircraft Div.

INTAKES FOR HIGH ANGLE OF ATTACK

D. C. LEYLAND *In* VKI, Intake Aerodynamics, Volume 1 26 p 1988

Avail: NTIS HC A15/MF A01

Intake design and location for combat aircraft are reviewed. Experience of operation at moderate angles-of-attack was obtained from testing of models of existing aircraft, to the extent of showing what features and characteristics require investigation. Shielding to provide preturning of entry flow is desirable and the chin location chosen for EAP and EFA proves very effective. Research studies, however, included other locations to determine what can be expected and accepted. The chin intake is not always the best overall configuration choice; it constrains fuselage stores carriage in smaller aircraft and is likely to be unacceptable in STOVL aircraft because of hot gas reingestion. Results from research testing, mostly on fuselage integrated intakes, are given to show what flow changes take place with increasing angle-of-attack and what configuration choices can be made to give acceptable characteristics. ESA

N89-16746# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

TRANSONIC COWL DESIGN

J. SEDDON *In its* Intake Aerodynamics, Volume 1 23 p 1988 Avail: NTIS HC A15/MF A01

Transonic cowl design is discussed in the context of external

drag of engine nacelles on high-subsonic transport aircraft. The principal concern arises because at high subsonic speeds the airflow over the intake cowl, and in other regions of an overall podded installation, becomes locally supersonic, giving rise to shock waves and possible boundary layer separation. Both these features can lead to substantial increases in aircraft drag. Drag below the critical Mach number (where flow locally reaches sonic speed) and subcritical cowl design are treated. Supercritical cowl design and installation drag are discussed. ESA

N89-16749# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

TRANSPORT AIRCRAFT INTAKE DESIGN

JACKY LEYNAERT In VKI, Intake Aerodynamics, Volume 2 28 p 1988

Avail: NTIS HC A14/MF A01

Subsonic air intake, Mach 2+ transport aircraft intake, and Mach 3 are considered. Hypersonic cruise intakes are mentioned. The problem of supersonic intake adaptation to the intermediate flight Mach number range is reviewed. Future multicycle engine design is discussed.

N89-16773 Cranfield Inst. of Tech., Bedford (England). THE DESIGN, CONSTRUCTION AND TEST OF A POSTBUCKLED, CARBON FIBRE REINFORCED PLASTIC WING BOX Ph.D. Thesis

W. G. BROOKS 1987 290 p

Avail: Univ. Microfilms Order No. BRDX82023

Methods of analysis have been evaluated including: (1) non-linear finite element analysis for the prediction of panel postbuckling; (2) a simpler technique based on an effective width method (forming the core of a design program, OPTIMIST, it predicts buckling loads, postbuckled reduced stiffness and overall column failure of co-cured hat stiffened panels; and (3) the use of the effective width method allied to a large scale, linear finite element analysis. The work includes the development of a new method of construction for composite box structures. The wing skin, stiffeners and rib flanges are co-cured together. Integral slotted joint features are formed in each part. The structure is then adhesively bonded together. A full description of the manufacture of the wing box is included.

N89-16774# Texas A&M Univ., College Station. Dept. of Mechanical Engineering.

NONLINEAR DYNAMIC RESPONSES OF COMPOSITE ROTOR BLADES Final Technical Report, 1 Dec. 1985 - Jun. 1988

JOHN J. ENGBLOM and OZDEN O. OCHOA Aug. 1988 72 p (Contract F49620-86-K-0003)

(AD-A200145; ME-5375-88; AFOSR-88-1018TR) Avail: NTIS HC A04/MF A01 CSCL 01C

Summarized are research activities related to Nonlinear Dynamic Response of Composite Rotor Blades. Fundamental to the analysis is the development of a continuum formulation that can accurately account for the effects of interlaminar shear and interlaminar normal stress variation through-the-thickness of a laminate. Technical highlights of the research efforts to date are presented for each of the proposed tasks; namely, Nonlinear Displacement Formulation for Composite Media, Incorporate Damage Mechanisms into Dynamic Response Formulation and Correlation of Formulated Response Model with Experimental data. GRA

N89-16775# Analytical Methods, Inc., Redmond, WA. DEVELOPMENT OF A PANEL METHOD FOR MODELING CONFIGURATIONS WITH UNSTEADY COMPONENT MOTIONS, PHASE 1 Final Report, 1 Jul. 1987 - 31 Jan. 1988

DAVID R. CLARK and BRIAN MASKEW 15 Apr. 1988 35 p (Contract DAAL03-87-C-0011)

(AD-A200255; AMI-8801; ARO-25090.1-EG-SBI) Avail: NTIS HC A03/MF A01 CSCL 01C

This report reviews the background to the calculation of unsteady rotor and fuselage loads and presents results from an analysis of a typical helicopter configuration made using a panel method operated in a time-stepping mode. The method models the fuselage and blades using surface singularities and the shed and trailing wakes with doublet lattice sheets. Unsteady local pressures and component forces are presented and the ability of the analysis to determine dynamic phenomena such as fuselage/blade-passage events and blade/vortex interactions is demonstrated. GRA

N89-16778 Maryland Univ., College Park. AEROELASTIC OPTIMIZATION OF A HELICOPTER ROTOR Ph.D. Thesis

JOON WON LIM 1988 232 p

Avail: Univ. Microfilms Order No. DA8818424

Structural optimization of a hingeless rotor is investigated to reduce oscillatory hub loads while maintaining aeroelastic stability in forward flight. Design variables include spanwise distribution of nonstructural mass, chordwise location of blade center of gravity and blade bending stiffnesses. The objective function is expressed as a function of one or more components of oscillatory hub loads with suitable weighting functions. For inequality constaints, the aeroelastic stability of the blade in forward flight is selected to keep the blade aeroelastically stable. An aeroelastic analysis of rotors, based on a finite element method in space and time, is linked with optimization algorithms to perform optimization of rotor blades. The vehicle trim and blade steady response are calculated iteratively as one coupled solution using a modified Newton method. Eigenvalues corresponding to different blade modes are calculated using Floquet transition matrix theory. For the optimization process, a new methodology, direct analytical approach for calculation of sensitivity derivatives of blade response, hub loads and eigenvalues with respect to design variable is proposed. Dissert. Abstr.

N89-17278# Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (Germany, F.R.).

DAMAGE TOLERANCE BEHAVIOR OF FIBER REINFORCED COMPOSITE AIRFRAMES [ZUM SCHADENSTOLERANZVERHALTEN VON LUFTFAHRZEUGKONSTRUKTIONEN AUS FASERVERBUNDWERKSTOFFEN]

J. J. GERHARZ and H. HUTH In its Papers of the 5th LBF Colloquium p 93-110 1988 In GERMAN

Avail: NTIS HC A12/MF A01

The evaluation of the damage tolerance of fiber-reinforced composite aircraft constructions was investigated. An example shows which studies are needed to determine the effects of critical damage on the required properties and to determine how this damage is tolerated by the constructions. The smaller the impactor radius and the thinner the laminate, the lower the energy at which the impact damage is visible. Even at high impact energies, damage on nonhardened constructions is not visible. The importance and effect of damage depend on the impact location. The decrease of pressure strength of laminate plates depends on the relative damage size. The laminate structure in hardened laminates can affect the impact damage.

N89-17589 Crantield Inst. of Tech., Bedford (England). ANALYTICAL WING WEIGHT PREDICTION/ESTIMATION USING COMPUTER BASED DESIGN TECHNIQUES Ph.D. Thesis

N. A. D. MURPHY 1987 312 p

Avail: Univ. Microfilms Order BRDX82210

Every pilot knows that the size and position of masses in an aircraft has a fundamental effect on its performance. It comes as a surprise to learn that the methods used for predicting aircraft weights today were developed in the forties and there have only been half hearted attempts at making use of the digital computer. The usual methods are empirical and rely on experience gained from past projects. Things have changed and these methods are potentially inaccurate when applied by the inexperienced engineer to new aircraft based on radical concepts. Sixty percent of an airplane's program cost is determined at the initial stages of design and the structure of an aircraft accounts for up to 55 pct of the cost of a 200 aircraft program. Compare this with the 3 pct share that the initial design stage itself costs. Clearly the problem is that a small error can be very costly or even catastrophic. Dissert. Abstr.

N89-17590 Cranfield Inst. of Tech., Bedford (England). DESIGN SYNTHESIS FOR CANARD-DELTA COMBAT AIRCRAFT, VOLUMES 1 AND 2 Ph.D. Thesis V. C. SERGHIDES 1987 554 p

Avail: Univ. Microfilms Order No. BRDX82026

The development of a computerized Design Synthesis is presented for canard-delta combat aircraft. The background to the work and the objectives and limitations are examined. The design of a baseline canard-delta combat aircraft is then described together with all the assumptions and decisions which led to its final configurations. The philosophy behind the progressive evolution of the aircraft geometry and packaging modules from the baseline configuration is explained in detail. The development of detailed modules for the estimation of the aircraft aerodynamics and performance is then presented. A full description of the investigations into the effects of canard-delta interference on the aircraft aerodynamics is also included. The mathematical content of the aircraft geometry, packaging, aerodynamics and performance modules is presented separately in the appendices in greater detail. The development and architecture of the Design Synthesis and graphics programs are finally presented and the program operation is described with the aid of flow charts. A comprehensive user manual and a design example are also provided. Dissert. Abstr.

N89-17591# Rockwell International Corp., Los Angeles, CA. SUPERPLASTIC FORMED ALUMINUM-LITHIUM AIRCRAFT STRUCTURE Interim Report, 30 Apr. 1987 - 30 Apr. 1988

GARDNER R. MARTIN, CLAIRE ANTON, DEAN KLIVANS, M. A. RAMSEY, P. S. MCAULIFFE, J. C. GEORGE, M. K. GUESS, H. R. PEARSON, C. C. BAMPTON, R. A. GRIMM (Edison Welding Inst., Columbus, OH.) et al. Oct. 1988 133 p Prepared in cooperation with Washington State Univ., Pullman (Contract 503615 87 C 2023)

(Contract F33615-87-C-3223)

(AD-A200245; NA-88-1347L; AFWAL-TR-88-3080) Avail: NTIS HC A07/MF A01 CSCL 01C

This program selects, designs, fabricates, and evaluates SPF AI-Li airframe parts using advanced joining technology; it also screens and evaluates SPF AI-Li alloys for application to candidate parts. Factors used in part selection include supportability, technical risk, and required development. A design trade study modifies and improves the advanced SPF AI-Li candidate parts by implementing efficient design concepts and advanced joining methods. Design and joining methods are evaluated using material from the same lots used for material evaluation. Demonstration parts and the required tooling are fabricated using criteria generated from producibility evaluations. Finally, the demonstration parts are subjected to verification testing as prescribed in the test plan. GRA

N89-17593*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FLIGHT MEASURED DOWNWASH OF THE QSRA

JOSEPH C. EPPEL, DENNIS W. RIDDLE, and VICTOR C. STEVENS Dec. 1988 13 p

(NASA-TM-101050; A-88307; NAS 1.15:101050) Avail: NTIS HC A03/MF A01 CSCL 01C

Several reports have been written on the performance of the Quiet Short-Haul Research Aircraft, which shows the advantages of upper-surface blowing or the propulsive-lift wing as it applies to lift, maneuverability, and short takeoff and landing. This high lift generation at low speeds results in substantial downwash, especially in the low-aft fuselage tail position. The high T-tail of the Quiet Short-Haul Research Aircraft minimizes the undesirable downwash effects from the propulsive-lift wing. Queries from Department of Defense agencies and industry for quantitative values prompted a series of flight-measured downwash tests at the high T-tail and the low aft fuselage position. The results are presented in a summarized format, showing downwash, Delta epsilon/Delta a, for both locations. As would be expected,

downwash increases for increased power and USB flap settings. The downwash is greater in the low aft-fuselage position as compared to the high T-tail area. Author

N89-17594# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.

MPC-75 FEEDER CIVIL AIRCRAFT

MING KE 1 Nov. 1988 6 p Transl. into ENGLISH from Guoji Hangkong (Peoples Repubic of China), no. 12(298), 1987 p 5 (AD-A200907; FTD-ID(RS)T-0857-88) Avail: NTIS HC A02/MF A01 CSCL 01C

The project model and partial prototype of the MPC-75 feeder civil aircraft, which was jointly developed and manufactured by the China Aviation Technology Import-Export Company and the MBB Company of the Federal Republic of Germany, was placed at the center of MBB Company exhibition platform in this year's Aviation Exhibit, and it drew a huge crowd. The MPC-75 is a class feeder civil aircraft with 75 to 90 seats, Based upon an extensive market investigation and analysis conducted by the two companies, this aircraft was selected to be the model to fill the open market for feeder civil aircraft with over 60 seats but under 100 seats. GRA

N89-17595# Defense Science Board, Washington, DC. REPORT OF THE DEFENSE SCIENCE BOARD TASK FORCE ON THE NATIONAL AEROSPACE PLANE (NASP) Final Report Sep. 1988 90 p

(AD-A201124) Avail: NTIS HC A05/MF A01 CSCL 01C

The NASP started in 1984 as a program to explore hypersonic air breathing propulsion. It transitioned during 1985 to a program with the dual goals of demonstrating single stage to orbit and hypersonic cruise with the same vehicle. DSB Task Force conclusions include: (1) The NASP program goals are valid. The NASP technologies will make significant contributions to our national military and space capabilities and our civilian economy as we enter the 21st century. (2) The NASP is truly an X-Vehicle. Expectations of short term operational utility should not be raised. (3) Technical uncertainties in all critical disciplines must be narrowed before detailed design is initiated. Uncertainties are too large to estimate with any degree of accuracy the cost, schedule or performance which can be achieved in Phase 3. (4) Readjust the program funding priorities to favor the Technology Maturation effort, while retaining sufficient effort in definition airframe and propulsion configuration to provide focus for the technology work. (5) An experimental program of this type should be event driven, not schedule driven. Demonstration of quantitative technical milestones in all critical disciplines should pace the program.

GRA

N89-17691# Saab-Scania, Linkoping (Sweden). AN ANALYSIS METHOD FOR BOLTED JOINTS IN PRIMARY COMPOSITE AIRCRAFT STRUCTURE

INGVAR ERIKSSON *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures 19 p Mar. 1988 Prepared in cooperation with Royal Inst. of Tech., Stockholm (Sweden).

Avail: NTIS HC A14/MF A01

The analysis of bolted joints in composite structure requires, like structural analysis in general, methods for determining the stress distributions and relevant failure criteria. The stress analysis procedure discussed here starts by addressing the joints as an integrated part of the overall structure. The stresses in the vicinity of the hole boundary are obtained through a series of finite element analyses, which starts with an overall load distribution analysis and ends with a two-dimensional detailed contact stress analysis of the most highly stressed region in the joint. Strength is predicted for two basic failure modes occurring in a joint, net-tension and bearing failure. The failure hypotheses for these failure modes are described. Both the stress analysis and failure hypotheses are performed and established, respectively under certain idealizations. The conditions in a real joint in an aircraft may differ from these idealizations. Hence, further work is required and is also proposed here. The analysis procedure described here is

based on today's powerful computer facilities and offer great advantages compared with more empirical procedures. The procedure is presently used at Saab Aircraft Division. Author

N89-17693# Dornier-Werke G.m.b.H., Friedrichshafen (Germany, F.R.). Technology Programs.

TYPICAL JOINTS IN A WING STRUCTURE

DIETER ROSE, MANFRED ROTHER, and HELMUT SCHELLING (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart, Germany, F.R.) *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures 14 p Mar. 1988

Avail: NTIS HC A14/MF A01

For the development of the Alpha-Jet carbon fiber reinforced plastic (CFRP) wing, typical connections between different components were examined both theoretically and experimentally. Environmental conditions - component humidity and temperature were considered mainly within the experimental work which was performed by the DFVLR-Stuttgart. Covered here are typical joints such as: (1) single-shear connection between skins and spars with low load transfer; (2) joints between skins and ribs due to interior tank pressure; and (3) multibolt joint between the CFRP skins and the fuselage attachment fittings with reference to bolt strength distribution and bearing stresses.

N89-18380*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

V/STOL AIRCRAFT AND THE PROBLEM OF JET-INDUCED SUCKDOWN

CHERIANNE CARLISLE In its NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers p 9-20 Sep. 1988

Avail: NTIS HC A07/MF A01 CSCL 01C

The suckdown condition encountered when jet propelled, Vertical/Short Takeoff and Landing aircraft hover near the ground is described. A discussion of this ground effect problem and how it is being investigated is followed by a more detailed description of one of the methods researchers are using to investigate the basic mechanisms that influence the suckdown condition. Specific parameters that are taken into account include the height of the jet above the ground, jet exit conditions, and model geometry. Data from a current investigation is presented along with some conclusions from other recent investigations in order to relate the significance of some of the parameters influencing suckdown. Suggestions are made for additional testing methods which might be useful to researchers investigating the mechanisms involved in jet induced suckdown.

N89-18387*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE NATIONAL AERO-SPACE PLANE

BRUCE MENDEZ In its NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers p 49-53 Sep. 1988

Avail: NTIS HC A07/MF A01 CSCL 01C

The National Aerospace Plane is an extremely versatile and adaptable aircraft. It can be developed into an Orient Express that would dramatically improve trade with countries in Asia and elsewhere: a commuter transport to ferry men and materials to space, an advanced tactical fighter or bomber, and an unparalleled high altitude spy-plane to observe troubled spots all over the globe. Utilizing the technology developed by this pilot program, it will be possible to quickly and easily get to low Earth orbit, go halfway around the world in a fraction of the time it previously took, and lead the world in the development of advanced technology to improve our lives and the lives of many others.

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A89-27247

RESEARCH PRESSED TO IMPROVE FLIGHT INFORMATION CONTRIBUTION TO AIRCRAFT ACCIDENT INVESTIGATIONS

I. E. MASHKIVSKII (State Commission for the Supervision of Flight ICAO Bulletin (ISSN 0018-8778), vol. 43, Oct. Safety, USSR) 1988, p. 20-22.

Research by Soviet scientists to develop improved methods for recording and using flight information for accident investigations is reviewed. The technical features of the airborne flight parameter recorders used in the Soviet Union are examined. Also, the ground systems used to process and analyze flight information are considered. The development of a general-purpose conversational simulation system for studying flight dynamics in accident investigations is discussed. The operation of the system is described, including the analysis and secondary processing of information, the evaluation of flight dynamics, and information display. R.B.

A89-27624* Tennessee Univ., Tullahoma. AUTOMATIC ACQUISITION OF DOMAIN AND PROCEDURAL KNOWLEDGE

H. J. FERBER and M. ALI (Tennessee, University, Tullahoma) IN: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 2. Tullahoma, TN, University of Tennessee, 1988, p. 762-771. refs

(Contract NAG1-513; NGT-43-001-807)

The design concept and performance of AKAS, an automated knowledge-acquisition system for the development of expert systems, are discussed. AKAS was developed using the FLES knowledge base for the electrical system of the B-737 aircraft and employs a 'learn by being told' strategy. The system comprises basic modules, a system administration module, a four natural-language concept-comprehension module, a knowledgeclassification/extraction module, and a knowledge-incorporation module; details of the module architectures are explored. TK

A89-27664*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MINIATURE PCM COMPATIBLE WIDEBAND SPECTRAL ANALYZER FOR HYPERSONIC FLIGHT RESEARCH

JOHN K. DIAMOND (NASA, Langley Research Center, Hampton, VA) IN: International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 277-286.

The design concept and prototype performance of a 10-400-kHz wideband spectral analyzer being developed at NASA Langley as part of the Hypersonic Flight Instrumentation Research Experiment are described and illustrated with diagrams and graphs. The analyzer is intended to compress the bandwidth of data from up to 20 hot-film anemometers, so that the analog PSD waveform from each sensor can be encoded for serial PCM telemetry. Components include an analog multiplier, digital waveform generator, sine-wave VCO, digital VCO, analog low-pass filter, switched-capacitor filter, and rms-dc detector. The prototype demonstrated 1-percent accuracy (referred to a 5-V full-scale output) for sweep rates up to 3/sec over the 10-400-kHz spectrum. T.K.

National Aeronautics and Space Administration. A89-27668*# Hugh L. Dryden Flight Research Facility, Edwards, CA.

THE DESIGN AND USE OF A TEMPERATURE-COMPENSATED HOT-FILM ANEMOMETER SYSTEM FOR BOUNDARY-LAYER FLOW TRANSITION DETECTION ON SUPERSONIC AIRCRAFT HARRY R. CHILES (NASA, Flight Research Center, Edwards, CA) IN: International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 347-358.

A89-27670

SOFTWARE CONTROL OF A HIGH SPEED, MODULAR SIGNAL CONDITIONER AND PCM ENCODER SYSTEM

WILLIAM F. TROVER (Teledyne Controls, Los Angeles, CA) IN International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 369-380.

The increasing channel capacity and complexity of flight test data acquisition systems have made the problems of physical distribution of the system throughout the test aircraft and determining the system configuration a very time-consuming and costly portion of the flight test process. The solution to the installation problem is to have a highly modular system that can be configured as either a distributed system with remote multiplexing and a PCM central controller, or with the same multiplexed hardware as a stand-alone or master/slave system (where the functional power and complexity afforded by the PCM central controller are not required). The solution to the configuration control problem is to have a 'hands-off' data-acquisition system with all variables of the signal conditioning and PCM encoding functions under software control. Author

A89-28184

AVIONICS DISPLAY SYSTEMS

A. J. DANDEKAR (Rockwell International Corp., Cedar Rapids, IA) and L. E. FARHNER (Boeing Commercial Airplanes, Seattle, SAE, Aerospace Technology Conference and Exposition, WA) Anaheim, CA, Oct. 3-6, 1988. 10 p. (SAE PAPER 881371)

Electronic displays using multicolor cathode ray tube (CRT) technology were introduced to Air Transport cockpits in 1979 when Boeing and Airbus Industries selected CRTs for display of primary flight data, engine information and systems information in new generation aircraft. The introduction of CRTs to the flight deck has been very successful with display capability and symbology undergoing continuous improvement. The evolution of these display systems is reviewed with a look at the flat panel displays of tomorrow. Author

A89-28186

AN AVIONICS DIAGNOSTICS SYSTEM FOR REGIONAL AIRLINES AND BUSINESS AIRCRAFT APPLIED IN THE **BEECH STARSHIP 1**

DONALD K, GRIMM and PAUL D, HEYSSE (Rockwell International Corp., Avionics Group, Cedar Rapids, IA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 15 p.

(SAE PAPER 881374)

As avionics systems become more integrated, fault isolation becomes more costly and time consuming. The development of the Collins Concept 4 avionics architecture includes a unique central avionics diagnostics function as an integral part of the avionics structure to identify failed LRUs in the aircraft for guick flight line replacement. Repeat squawks are greatly reduced. The central diagnostics processor uses system-wide avionics data in a flexible, table-driven processing algorithm to pinpoint LRU failures. The application in the Beech Starship 1 is described. Author

A89-28199

AIRCRAFT AUTOMATION WITH AN ELECTRONIC LIBRARY SYSTEM

EARL MINCER (Honeywell, Inc., Sperry Commercial Flight Systems Group, Phoenix, AZ) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 6 p. (SAE PAPER 881415)

An electronic library system is being developed for use in commercial aircraft. This system will supplement and eventually replace the conventional paper manuals with electronically stored data. Using advanced technologies of optical disk data storage,

high resolution displays, and sophisticated software, the system will provide a high degree of cockpit automation and added functionality for many avionics applications. This paper describes some proposed features of the system as well as the technology used to implement it. Author

A89-28200

USE OF COLOR DISPLAYS IN THE A320 COCKPIT

ROBERT J. WITWER and JAMES C. STAEHLE (Honeywell Inc., Sperry Commercial Flight Systems Group, Phoenix, AZ) SAE. Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 9 p.

(SAE PAPER 881416)

The Airbus A320 is the first commercial aircraft to provide a color display unit as the primary interface between the flight crew and the flight management system. In order to obtain maximum information about the flight management data being displayed, specific rules concerning color usage apply. This enables a more manageable operation thus reducing flight crew workload.

Author

A89-28201

SENSOR CONSIDERATION IN THE DESIGN OF A WINDSHEAR DETECTION AND GUIDANCE SYSTEM

TERRY ZWEIFEL (Honeywell, Inc., Sperry Commercial Flight Systems Group, Phoenix, AZ) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 7 p. (SAE PAPER 881417)

The sensor requirements for a windshear detection and guidance system and the impact of sensor inaccuracies on detection and flight guidance are examined. Inertial parameters for windshear detection and guidance algorithms are discussed, including longitudinal acceleration, normal acceleration, and pitch angle. Consideration is also given to air mass parameters such as true air-speed and angle-of-attack. Methods for compensating for sensor errors are analyzed, including increasing the detection threshold to allow for sensor errors and developing algorithms to account for errors to minimize their effect. B.B.

A89-28213

MECHANIZATION, DESIGN AND METHODOLOGICAL LESSONS LEARNED FROM A DYNAMIC COCKPIT MOCK-UP EVALUATION

KIM M. MAZUR, RICHARD W. MOSS (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), and GREGORY J. BARBATO (Midwest Systems Research, Inc., Dayton, OH) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 12 p. (SAE PAPER 881438)

By applying existing and evolving design methodolgy, cockpits of tactical aircraft can be designed, based on the the crew system concept. The USAF Crew Systems Development Branch undertook the Tactical Aircraft Cockpit Study (TACS) to establish a firm understanding of the vehicle's mission and the accompanying crew station design issues. The TACS design was mechanized in a dynamic mock-up. Air-to-air and air-to-ground situation formats were considered. The methodology issues dealt with the procedures used during testing of the crew station design, as well the processs involved in the design development. Much more useful evaluations were obtained with full-scale dynamic mock-ups than with nondynamic mock-ups - a finding attributed to subjective factors affecting the test personnel. A.A.F.

A89-28214

COMPUTER-GENERATED MAP DISPLAY FOR THE **PILOT/VEHICLE INTERFACE**

STEVEN P. ROGERS and V. ALAN SPIKER (Anacapa Sciences, Inc., Santa Barbara, CA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 16 p. refs (SAE PAPER 881440)

The computer-generated map display system offers a host of powerful new capabilities. Among these are opportunities to greatly improve the pilot/vehicle interface in tactical aircraft cockpits

through integration and clarification of spatial/geographic data. This report describes the results of a survey conducted to evaluate and prioritize formats for integrated digital map displays. Sixteen of the formats judged most valuable by 38 experienced pilots are presented and described, along with the specific survey findings. Author

A89-28224

RECONFIGURABLE COCKPIT DEVELOPMENT

PAUL PENCIKOWSKI (Northrop Corp., Aircraft Div., Hawthorne, SAE, Aerospace Technology Conference and Exposition, CA) Anaheim, CA, Oct. 3-6, 1988. 6 p.

(SAE PAPER 881472)

The Reconfigurable Cockpit (RCP), a cockpit-design software and hardware system, is described and illustrated with drawings and diagrams. The RCP can rapidly generate cockpit layouts and display formats. The user manipulates the high-fidelity graphics representation of multiple avionics devices through virtual touch and voice systems. The RCP is a stand-alone system and utilizes two computers, two terminals, and a physical cockpit. A twodimensional graphics editor is interfaced to a real-world simulation supporting both the head-down displays of the cockpit and the three-dimensional external world scene. A.A.F.

N89-16785# German Air Force Air Armament Directorate, Cologne (Germany, F.R.).

ON BOARD LIFE MONITORING SYSTEM TORNADO (OLMOS)

J. H. KUNZ and U. SCHULZ (Dornier-Werke G.m.b.H., Friedrichshafen, Germany, F.R.) In AGARD, Engine Condition Monitoring: Technology and Experience 6 p Oct. 1988 Avail: NTIS HC A20/MF A01

The development of the onboard life monitoring system (OLMOS) of the GE Tornado proved, that on-board monitoring is possible, and the received data can be used in the logistic system. The Tornado OLMOS is a system which serves engine, structure, and functional equipment. The level of integration is high, but due to the structured software approach the system can be handled. The software was developed by four companies, and in the using phase the same companies are sharing the SW maintenance. High integrated systems definitely do need a very close management on both sides, the government and the industry. The OLMOS proves that even commercial and proprietary aspects can be worked out. Author

N89-16786# Royal Air Force, London (England). INFORMATION MANAGEMENT SYSTEMS FOR ON-BOARD MONITORING SYSTEMS

P. J. JENKINS In AGARD, Engine Condition Monitoring: Technology and Experience 8 p Oct. 1988

Avail: NTIS HC A20/MF A01

With the advent of microprocessors is a phase which has heralded a host of advances in aircraft mounted equipment. It promises to yield rich dividends for the hard pressed maintenance engineer by providing detailed information on equipment performance to enable defects to be accurately and rapidly diagnosed. Latest developments in the propulsion field show the potential of being able to anticipate certain types of defects and thus achieve true on-condition maintenance in these cases. The aim is to highlight the vitally important role played by maintenance information management systems in storing, analyzing, and displaying the data captured by on-board monitoring systems and to make recommendations for a code of practice for the successful implementation of such systems. Author

N89-16788# Rockwell International Corp., Lakewood, CA. **B-1B CITS ENGINE MONITORING**

B. LAINE and K. DERBYSHIRE In AGARD, Engine Condition Monitoring: Technology and Experience 12 p Oct. 1988 Avail: NTIS HC A20/MF A01

The Central Integrated Test Systems (CITS) is a real-time tests system which continually monitors the performance of the 34 principal systems, onboard the B-1B aircraft, including the four General Electric F101 turbofan engines. The CITS consists of an

onboard computer, four data acquisition units, a data conversion unit, a printer, a magnetic tape recorder, and a control and display panel. Approximately 19,000 parameters are available for recording and display purposes. The engine diagnostic algorithm was designed in close coordination with General Electric. Information obtained from early test cell runs was utilized in the original logic design. Many modifications were made as a result of flight test experience, but the overall test sequence has remained unchanged. The engine diagnostic software utilizes approximately 100 parameters per engine. The test logic is exercised four time per second and a fault is declared is a failure condition occurs for six consecutive passes. Every effort is made to ensure that a single failure will result in only one fault code out of 154 possible codes per engine. The B-1B engine diagnostic program is the most advanced flying test algorithm. Its inherent complexities are due to calculations of test limits based on aircraft flight mode, environmental conditions, and engine control schedules. These limits are then compared to actual engine readings, and if established limits are exceeded, a fault code is annunciated.

Author

N89-16789# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).

ÈNGINE LIFE CONSUMPTION MONITORING PROGRAM FOR RB199 INTEGRATED IN THE ON-BOARD LIFE MONITORING SYSTEM

J. BROEDE *In* AGARD, Engine Condition Monitoring: Technology and Experience 11 p Oct. 1988

Avail: NTIS HC A20/MF A01

The On-board Life Monitoring System (OLMOS) of the GE Tornado consists of on-board equipment (data acquisition unit, DAU) where the majority of the data processing is carried out, and of ground equipment (OLMOS Ground Station, OGS, connected to the Central Logistic Support System, BMS) where the majority of the data management tasks are carried out. The Engine Life Consumption Monitoring Program (ELCMP) is part of OLMOS. Its main task is LCF life consumption calculation, which consists of data acquisition and data checking, calculation of temperatures and stresses, as well as damage assessment. A general view of the calculation path within ELCMP is given, and the hardware structure of the system is presented. Some advantages of individual and complete engine monitoring are pointed out.

N89-16793# Air France, Paris. Direction du Materiel. THE CFM 56-5 ON THE A-320 AT AIR FRANCE [LE CFM 56-5 SUR A320 A AIR FRANCE]

P. CHETAIL *In* AGARD, Engine Condition Monitoring: Technology and Experience 19 p Oct. 1988 In FRENCH

Avail: NTIS HC A20/MF A01

A brief history of engine monitoring strategies used by Air France is presented and the systems limitations encountered in service are discussed. The engine monitoring system to be used for the A-320 aircraft is described. The use of the AIRCOM system, the automatic alert function, and the use of the GEM (Ground based Engine Monitoring) program for data analysis are discussed.

M.G.

N89-16795# Pratt and Whitney Aircraft, West Palm Beach, FL. F100-PW-220 ENGINE MONITORING SYSTEM

DENNIS A. MYERS and G. WILLIAM HOGG *In* AGARD, Engine Condition Monitoring: Technology and Experience 9 p Oct. 1988

Avail: NTIS HC A20/MF A01

The development and operational experience is reviewed of the F100-PW-220 Engine Monitoring System currently in service with the U.S.A.F. and other national defense air forces utilizing the F100-PW-220 engine and its derivatives. The F100-PW-220 Engine Monitoring System (EMS) is an advanced logistics support tools in production for the Pratt and Whitney F100 family of gas turbine engines. The introduction of the PW-220 EMS represents over 10 yrs of diagnostic system and maintenance technology development using aerospace electronic component design and digital engine control system implementation. The PW-220 EMS is a comprehensive engine support system that is fully integrated with in-flight aircraft operating systems, as well as, ground based maintenance and logistics systems. Author

N89-16797# Rolls-Royce Ltd., Bristol (England). Engine Data Systems.

MILITARY ENGINE CONDITION MONITORING SYSTEMS: THE UK EXPERIENCE

C. M. OCONNOR *In* AGARD, Engine Condition Monitoring: Technology and Experience 8 p Oct. 1988

Avail: NTIS HC A20/MF A01

The monitoring of engine usage is probably as old as the gas turbine engine itself. However, it was not until the mid-seventies that the concept of engine monitoring became viable following the appearance and general availability of digital electronics, including the minicomputer. Since, the proliferation of engine condition monitoring has resulted in the development of many different systems and it is now customary for defense organizations to include it among their requirements for new military aircraft. The functional requirements for engine condition monitoring are usually defined in general terms, except for the life usage monitoring of major rotating components, these being the discs and the turbines. The level of importance afforded to the monitoring of these components is attributable to safety and economic factors. Engine condition monitoring in the UK military has been built on the foundations of usage monitoring. It is interesting that except for vibration and oil system monitoring, the engine parameters required for usage monitoring can provide enough data for many other condition monitoring functions. This idea is further expanded and detailed. Author

N89-16798# General Electric Co., Cincinnati, OH. Monitoring Systems Engineering.

MÍLITARY ENGINE MONITORING STATUS AT GE AIRCRAFT ENGINES, CINCINNATI, OHIO

R. J. E. DYSON and M. J. ASHBY *In* AGARD, Engine Condition Monitoring: Technology and Experience 11 p Oct. 1988 Avail: NTIS HC A20/MF A01

The design and development of GE Aircraft engines of recent military engine monitoring systems is described. In particular, the systems for the F101-GE-102 engine in the B-1B aircraft and the F110-GE-100 engine in the F-16C/D are used as examples. Since both of these systems have recently been introduced into service, this experience is discussed together with operational status. These present systems are compared with future evolutionary trends which are affected by the development of miniaturized, rugged electronics and by the desire to minimize the unique hardware and software required for engine monitoring. A discussion of interfaces, both airborne to the flight crew, and, through support equipment and ground analysis programs, to the ground crew, is included.

Author

N89-16799# General Electric Co., Cincinnati, OH. Monitoring Systems Engineering.

COMMERCIAL ENGINE MONITORING STATUS AT GE AIRCRAFT ENGINES, CINCINNATI, OHIO

R. J. E. DYSON and J. E. PAAS *In* AGARD, Engine Condition Monitoring: Technology and Experience 12 p Oct. 1988 Avail: NTIS HC A20/MF A01

The design, introduction and development of expanded commercial engine monitoring systems by GE Aircraft Engine is described. The history of present systems is outlined, starting from the introduction of the CF6-80A3 engine for the A310 aircraft of the Propulsion Multiplexer (PMUX) which has led to similar systems on the CF6-80C2 engine. The impact of the full authority digital control on future systems is also discussed. The introduction and application of the Ground-based Engine Monitoring (GEM) software developed by GE in conjunction with several airline users is recounted. The original software development occurred in parallel with the expanded sensor complement and digitization of data. A description of the functions of a typical ground software program

is provided together with proposed improvements and future directions. Author

N89-16801# Bureau Veritas, Paris (France). TREND MONITORING OF A TURBOPROP ENGINE AT LOW AND MEAN POWER [TREND-MONITORING DES

TURBO-PROPULSEUR DE PETITE ET MOYENNE PUISSANCE] PHILIPPE VAQUEZ *In* AGARD, Engine Condition Monitoring: Technology and Experience 9 p Oct. 1988 In FRENCH Avail: NTIS HC A20/MF A01

Trend monitoring relates to the observation, between two maintenance periods, of changes in certain parameters that represent the physical state of an engine. The experiences of French engineers with the use of this method are discussed. Specifically, the application of trend monitoring to the Pratt and Whitney PT6 A and PW 120, and the General Electric CT 7 turboprop engines is discussed. The engines were mounted on various single and twin engine aircraft.

N89-16811# Hochschule der Bundeswehr, Hamburg (Germany, F.R.).

GAŚ PATH MODELLING, DIAGNOSIS AND SENSOR FAULT DETECTION

R. LUNDERSTAEDT and K. FIEDLER *In* AGARD, Engine Condition Monitoring: Technology and Experience 13 p Oct. 1988

Avail: NTIS HC A20/MF A01

The gas path analysis (GPA) becomes more and more an important method for the diagnosis of jet engines. Here, a fundamental way of finding the mathematical engine model is shown, especially with regard to the adaptation of the coefficients of the system matrix to the gradients of the characteristic curves of the turbomachines. The theoretical fundamentals are applied to a two-shaft jet engine. In order to test the method some faults in the engine are simulated. All faults are detected very accurately and the method shows by this its efficiency. For practical use of the method, the faults of the measuring device (sensors) are to be taken into consideration. Therefore filter algorithms are outlined to diminish the stochastic parts of these faults. For the systematic parts (offsets), a special and new theory is developed for compensation. For both, simulation results are given based on Author actual test stand data.

N89-16812# Technische Univ., Munich (Germany, F.R.). Inst. fuer Luft-und Raumfahrt/Flugantriebe.

SYSTEM-THEORETICAL METHOD FOR DYNAMIC

ON-CONDITION MONITORING OF GAS TURBINES

F. HOERL, G. KAPPLER, and H. RICK *In* AGARD, Engine Condition Monitoring: Technology and Experience 17 p Oct. 1988

Avail: NTIS HC A20/MF A01

In order to ensure reliability and safety of such complex technical systems as aero-engines, model-related diagnostic techniques must be applied. The basis for this is a linear, time-invariant, dynamic engine state space model derived from system analysis. Due to the model order and the associated difficulties, order reduction procedures are used. The diagnostic parameters to be taken into account are integrated into a dynamic disturbance model. This disturbance model and the reduced engine model form the extended dynamic engine state space model. A detailed investigation of the dynamic system for observability and disturbability is essential. Because of measuring/process noise and other system disturbances, dynamic state estimation methods are applied in the diagnosis, whereby the synthesis of such observer systems is a crucial point. The usefulness of the dynamic monitoring method is demonstrated on the example of the helicopter engine using computed simulations. A sensitivity analysis allows the accuracy of the diagnostic results to be estimated. Author

N89-16817# Stewart Hughes Ltd., Southhampton (England). Centre for Advanced Technology. GAS PATH CONDITION MONITORING USING

ELECTROSTATIC TECHNIQUES

CELIA FISHER In AGARD, Engine Condition Monitoring: Technology and Experience 10 p Oct. 1988 Sponsored by Ministry of Defence Procurement Executive, London, United Kingdom

Avail: NTIS HC A20/MF A01

The concept of condition monitoring using electrostatics offers the opportunity to monitor gas path faults as they occur. It is based on the assumption that gas path distresses, such as blade rubs and combustor burns, cause the production of minute particles of debris, which carry electrostatic charge, and can be monitored on suitable sensors mounted in the engine. The engine has a normal level of charge, which produces a background signal. The debris produced by distresses causes a change in the signal which can be monitored using suitable signal processing techniques. Described here is the research work which was necessary to provide an understanding of the mechanisms involved. This forms the basis of the technique which is described, with examples of the application of the systems to various engines. Author

N89-16819# Rolls-Royce Ltd., Derby (England).

COMPASS (TRADEMARK): A GENERALIZED GROUND-BASED MONITORING SYSTEM

M. J. PROVOST *In* AGARD, Engine Condition Monitoring: Technology and Experience 13 p Oct. 1988

Avail: NTIS HC A20/MF A01

Condition monitoring has developed from simple hand recording and analysis of cockpit instrumentation to the use of electronic systems selecting and recording a multitude of measurements for transmission to ground-based computer systems, which store and analyze data from an entire fleet. COMPASS (Condition Monitoring and Performance Analysis Software System) is a ground-based computer system, currently being developed by Rolls-Royce plc for application on the Rolls-Royce RB211 and Tay and International Aero Engines (IAE) V2500 turbofans. After discussing the benefits of monitoring system, COMPASS, its sources of data and its analytical functions, including details of new techniques developed to improve the usefulness of the analysis that is done are described. Also shown is how COMPASS is designed in two parts: - analytical functions specific to a given application and general host routines, providing all the housekeeping functions required in any monitoring system, including smoothing and trending, alert generation, fleet averaging, compression, data management and data plotting. The use of the general host routines could be extended to cover any operation. The approach Rolls-Royce plc is adopting to enable the COMPASS host to be made available for widespread application is discussed. Author

N89-16820*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. PILOTED-SIMULATION EVALUATION OF ESCAPE GUIDANCE

PILOTED-SIMULATION EVALUATION OF ESCAPE GUIDANCE FOR MICROBURST WIND SHEAR ENCOUNTERS M.S. Thesis -George Washington Univ.

DAVID A. HINTON Washington, DC Mar. 1989 57 p Sponsored in part by FAA. Washington, DC

(NASA-TP-2886; L-16498; NAS 1.60:2886; DOT/FAA/DS-89/06) Avail: NTIS HC A04/MF A01 CSCL 01D

Numerous air carrier accidents and incidents result from encounters with the atmospheric wind shear associated with microburst phenomena, in some cases resulting in heavy loss of life. An important issue in current wind shear research is how to best manage aircraft performance during an inadvertent wind shear encounter. The goals of this study were to: (1) develop techniques and guidance for maximizing an aircraft's ability to recover from microburst encounters following takeoff, (2) develop an understanding of how theoretical predictions of wind shear recovery performance might be achieved in actual use, and (3) gain insight into the piloting factors associated with recovery from microburst encounters. Three recovery strategies were implemented and tested in piloted simulation. Results show that a recovery strategy based on flying a flight path angle schedule produces improved performance over constant pitch attitude or acceleration-based recovery techniques. The best recovery technique was initially counterintuitive to the pilots who participated in the study. Evidence

07 AIRCRAFT PROPULSION AND POWER

was found to indicate that the techniques required for flight through the turbulent vortex of a microburst may differ from the techniques being developed using classical, nonturbulent microburst models. Author

07

AIRCRAFT PROPULSION AND POWER

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

A89-24916

RELATION BETWEEN DIFFUSOR LOSSES AND THE INLET FLOW CONDITIONS OF TURBOJET COMBUSTORS **RELATION ENTRE LES PERTES DANS LES DIFFUSEURS ET** LES CONDITIONS D'ENTREE DE L'ECOULEMENT A L'ENTREE DE LA CHAMBRE DE COMBUSTION POUR DES TURBOREACTEURS1

L'Aeronautique et l'Astronautique (ISSN ARMIN KLEIN 0001-9275), no. 133, 1988, p. 22-31. In French. refs

Experimental results on the correlation between diffusor losses and the inlet flow conditions of turbojet combustors were obtained, using cascades of compressor blades upstream of the diffusor to simulate the inlet flow field. The measurements show that distortions in the radial direction affect diffusor losses much more than heterogeneities in the azimuthal direction. It is demonstrated that the inlet radial blockage factor is a reliable measurement of turbojet performance. R.R.

A89-24917

COMBINED PROPULSION FOR HYPERSONIC AND SPACE VEHICLES [LA PROPULSION COMBINEE POUR VEHICULES HYPERSONIQUES ET SPATIAUX]

J. CALMON (AAAF, Paris; ONERA, Chatillon-sous-Bagneux, L'Aeronautique et l'Astronautique (ISSN 0001-9275), France) no. 133, 1988, p. 32-46. In French. refs

Various configurations of combined propulsion for hypersonic and space flight are evaluated with respect to such factors as specific impulse and specific thrust. Special attention is given to the turboramjet, and it is noted that from takeoff up to Mach 4 flight, both the turborocket and the ramjet chambers are in operation, while between Mach 4 and 7, only the ramjet engine is in operation. Air intake, combustion, flame stabilization, and ignition characteristics of scramjets are also discussed. RR

A89-24989*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NNEPEQ - CHEMICAL EQUILIBRIUM VERSION OF THE NAVY/NASA ENGINE PROGRAM

L. H. FISHBACH (NASA, Lewis Research Center, Cleveland, OH) and S. GORDON (Sanford Gordon and Associates, Cleveland, OH) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 111, Jan. 1989, p. 114-116. Previously announced in STAR as N88-21161.

(ASME PAPER 88-GT-314)

The Navy NASA Engine Program, NNEP, currently is in use at a large number of government agencies, commercial companies and universities. This computer code has been used extensively to calculate the design and off-design (matched) performance of a broad range of turbine engines, ranging from subsonic turboprops to variable cycle engines for supersonic transports. Recently, there has been increased interest in applications for which NNEP was not capable of simulating, namely, high Mach applications, alternate fuels including cryogenics, and cycles such as the gas generator air-turbo-rocker (ATR). In addition, there is interest in cycles employing ejectors such as for military fighters. New engine component models had to be created for incorporation into NNEP, and it was found necessary to include chemical dissociation effects of high temperature gases. The incorporation of these extended capabilities into NNEP is discussed and some of the effects of these changes are illustrated. Author

A89-25004#

IMPROVED METHODS OF CHARACTERIZING EJECTOR PUMPING PERFORMANCE

JOE DER, JR. (Northrop Corp., Pico Rivera, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs (AIAA PAPER 89-0008)

The present method for the characterization of ejector-pumping performance data performs continuously from zero-flow to high primary nozzle pressure ratio conditions. Choked and unchoked secondary ejector flow regions are distinguished; in the former, ejector pumping characteristics are simplified because the corrected secondary-to-primary weight flow ratio is a function solely of secondary-to-primary pressure ratio for a given ejector area ratio. Attention is also given to a new spacing-ratio definition, which characterizes ejector mixing length in terms of the height of the secondary flow gap rather than the nozzle diameter, is based on the detailed flow mechanics of entrainment due to the development of a free mixing layer. 00

A89-25005*# Old Dominion Univ., Norfolk, VA. ADAPTIVE COMPUTATIONS OF MULTISPECIES MIXING BETWEEN SCRAMJET NOZZLE FLOWS AND HYPERSONIC FREESTREAM

OKTAY BAYSA, WALTER C. ENGELUND, MOHAMED E. ELESHAKY (Old Dominion University, Norfolk, VA), and JAMES L. PITTMAN (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract NAG1-811)

(AIAA PAPER 89-0009)

The objective of this paper is to compute the expansion of a supersonic flow through an internal-external nozzle and its viscous mixing with the hypersonic flow of air. The supersonic jet may be that of a multispecies gas other than air. Calculations are performed for one case where both flows are those of air, and another case where a mixture of freon-12 and argon is discharged supersonically to mix with the hypersonic airflow. Comparisons are made between these two cases with respect to gas compositions, and fixed versus flow-adaptive grids. All the computational results are compared successfully with the wind-tunnel tests results. Author

A89-25006*# United Technologies Research Center, East Hartford, CT

PERFORMANCE POTENTIAL OF AIR TURBO-RAMJET **EMPLOYING SUPERSONIC THROUGH-FLOW FAN**

C. E. KEPLER (United Technologies Research Center, East Hartford, CT) and G. A. CHAMPAGNE (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs (Contract NAS3-24843)

(AIAA PAPER 89-0010)

A study was conducted to assess the performance potential of a supersonic through-flow fan in an advanced engine designed to power a Mach-5 cruise vehicle. It included a preliminary evaluation of fan performance requirements and the desirability of supersonic versus subsonic combustion, the design and performance of supersonic fans, and the conceptual design of a single-pass air-turbo-rocket/ramjet engine for a Mach 5 cruise vehicle. The study results showed that such an engine could provide high thrust over the entire speed range from sea-level takeoff to Mach 5 cruise, especially over the transonic speed range, and high fuel specific impulse at the Mach 5 cruise condition, with the fan windmilling. Author

A89-25092#

FLOWFIELD MODIFICATIONS OF COMBUSTION RATES IN **UNSTABLE RAMJETS**

D. M. REUTER, U. G. HEGDE, and B. T. ZINN (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting, 27th,

Reno, NV, Jan. 9-12, 1989. 12 p. refs (Contract N00014-84-K-0470) (AIAA PAPER 89-0105)

This paper describes interactions between unsteady combustion and vorticity in the flame region of an unstable laboratory ramjet burner. The steady and unsteady components of the velocity field are obtained using a conditional sampling laser-Doppler velocimetry (LDW) technique. The vorticity field is then derived from the measured velocity field. It is shown that combustion instability in the ramjet burner is accompanied by unsteady vortex shedding at the flame holding region. The vortex shedding occurs at the frequency of instability and it periodically distorts the flame front causing a cyclic variation of the flame area. A second important effect of the unsteady vortex shedding is an oscillatory variation of the flame speed. These effects result in a strong unsteady heat release rate capable of driving the longitudinal instabilities in the system. Author

A89-25218# TURBULENT MIXING IN SUPERSONIC COMBUSTION SYSTEMS

J. SWITHENBANK, I. W. EAMES, S. B. CHIN, B. C. R. EWAN, Z. Y. YANG (Sheffield, University, England) et al. AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 14 p. refs (AIAA PAPER 89-0260)

Fundamental principles of turbulence generation, dissipation and mixing-limited combustion were applied to the scramjet with particular attention given to the combustor. It is shown that the overall engine performance may be compromised in order to achieve adequate mixing and good combustion efficiency in an acceptable combustor length. Cycle optimization studies show that the highest performance, in terms of fuel specific impulse, is obtained at a combustion efficiency of about 80 percent at M = K.K. 10.

A89-25491#

AN EXPERIMENTAL AND COMPUTATIONAL INVESTIGATION OF ISOTHERMAL SWIRLING FLOW IN AN AXISYMMETRIC DUMP COMBUSTOR

S. C. FAVALORO (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia), A. S. NEJAD, S. A. AHMED, T. J. MILLER (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH), and S. P. VANKA (Argonne National Laboratory, IL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 14 p. refs

(AIAA PAPER 89-0620)

Experimental and theoretical studies of nonreacting swirling flow have been performed in a model of an axisymmetric dump combustor. A two-component laser Doppler velocimeter was used to obtain measurements of the three velocity components and a number of fundamental turbulence quantities in two series of tests with minimum disturbance to the combustor flow field. The results showed the significant effects of swirl, both with and without vortex breakdown, on the mean and turbulent flow fields. The experimental results were used to check the performance of a recently developed computer program which used the k-epsilon closure model. Comparison of the numerical and experimental results showed the inadequacy of the k-epsilon turbulence model in representing Author the complex structure of confined swirling flows.

A89-25493#

LOW FREQUENCY PRESSURE OSCILLATIONS IN A MODEL RAMJET COMBUSTOR - THE NATURE OF FREQUENCY SELECTION

K. YU, A. TROUVE, R. KEANINI, L. BAUWENS (California, University, Berkeley), and J. W. DAILY (Colorado, University, Boulder) AIAA, Aerospace Jan. 9-12, 1989. 21 p. refs AIAA, Aerospace Sciences Meeting, 27th, Reno, NV,

(Contract N00014-84-K-0372)

(AIAA PAPER 89-0623)

Low frequency pressure oscillations have been studied in a model ramiet dump combustor facility. The facility has a variable geometry test section with full optical access. Pressure and velocity

07 AIRCRAFT PROPULSION AND POWER

measurements are made at various locations in the inlet duct and combustor. Global C2 and CH radical emission intensities in the combustor are measured to determine the phase relation between heat release rate and pressure in the combustor. Holding the equivalence ratio fixed, the combustor geometry and inlet velocity are varied to determine the effect of mean fluid residence time on frequency of the oscillation. Phase locked schlieren visualization results will be shown which allow tracking of the flame front during an entire pressure cycle. The experimental results are interpreted with the aid of acoustic and residence time analyses. The results indicate that the frequency is controlled by the acoustics in the inlet duct and the vortex convection inside the combustor. The amplitude of oscillation is determined by the nature of the perturbed flow entering and leaving the combustor and there is evidence for a chaotic type of variation in amplitude. Author

A89-25494# EVIDENCE OF A STRANGE ATTRACTOR IN RAMJET COMBUSTION

RUSSELL G. KEANINI, KENNETH YU (California, University, Berkeley), and JOHN W. DAILY (Colorado, University, Boulder) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (Contract N00014-84-K-0372)

(AIAA PAPER 89-0624)

Preliminary evidence suggests that the random pressure fluctuations which occur during acoustically coupled unstable combustion inside a laboratory ramjet combustor describe a strange attractor. Power spectra, phase portraits, and Poincare sections are all indicative of a strange attractor. The fractal dimension of the attractor is estimated to be in the range of 1.5 to 3.8. The apparent attractor appears to have other properties associated with strange attractors, most notably, exponentially diverging phase trajectories and the tendency to transmute to other structures as a critical parameter is varied. This appears to be the first reported instance of chaotic dynamics occurring in a combustion process. Author

A89-25533#

SCRAMJET ANALYSIS WITH CHEMICAL REACTION USING THREE-DIMENSIONAL APPROXIMATE FACTORIZATION

J. C. WAI and D. SOMMERFIELD (Boeing Advanced Systems, Seattle, WA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(AIAA PAPER 89-0672)

The design of a scramjet propulsion system for a hypersonic vehicle is a challenging engineering problem. A thin-layer Navier-Stokes computer program has been developed to study the associated viscous and chemically reacting flow fields. A significant computing speed improvement in the finite rate chemistry analysis was achieved relative to other methods by using an existing proven flow solver technology. The new code solves the gas dynamic and species conservation equations in a fully coupled manner using the diagonalization of the approximate factorization algorithm. The flows of two generic lobed fuel injectors with hydrogen-air combustion were investigated to explore scramjet lobed injector design. Author

A89-27694#,

SUBCRITICAL SWIRLING FLOWS IN CONVERGENT, ANNULAR NOZZLES

K. KNOWLES (Royal Military College of Science, Shrivenham, England) and P. W. CARPENTER (Exeter, University, England) AIAA Journal (ISSN 0001-1452), vol. 27, Feb. 1989, p. 184-191. refs

A quasicylindrical theory is developed for subcritical, inviscid, swirling flows in annular nozzles and extended to include nonuniform stagnation conditions. A small perturbation theory is also developed and shown to give remarkably good agreement, even for high swirl levels. The effects on mass flow rate, impulse function, and thrust of different swirl velocity profiles are investigated for a typical turbofan geometry, with nonswirling core nozzle flow, at differing nozzle pressure ratios. Specific thrust is found to decrease with swirl. The rate of decay depends on the swirl velocity profile, and the relative effects of different swirl profiles depend on the basis of comparison. Author

A89-28202

PROP-FAN STRUCTURAL RESULTS FROM PTA TESTS

P. C. BROWN and J. E. TURNBERG (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988, 12 p. refs

(SAE PAPER 881418)

The Propfan Test Assessment program has used a testbed aircraft wing-mounted 9-ft diameter rotor, driven by a gas turbine engine, to both demonstrate this technology and obtain baseline-defining structural data useful in the understanding of larger propfans. Blade dynamic strain measurements have been made over a range of ground-operation and flight-operation conditions; these encompass the effects of various nacelle tilt angles. The trends in blade dynamic response with aircraft operating condition that emerge are compared to propfan forced-response predictions. 00

A89-28228* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RESULTS FROM NASA LANGLEY EXPERIMENTAL STUDIES OF MULTIAXIS THRUST VECTORING NOZZLES

BOBBY L. BERRIER (NASA, Langley Research Center, Hampton, SAE, Aerospace Technology Conference and Exposition, VA) Anaheim, CA, Oct. 3-6, 1988. 18 p. refs

(SAE PAPER 881481)

Multiaxis thrust-vectoring nozzles can furnish substantial combat performance gains for military aircraft; in pursuit of these gains, NASA-Langley has conducted an extensive experimental research program encompassing both static and freestream performance evaluations for numerous multiaxis thrust-vectoring nozzle concepts using air-powered simulation models. An evaluation is presently made of a selection of these experimental results. Two-dimensional and axisymmetric convergent-divergent configurations and hybrid configurations, with and without postexit vanes, have been O.C. studied.

A89-28254

AEROSPACE POWER SYSTEMS TECHNOLOGY: PROCEEDINGS OF THE AEROSPACE TECHNOLOGY CONFERENCE AND EXPOSITION, ANAHEIM, CA, OCT. 3-6, 1988

Conference and Exposition sponsored by SAE. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-758), 1988, 151 p. For individual items see A89-28255 to A89-28269. (SAE SP-758)

The present conference on aircraft auxilliary power systems discusses aircraft thermal management, highly reliable DC power sources for avionic subsystems, a cascaded doubly-fed variable-speed/constant-frequency generator, the evolution of battery systems employed by USAF aircraft, electrical power system architectures for future aerospace vehicles, and high-reliability aircraft generators. Also discussed are the benefits of digital control and management system integration in secondary power systems, pneumatic link secondary power systems for military aircraft, the combination of emergency power with an APU, X-29A subsystems integration, and the T-100 multipurpose small power unit. 00

A89-28257

A HIGHLY RELIABLE DC POWER SOURCE FOR AVIONIC SUBSYSTEMS

MARIO R. RINALDI (Sundstrand Corp., Sundstrand Advanced Technology Group, Rockford, IL) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 27-31. (SAE PAPER 881408)

A highly reliable alternative source for aircraft + 28 V dc power is presented. This alternative uses a permanent magnet generator and an electronic converter/regulator (C/R). The power system includes such features as independence from the main power system, high power quality with terminal or remote point of regulation, light weight, and constant power availability from engine idle to maximum rpm. Included is a brief system description, a review of steady state and transient performance, and a conclusion with a perspective on future expectations. Author

A89-28258

EXPERIMENTAL CASCADED DOUBLY FED VARIABLE SPEED CONSTANT FREQUENCY GENERATOR SYSTEM

MIGUEL A. MALDONADO and STEVEN M. IDEN (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) ĪN Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers. Inc., 1988, p. 33-39.

(SAE PAPER 881409)

Brushless variable-speed constant frequency (VSCF) electric power generation may be obtained using cascaded, symmetricallywound machines. The feasibility of using these machines as the basis for a stand-alone aircraft generator system was investigated. The concept is attractive as the system operates without hydraulics and employs a solid-state power converter which operates at a fraction of the system output power and frequency. These factors combine to offer a system of relatively low complexity, with the potential for high-reliability operation. This paper will discuss the operation of the cascaded doubly-fed VSCF generator system and microprocessor control unit. Author

A89-28259

PARALLEL OPERATION OF VSCF ELECTRICAL POWER GENERATORS

D. E. BAKER and E. R. HONIGFORD (Westinghouse Electric Corp., Lima, OH) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 41-50.

(SAE PAPER 881410)

While variable-speed/constant-frequency (VSCF) electrical power generation systems have in the past been restricted to aircraft not requiring the parallel operation of multiple channels, novel multiengine aircraft applications entail the continuous parallel operation of installed channels to furnish superior system reliability and equal loading of the generators. In VSCF systems, synchronous operation with precise angle control between channels is furnished during either parallel or split operational modes; the autoparalleling of channels therefore results in very small amplitude transients and virtually no frequency or phase-angle transients on the bus. O.C.

A89-28260

OVERVIEW ON THE EVOLUTION OF AIRCRAFT BATTERY SYSTEMS USED IN AIR FORCE AIRCRAFT

RICHARD A. FLAKE (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 51-53. (SAE PAPER 881411)

Efficient USAF operations require maintenance-free aircraft batteries; potential cost-savings of the order of millions of dollars/year have been projected for maintenance-free battery systems. Attention is given to the current development status and maintenance consequences of Ni-Cd batteries and sealed lead-acid batteries, as well as the the prospects foreseen for their improvement from a maintenance-requirement viewpoint. In 1986, initiated the development of a sealed Ni-Cd AFWAL battery/charger/microprocessor-controlled unit with built-in test capability which can fly aboard aircraft for 3 years (1500 flight hours) before scheduled maintenance. O.C.

A89-28262

UNBALANCED AND NONLINEAR LOADS IN AIRCRAFT ELECTRICAL SYSTEMS

BERNARD A. RAAD (Sundstrand Corp., Sundstrand Advanced Technology Group, Rockford, IL) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 63-68. refs (SAE PAPER 881413)

Analytical and empirical data are presently brought to bear on the problematic effects of unbalanced and nonlinear loads on three-phase synchronous generator-driven aircraft electrical power system behavior. The effects extend to voltage imbalances, phase-angle displacements, line-induced harmonics, voltage spikes, waveform distortion, and coronas. The present treatment recommends the institution of filtering, load-induced distortionlimiting specifications, and novel voltage regulator designs. O.C.

A89-28263

HIGH RELIABILITY AIRCRAFT GENERATOR SYSTEM

STEVEN M. IDEN and ANGELA MORRIS (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 69-74.

(SAE PAPER 881414)

The resonant-link power system presently considered as an approach to the generation of constant-voltage power by a variable-speed/constant-frequency apparatus. A permanent-magnet genertor is used in conjunction with a resonant-link solid state power converter. The use of the resonant-link allows a bidirectional power flow for engine-start capability, and permits power semiconductor devices to be switched during the high-frequency link zero-crossings; this reduces device stresses and thereby improves reliability. A 40-kVA technology demonstrator resonant link device is under development. O.C.

A89-28264

SECONDARY POWER - BENEFITS OF DIGITAL CONTROL AND VEHICLE MANAGEMENT SYSTEM INTEGRATION

JAMES M. BENSON (McDonnell Aircraft Co., Saint Louis, MO) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 75-81.

(SAE PAPER 881498)

Seconary power by definition is any power other than main propulsive power. Integrated digital control of the secondary power system will play an important role in the overall enhancement of advanced fighter aircraft. This paper will address the design and development philosophy of an integrated, digitally-controlled and monitored secondary power system. Subsystem design requirements and critical technologies needed for implementation and integration with a Vehicle Management System (VMS) will be identified. A design approach and road map will be presented on the procedure to target such a system for a fully integrated application such as a VMS.

A89-28265

PNEUMATIC LINK SECONDARY POWER SYSTEMS FOR MILITARY AIRCRAFT

COLIN RODGERS (Sundstrand Corp., Sundstrand Turbomach Div., San Diego, CA) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 83-98. refs (SAE PAPER 881499)

Recent requirements for in-flight engine cross-bleed starts in twin-engined military aircraft at the higher Mach numbers have compelled increases of bleed internal duct temperatures to 1200 F. Attention is presently given to the consequences of the direct

07 AIRCRAFT PROPULSION AND POWER

use of higher APU bleed air pressure ratios, or the alternative use of 'bleed-and-burn' power-augmentation, for the power density of pneumatic-link startup systems. It is found that bleed pressure ratios as high as 6.0 can furnish a more that 10-percent savings in power/volume ratio, depending on APU location; the use of power augmentation is found able to furnish a more-than 25-percent weight/volume reduction, but may conflict with increasing avionics ground cooling capacity demands.

A89-28266

EMERGENCY POWER COMBINED WITH AUXILIARY POWER UNIT

DONALD B. STEWART, JR. (Allied-Signal Aerospace Co., Garrett Auxiliary Power Div., Phoenix, AZ) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 99-113. (SAE PAPER 881500)

A testing program has demonstrated the feasibility and advantages of combining emergency power unit (EPU) and auxiliary power unit (APU) in a single powerpack, designated the Multifunction Integrated Power Unit, for fighter aircraft. Weight, volume, and cost are thereby reduced due to the obviation of a gearbox and separate control systems. The lower parts count also reduces maintenance, logistics support, and spares requirements. An APU by itself would not supply the requisite fast power initiation, especially at extreme altitudes. The EPU employed uses conventional jet fuel to simplify operational and maintenance requirements. O.C.

A89-28336#

ACOUSTIC-VORTEX INTERACTIONS AND LOW-FREQUENCY OSCILLATIONS IN AXISYMMETRIC COMBUSTORS

K. KAILASANATH, J. H. GARDNER, J. P. BORIS, and E. S. ORAN (U.S. Navy, Naval Research Laboratory, Washington, DC) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Mar.-Apr. 1989, p. 165-171. Research sponsored by the U.S. Navy. Previously cited in issue 08, p. 1050, Accession no. A87-22454. refs

A89-28337#

MODULAR ANALYSIS OF SCRAMJET FLOWFIELDS

JOSEPH A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg), FREDERICK S. BILLIG, and STANLEY FAVIN (Johns Hopkins University, Laurel, MD) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Mar.-Apr. 1989, p. 172-180. Research supported by the U.S. Navy. Previously cited in issue 20, p. 3179, Accession no. A87-45443. refs

A89-28342#

INFLUENCE OF VANE/BLADE SPACING AND INJECTION ON STAGE HEAT-FLUX DISTRIBUTIONS

M. G. DUNN (Calspan Advanced Technology Center, Buffalo, NY) and R. E. CHUPP (Teledyne CAE, Toledo, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Mar.-Apr. 1989, p. 212-220. Research supported by the Teledyne CAE Independent Research and Development Funds. Previously cited in issue 20, p. 3156, Accession no. A87-45295. refs

A89-28403*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPARISON OF 3D COMPUTATION AND EXPERIMENT FOR NON-AXISYMMETRIC NOZZLES

H. LAI and E. NELSON (NASA, Lewis Research Center, Cleveland; Sverdrup Technology, Inc., Middleburg Heights, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs

(Contract NAS3-24105; NAS3-25266)

(AIAA PAPER 89-0007)

Three-dimensional solutions of a single expansion ramp nozzle are computed with the existing PARC computer code by solving the full Navier-Stokes equations. The computations are performed to simulate the non-axisymmetric nozzle flowfield in both the internal/external expansion regions and the exhaust plume in a quiescent ambient environment. Two different configurations of the nozzle at a pressure ratio NPR = 10 are examined. Numerical results of laminar flows are presented, and the wall pressure distributions are compared with the experimental data. Author

A89-28462*# Purdue Univ., West Lafayette, IN. EFFECT OF HEAVY RAIN ON AVIATION ENGINES

S. N. B. MURTHY (Purdue University, West Lafayette, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 20 p. refs

(Contract NAG3-481; DOT-FA03-83-A-00328)

(AIAA 89-0799)

High bypass ratio gas turbine engines may ingest water and hail during flight in an environment of thunderstorms, and the performance and the operation-handling characteristics of the engine and its control become affected often substantially and critically. It is, therefore, of interest to establish predictive schemes for determining changes in performance of components and the total system. The current status of development of such predictive schemes is discussed along with illustrative examples. The needs for additional research are discussed, that are essential for improving: (1) the predictive schemes and (2) the methods of simulating in-rain flight conditions on ground.

N89-16782# Naval Air Systems Command, Washington, DC. AN OVERVIEW OF US NAVY ENGINE MONITORING SYSTEM PROGRAMS AND USER EXPERIENCE

ANDREW J. HESS In AGARD, Engine Condition Monitoring: Technology and Experience 16 p Oct. 1988

Avail: NTIS HC A20/MF A01

The Naval Air System Command (NAVAIR) has made a commitment to require inflight engine monitoring capabilities and Engine Monitoring Systems (EMS) on all new aircraft and engine programs. The current EMS requirement and system design concepts are the end result of over 15 years of developing system capabilities and justifying system benefits. These requirements and system design concepts are based on the lessons learned from the F/A-18 and A-7E Inflight Engine Condition Monitoring System (IECMS) program. The highly successful A-7E IECMS is the cornerstone on which all Navy EMS are based today. NAVAIR has revised the general engine specifications to contain detailed requirements for a comprehensive EMS. These requirements were included for flight safety, maintenance, engineering management, and operational support benefits. These specification requirements were used on all new aircraft/engine programs (e.g., F-14A+, F-14D, A-6F, AV-8B, E-2C re-engine, and V-22). When justifiable, EMS is also being considered for retrofit on several older aircraft/engine applications. An overview is given of the U.S. Navy EMS program status. Established EMS functional capabilities and requirements are discussed and detailed specification items are reviewed. Current EMS projects are examined with respect to system description, program status and individual peculiarities. Finally, conclusions are given on EMS projected benefits, user lessons learned, and future directions of this experience, Author technology.

N89-16783# Royal Air Force, London (England). ENGINE USAGE CONDITION AND MAINTENANCE MANAGEMENT SYSTEMS IN THE UK ARMED FORCES W. D. M. FLETCHER and N. A. BAIRSTO In AGARD, Engine

Condition Monitoring: Technology and Experience 5 p Oct. 1988 Avail: NTIS HC A20/MF A01

The cost effectiveness of engine condition monitoring is often questioned. The Royal Air Force (RAF) has considerable experience in engine condition monitoring based on a series of trials. Recently aircraft were introduced with comprehensive monitoring systems. Previous condition usage monitoring trials are outlined together with the reasons for changing from scheduled based maintenance to condition based maintenance. The cost effectiveness of various methods is revealed and the difficulty of justifying the retrofit of equipment fleetwide is discussed. Finally, some of the current activities in the RAF on condition monitoring are presented. Author

N89-16784# National Defence Headquarters, Ottawa (Ontario). Directorate of Transport and Helicopter Engineering and Maintenance.

CANADIAN FORCES AIRCRAFT CONDITION/HEALTH MONITORING: POLICY, PLANS AND EXPERIENCE

CHRISTOPHER SCHOFIELD, ROSS LAGRANDEUR, FRANCOIS DUBE, THOMAS HARRIS, ROBERT W. CUE, and ALAIN LEBLANC *In* AGARD, Engine Condition Monitoring: Technology and Experience 10 p Oct. 1988

Avail: NTIS HC A20/MF A01

Current Canadian Forces (CF) policy with respect to aircraft Engine Condition/Health Monitoring (ECM/EHM) is highlighted. In doing so, a summary of CF aircraft types and the ECM/EHM techniques applied to each is presented. The CF's experience to date with the development and application of ECM/EHM is reviewed. This includes an examination of the effectiveness of the CF Spectrometric Oil Analysis Program and the use of magnetic particle detectors and manual performance trending. Present plans for further development and implementation of policy; methodologies and techniques; and for the integration of these into an effective ECM/EHM capability that will pay benefits both in terms of life cycle costs and operational availability, are presented.

N89-16787# GasTOPS Ltd., Ottawa (Ontario). CF-18 ENGINE PERFORMANCE MONITORING

D. E. MUIR, D. M. RUDNITSKI, and ROBERT W. CUE (National Defence Headquarters, Ottawa, Ontario) /n AGARD, Engine Condition Monitoring: Technology and Experience 20 p Oct. 1988 Avail: NTIS HC A20/MF A01

The Canadian Forces (CF) have adopted a conditional maintenance concept for the engines of the CF-18 fighter aircraft. In support of this concept, advanced engine performance monitoring procedures are being developed to track the general performance level of each engine and identify problematic engine components. The procedures are based on takeoff ground roll data recorded by the aircraft In-Flight Engine Condition Monitoring System and steady-state data obtained from automated Engine Test Facilities. The development and field evaluation of these procedures is described. A discussion of future development work and related research activities is also included.

N89-16790# Ministry of Defence, London (England). Directorate of Engines.

RECENT UK TRIALS IN ENGINE HEALTH MONITORING: FEEDBACK AND FEEDFORWARD

M. J. SAPSARD *In* AGARD, Engine Condition Monitoring: Technology and Experience 8 p Oct. 1988

Avail: NTIS HC A20/MF A01

Engine health monitoring effectiveness had to be quantified prior to large scale commitment by the UK Services. Some of the activities undertaken in Air Staff Target 603 are described. A program was set up to assess that effectiveness. Also described are some of the incidental lessons learned from this and other related health monitoring exercises. Author

N89-16796# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry Cedex (France).

SERVICE LIFE CALCULATOR FOR THE M53 TURBOFAN ENGINE [LE CALCULATEUR DE POTENTIEL SUR LE REACTEUR M53]

CLAUDE SPRUNG In AGARD, Engine Condition Monitoring: Technology and Experience 15 p Oct. 1988 In FRENCH Avail: NTIS HC A20/MF A01

The functional requirements for a service life calculator are defined and the flight and ground equipment comprising such a system are described. A system utilization philosophy is defined and preliminary results from studies considering the application of service life calculators are presented. Author

N89-16800# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).

THE ADVANTAGE OF A THRUST RATING CONCEPT USED **ON THE RB199 ENGINE**

P. THEIMER In AGARD, Engine Condition Monitoring: Technology and Experience 15 p Oct. 1988

Avail: NTIS HC A20/MF A01

The control system of the RB199 engine was designed for a rating, using the HP-turbine inlet temperature as a limiter. The engine has now been in service for 7 years and still uses the original concept throughout all fleets in the UK, Italy and Germany, although new digital engine control units are being introduced which will allow considerable improvements. For some fleets a thrust rating concept based on the original control system design has been installed recently. The concept is described and the procedure explained. A comparison is made between the existing full thrust concept at the maximum cleared HP turbine temperature and the applied thrust rating concept. Besides the basic behavior of seal gaps, the influence of thrust rating in view of the life usage of life-limited parts as well as in the change of the maintenance material costs is explained. The assumptions for the comparison with their background are described. Finally, a refined thrust rating concept is introduced. Author

N89-16802# Aeronautical Research Labs., Melbourne (Australia).

GAS PATH ANALYSIS AND ENGINE PERFORMANCE MONITORING IN A CHINOOK HELICOPTER

D. E. GLENNY In AGARD, Engine Condition Monitoring: Technology and Experience 14 p Oct. 1988 Avail: NTIS HC A20/MF A01

Periodic and consistent assessment of engine performance in military heicopters is essential if in-service operating margins are not to be eroded by harsh environmental conditions. Manually initiated GO-NO-GO pre-flight checks (HIT, etc.) or ad-hoc in-flight performance checks rarely provide sufficiently reliable data for maintenance or diagnostic purposes. In contrast, performance assessment methods based on gas path analysis principles and engine/aircraft data, automatically recorded during flight, offer a potentially attractive alternative. ARL has investigated a number of these alternatives, and has carried out an in-service trial on a Boeing CH47C Chinook helicopter operated by the RAAF. In the trial existing aircraft/engine instrumentation was complemented by specially designed probes located at module interfaces while the data was recorded on an ARL designed acquisition system. The performance-fault algorithms used in the analyses were configured for a range of engine operating speeds. Results for the trial are presented in terms of deviations from pre-established baseline conditions. Statistical analyses using linear regression fits and Kalman filtering techniques have been investigated to minimize the effects of data uncertainty. The applicability of the procedures, including thermodynamic analyses and equipment are discussed in terms of fleetwide adoption of the Chinook. Author

N89-16803# National Research Council of Canada, Ottawa (Ontario).

THE EFFECTS OF A COMPRESSOR REBUILD ON GAS TURBINE ENGINE PERFORMANCE

J. D. MACLEOD and J. C. G. LAFLAMME (Canadian Forces Base, Baden-Soellingen, Germany, F.R.) In AGARD, Engine Condition Monitoring: Technology and Experience 14 p Avail: NTIS HC A20/MF A01 Oct. 1988

The Canadian Department of Defence, in conjunction with the Engine Laboratory of the National Research Council Canada, initiated a project for the evaluation of gas path coatings on the Allison T56 engine. The objective of this work was to evaluate blade coatings in terms of engine performance effects and material durability. The project included a study of the influence of rebuilding the compressor on performance, since dismantling and rebuilding was required in the coating process. Described is the compressor rebuild study, including the overall objectives, the test set-up, the performance effects, and the uncertainty of the measured results. The impact of this work on the coatings project is also documented. Author

GEC Avionics Ltd., Rochester (England). Future N89-16804# Systems Group.

SYSTEM CONSIDERATIONS FOR INTEGRATED MACHINERY **HEALTH MONITORING**

R. M. TESTER In AGARD, Engine Condition Monitoring: Technology and Experience 14 p Oct. 1988

Avail: NTIS HC A20/MF A01

Aircraft engine health monitoring, and other related machinery condition monitoring, has been gaining in credibility and implementation over recent years. It is destined to become standard fit on all new major aircraft programs in the near future. To date the monitoring systems have mainly been stand-alone in form. and have been treated as separate functions. This paper discusses the considerations for integrating health monitoring into other aircraft systems, and reviews the potential benefits to be gained by such integration. In conclusion, the paper presents two products from both ends of the spectrum, representing a simple single unit integration, and a full aircraft-wide implementation. Author

N89-16805# Societe de Fabrication d'Instruments de Mesure, Massy (France). Measurement and Flight Test Dept.

MAINTENANCE AID SYSTEM FOR WIDE BODY AIRCRAFT

ALBERT LEVIONNOIS In AGARD, Engine Condition Monitoring: Technology and Experience 7 p Oct. 1988 Avail: NTIS HC A20/MF A01

Aircraft maintenance personnel, when troubleshooting aircraft failures, must first acquire a great deal of information about the aircraft's engines before being able to arrive at any kind of diagnosis. Computerized modern aircraft provide all necessary parameters with good precision. Aircraft condition monitoring systems centralize information from data buses, compute flight phases, determine the reports to be made per flight phase and function, and carry out automatic parameter identification. Should an incident occur, then the parameter's history is stored before and after the incident, together with its evolution. All this information is stored in static memory for transmission by data link, is printed during or after the flight, or downloaded when the aircraft is back at its base. Today between 35 and 40 reports are currently produced by wide body aircraft. This technology is easily adaptable to combat aircraft. Author

N89-16806# Computing Devices Co., Ottawa (Ontario). INSTALLED THRUST AS A PREDICTOR OF ENGINE HEALTH FOR JET ENGINES

G. B. MACKINTOSH and M. J. HAMER In AGARD, Engine Condition Monitoring: Technology and Experience 10 p Õct. 1988

Avail: NTIS HC A20/MF A01

Extensive installed and uninstalled gross thrust measurements were made over one complete maintenance cycle on 19 afterburning turbojet engines. Installed measurements utilized a sensor which can compute the thrust in real time from engine tailpipe pressure measurements. Correlation of installed thrust with maintenance history indicated a maximum degradation below which engines were removed from service. The engines were trimmed uninstalled, using lapse rate charts to produce a specific value of uninstalled thrust, corrected to standard conditions. Significant variations in installed corrected thrust resulted. Higher initial values of installed corrected thrust resulted in more rapid engine degradation and a shorter time before maintenance was required. Author

N89-16809# Pratt and Whitney Aircraft of Canada Ltd., Longueuil (Quebec).

FAULT MANAGEMENT IN AIRCRAFT POWER PLANT CONTROLS

S. MAZAREANU and A. NOBRE In AGARD, Engine Condition Monitoring: Technology and Experience 16 p Oct. 1988 Avail: NTIS HC A20/MF A01

The advent of Digital Electronics in aviation has opened new

07 AIRCRAFT PROPULSION AND POWER

doors to fault management as a tool to enhance aircraft operability and safety in flight. Today it is possible to integrate flight control systems with power plant management systems. Operability of a battle-damaged aircraft can be enhanced under certain conditions through sophisticated fault management systems. This paper reviews some of the considerations applicable to engine control fault management systems in commercial aviation. Engine control systems have evolved in the last decade from being primarily hydromechanical to being primarily electronics. This rapid growth in acceptance of the electronic systems by the aviation industry was due to the improvement in reliability of the digital system over analog systems previously in use. The fault management system is a powerful tool to organize and optimize maintenance logistics. Operating costs can be significantly reduced with an appropriate fault management system on board. The paper presents: (1) a brief review of the evolution of engine controls; (2) the emergence of fault management systems (as part of engine control systems); (3) maturity of fault management systems (still evolving); and (4) future potential. Author

N89-16813# Aeronautical Research Labs., Melbourne (Australia).

IDENTIFICATION OF DYNAMIC CHARACTERISTICS FOR FAULT ISOLATION PURPOSES IN A GAS TURBINE USING CLOSED-LOOP MEASUREMENTS

G. L. MERRINGTON In AGARD, Engine Condition Monitoring: Technology and Experience 13 p Oct. 1988

Avail: NTIS HC A20/MF A01

Combat aircraft, because of the mission profiles involved, tend to rarely operate with their engines in a steady-state condition for extended periods. Furthermore, current generation aircraft contain Engine Monitoring Systems (EMS) which automatically capture a record of important engine parameters when a parameter exceedance is detected. It follows then that any subsequent post-flight data analysis for fault isolation purpose will often necessitate the extraction of the required diagnostic information from transient data records. This generally contrasts with past practice where most of the available fault diagnostic procedures have been derived from steady-state information. In an attempt to overcome this, and thereby provide effective tools for diagnosing faults from transient data records, a procedure is outlined to extract information about the dynamic characteristics of gas turbines from input/output measurements. The parameter estimator technique involved has the potential to provide a means of detecting changes in some unmeasured/unrecorded parameter, such as shifts in variable geometry schedules. Thus in essence, it provides a tool for identifying problems from simple transient test data which were Author previously inaccessible or difficult to obtain.

Canadian Forces Base Trenton, Astra (Ontario). N89-16814# Aerospace Maintenance Development Unit.

CF-18/F404 TRANSIENT PERFORMANCE TRENDING

J. R. HENRY In AGARD, Engine Condition Monitoring: Technology and Experience 13 p Oct. 1988 (Contract FE220786FRMC4; ARP-3610-147)

Avail: NTIS HC A20/MF A01

The on condition concept of aircraft engine maintenance has led to intensive analysis of the data recorded by Engine Health Monitoring systems during steady-state operation of the engine. To date however the transient data acquired during take-off or in-flight have received far less attention. Presented here are the results of an investigation into the feasibility of utilizing engine data acquired during take-off to trend the performance of a modern turbofan engine (GE-F404). Factors influencing the repeatability of take-off data such as throttle rate, variable geometry and instrumentation effects are discussed. Using engine data from operational aircraft, various trending parameters are evaluated using a data capture window developed to minimize the scatter of nominal engine performance. A statistical tool to identify performance shifts is briefly described, and is shown to successfully detect a shift in the take-off performance of a recently repaired engine. It is concluded that the trending of transient performance data is a viable means of detecting certain engine faults and recommendations are made concerning the implementation of such Author a program for the F404 engine.

N89-16821# Naval Postgraduate School, Monterey, CA. Dept. of Aeronautics and Astronautics.

MEASUREMENTS OF GAS TURBINE COMBUSTOR AND ENGINE AUGMENTOR TUBE SOOTING CHARACTERISTICS Final Report, Oct. 1986 - Sep. 1987

M. F. YOUNG, T. A. GRAFTON, H. CONNER, and DAVID W. NETZER Jul. 1988 57 p

(AD-A199768; NPS67-88-002) Avail: NTIS HC A04/MF A01 CSCL 21B

An experimental investigation was conducted to determine the changes in soot mean diameter across the combustor and exhaust nozzle of a T63 gas turbine engine, and across an exhaust augmentor tube. D32 within the combustor varied between 0.16 and 0.25 microns, depending upon fuel composition. Data correlation was most successful in this location using an index of refraction of 1.95 -0.66i with sigma = 1.5. In the aft can location (ahead of the exhaust nozzle) D32 was between 0.35 and 0.45 microns, depending upon the fuel-air ratio. Increasing fuel-air ratios decreased D32, also in agreement with the results presented in reference 1. Using NAPC 9 high aromatic fuel, D32 increased across the exhaust nozzle (0.35 to 1.2 microns) and across the augmentor tube (1.2 to 1.5 = 1.9 microns). Malvern data were in good agreement with the results obtained using larger scattering GRA angles.

N89-16825# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

TRANSONIC COMPRESSORS, VOLUME 1

1988 240 p Lecture series held in Rhode-Saint-Genese, Belgium, 1-4 Feb. 1988

(VKI-LS-1988-03-VOL-1; ISSN-0377-8312; ETN-89-93590) Avail: NTIS HC A11/MF A01

Loss development in transonic compressor cascades; incidence angle rules in supersonic cascades; exit angle rules in supersonic cascades; shock losses in transonic and supersonic compressor cascades: axial velocity density ratio influence on exit flow angle in transonic/supersonic cascades; analysis of 3D viscous flows in transonic compressors; and inverse methods for blade design, controlled diffusion blading for supercritical compressor flow were discussed.

ESA

N89-16826# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (Germany, F.R.). Inst. fuer Strahlantrieb.

LOSS DEVELOPMENT IN TRANSONIC COMPRESSOR CASCADES

HANS STARKEN In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 1 17 p 1988 Avail: NTIS HC A11/MF A01

Loss in a supercritical cascade is discussed. It is argued that efficient transition of a compressor cascade to supersonic velocities requires a limitation of the suction surface Mach number to values below 1.3. This, in turn, limits pitch-chord ratio, front suction surface camber, and leading edge radius as the responsible parameters. In order to elucidate this, the influence of the blade suction surface and the pitch chord ratio is demonstrated by test results obtained at subsonic and low supersonic velocities. ESA

Deutsche Forschungs- und Versuchsanstalt fuer N89-16827# Luft- und Raumfahrt, Porz (Germany, F.R.). Inst. fuer Strahlantriebe.

INCIDENCE ANGLE RULES IN SUPERSONIC CASCADES

HANS STARKEN In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 1 31 p 1988

Avail: NTIS HC A11/MF A01

Supersonic inlet flow of flat plate cascades, and blades having cambered suction surfaces is analyzed. The whole flow field is computed with the method of characteristics in cases where supersonic velocity is assumed everywhere in the entrance region. Where the flow field contains local subsonic regions, approximations can be applied, if the subsonic regions are small enough. Calculations were performed for a straight flat plate profile. The maximum mass-flow of a two dimensional cascade is shown to be limited by the ratio of leading edge over blade pitch. The strong influence of leading edge radius, and the minor influence of stagger angle on the maximum axial Mach number are noted. ESA

Deutsche Forschungs- und Versuchsanstalt fuer N89-16828# Luft- und Raumfahrt, Porz (Germany, F.R.). Inst. fuer Strahlantriebe.

EXIT ANGLE RULES IN SUPERSONIC CASCADES

HANS STARKEN In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 1 19 p 1988

Avail: NTIS HC A11/MF A01

The infinitely thin flat plate cascade is used to describe the fundamental flow phenomena which apply to compressor and turbine cascades. With increasing flow angle at the blade trailing edges, which is equivalent to an increase in back pressure, left running obligue shock waves occur at the suction sides of the trailing edges and are reflected at the pressure sides of the adjacent blades. Up to these left running trailing edge shock waves the supersonic flow field in front and within the cascade remains unchanged. For the calculation of the exit flow field behind these shock waves it is necessary to realize that all left running characteristics emanate from the uniform flow field infinitely far downstream. Therefore, the exit flow field can be assumed, in first approximation, to be of the simple wave type, which means that the right running characteristics are straight lines with constant properties. In order to calculate the neutral exit characteristic, it would be necessary to continue the computation up to infinity downstream. But if the knowledge of the complete flow field behind the cascade is not required, a method based upon the simple wave approximation can be used. ESA

N89-16829# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (Germany, F.R.). Inst. fuer Strahlantriebe.

SHOCK LOSSES IN TRANSONIC AND SUPERSONIC COMPRESSOR CASCADES

H. A. SCHREIBER In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 1 58 p 1988

Avail: NTIS HC A11/MF A01

Flow phenomena and the associated losses of transonic blade sections for upstream Mach numbers of 0.8 to 1.2 are described. Shock losses of two supersonic blade sections of the so-called precompression type are analyzed. Theoretical results of a shock loss model are discussed, showing the influence of inlet Mach number and inlet flow angle. The shock structure and strength within the blade passage of a supersonic blade section is studied, and an insight into the problem of strong shock wave boundary laver interaction with turbulent boundary layer separation is given. Depending on inlet Mach number, inlet flow angle, and back pressure the shock loss level reaches 40 to 70 percent of the overall losses. The data show that shock loss calculations should not be oversimplified but should be carefully modeled according to the real flow conditions. The overall losses have their origins in the leading edge bow shock of supersonic blades that contributes up to 30 percent to the shock losses; the main compression shock or strong passage shock; and viscous losses related to the boundary layer evolution including regions of shock/boundary layer interactions. ESA

N89-16830# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (Germany, F.R.). Inst. fuer Strahlantriebe.

AXIAL VELOCITY DENSITY RATIO INFLUENCE ON EXIT FLOW ANGLE IN TRANSONIC/SUPERSONIC CASCADES

H. A. SCHREIBER In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 1 22 p 1988 Avail: NTIS HC A11/MF A01

Axial velocity density ratio (AVDR) influence on the cascade exit flow angle Beta sub 2 is discussed. A simple relationship between AVDR and Beta sub 2 is outlined. The AVDR influence on the exit flow properties of supersonic cascades which operate with started supersonic flow at cascade entrance is reviewed.

ESA

N89-16831# Cambridge Univ. (England). ANALYSIS OF 3D VISCOUS FLOWS IN TRANSONIC COMPRESSORS

W. N. DAWES In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 1 27 p 1988

Avail: NTIS HC A11/MF A01

A computer code to solve the 3D Reynolds averaged compressible Navier-Stokes equations was applied to a linear cascade of compressor blades and the effect of mesh refinement on profile loss prediction studied. Secondary flow development in a cascade of compressor stator blades is predicted and compared with measurement. The code was applied to the study of the flow field in a transonic axial compressor rotor at design speed and maximum efficiency. The first test case shows that near grid independent predictions could be achieved for profile loss. The second case shows predictions of secondary flow development in a cascade of compressor stator blades comparing well with measurement. The third case shows predictions for the flow in a transonic compressor rotor with clearance. Good agreement with experimental evidence is achieved and valuable insight obtained into the loss production mechanisms associated with clearance ESA flows.

N89-16832# Stuttgart Univ. (Germany, F.R.). Inst. fuer Aerodynamik und Gasdynamik.

INVERSE METHODS FOR BLADE DESIGN, CONTROLLED DIFFUSION BLADING FOR SUPERCRITICAL COMPRESSOR FLOW

In Von Karman Institute for Fluid Dynamics, E. SCHMIDT Transonic Compressors, Volume 1 56 p 1988

Avail: NTIS HC A11/MF A01

Cascade design methods are reviewed, and an inverse cascade design method on stream surfaces of revolution is presented. The method seems to be an effective procedure to design highly loaded axial compressor cascades on stream surfaces of revolution. It produces accurate results compared with complete flow field measurements and computations from other methods. It was applied to cascade and multisection compressor blade design. Lower losses are obtained, compared with conventional NACA blading. ESA

Von Karman Inst. for Fluid Dynamics, N89-16833# Rhode-Saint-Genese (Belgium). TRANSONIC COMPESSORS, VOLUME 2

1988 390 p Lecture series held in Rhode-Saint-Genese, Belgium, 1-4 Feb. 1988

(VKI-LS-1988-03-VOL-2; ISSN-0377-8312; ETN-89-93591) Avail: NTIS HC A17/MF A01

The design and development of transonic multistage compressors; design of critical compressor stages; supersonic compressors; supersonic throughflow fans; variable geometry in supersonic compressors; axial supersonic inlet components; design methodology for high pressure compressors; and holographic inteferometry for flow visualization studies in high speed fans, and in vibration and flutter study of fans were discussed.

ESA

N89-16834*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE DESIGN AND DEVELOPMENT OF TRANSONIC MULTISTAGE COMPRESSORS

C. L. BALL, R. J. STEINKE, and F. A. NEWMAN In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 2 1988 97 p

Avail: NTIS HC A17/MF A01

The development of the transonic multistage compressor is

reviewed. Changing trends in design and performance parameters are noted. These changes are related to advances in compressor aerodynamics, computational fluid mechanics and other enabling technologies. The parameters normally given to the designer and those that need to be established during the design process are identified. Criteria and procedures used in the selection of these parameters are presented. The selection of tip speed, aerodynamic loading, flowpath geometry, incidence and deviation angles, geometry, blade/vane solidity, stage reaction, blockage, inlet flow per unit annulus area, velocity ratio, and aerodynamic losses are blade/vane aerodynamic stage/overall considered. Trends in these parameters both spanwise and axially through the machine are highlighted. The effects of flow mixing and methods for accounting for the mixing in the design process **FSA** are discussed.

N89-16835# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.

DESIGN OF CRITICAL COMPRESSOR STAGES

A. J. WENNERSTROM In Von Karman Institute for Fluid Dynamics, 1988 Transonic Compressors, Volume 2 32 p

Avail: NTIS HC A17/MF A01

The through blade design approach to axial compresor stages for which high performance is critical as to thermodynamic cycle, and difficult due to high aerodynamic loading and/or Mach number is introduced. The mathematical models used, and the treatment of empirical inputs and shock losses are outlined. Design control and optimization are explained. Other major design factors, including mass flow, solidity, ramp angle, flow distribution, airfoil stacking, and structural parameters are reviewed. Design system weaknesses and trends are indicated, and computational goals FSA are mentioned.

N89-16836# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.

SUPERSONIC COMPRESSORS

A. J. WENNERSTROM In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 2 54 p Avail: NTIS HC A17/MF A01 1988

The analysis of shock losses and tip clearance losses in supersonic compressors is introduced. Boundary layer control, including rotor vortex generators, casing vortex generators, and stator slots is reviewed. Unconventional design concepts such as splitter vanes, counterswirl, and nonsteady flow are discussed.

ESA

National Aeronautics and Space Administration. N89-16837*# Lewis Research Center, Cleveland, OH.

SUPERSONIC THROUGHFLOW FANS

C. L. BALL and R. D. MOORE In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 2 30 p 1988 Avail: NTIS HC A17/MF A01

Supersonic throughflow fan research, and technology needs are reviewed. The design of a supersonic throughflow fan stage, a facility inlet, and a downstream diffuser is described. The results from the analysis codes used in executing the design are shown. An engine concept intended to permit establishing supersonic throughflow within the fan on the runway and maintaining the supersonic throughflow condition within the fan throughout the ESA flight envelope is presented.

Von Karman Inst. for Fluid Dynamics, N89-16838# Rhode-Saint-Genese (Belgium). Turbomachinery Dept.

VARIABLE GEOMETRY IN SUPERSONIC COMPRESSORS F. A. E. BREUGELMANS In its Transonic Compressors, Volume

Sponsored in part by the European Office of 1988 2 23 p Aerospace Research

Avail: NTIS HC A17/MF A01

A flexible inlet guide vane was designed for an independent control of the pre- or counterswirl condition over the blade height. The model was investigated with a Mach 2 supersonic rotor. The vertical supersonic compressor characteristic can be adapted to important mass flow variations by introducing a limited amount of

inlet swirl. The matching and flow problems of the rotor supersonic inlet conditions and the variable inlet guide vanes are demonstrated. Large changes in the rotor exit flow field are observed when operating the variable guide vane. The classical variable stagger stator vanes are not the solution to the large angle variations at high subsonic Mach numbers. A flexible blade is also proposed in the exit flow field. **FSA**

N89-16839# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium). Turbomachinery Dept.

AXIAL SUPERSONIC INLET COMPOUND

F. A. E. BREUGELMANS In its Transonic Compressors, Volume Sponsored in part by the European Office of 1988 2 25 p Aerospace Research

Avail: NTIS HC A17/MF A01

A prototype rotor was designed to investigate the supersonic axial component at the inlet face of a compressor. A flexible inflatable nozzle is installed in the inlet duct in order to simulate a continuously variable inlet Mach number up to 1.5. A relative inlet Mach number of 2.4 is achieved at 90 percent of the design speed. The transition from the subsonic to the supersonic axial component is explored. A blade failure prevented completion of the research on the dynamic response of the compressor to throttle valve, speed, and inlet nozzle variations. ESA

N89-16840# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France).

DESIGN METHODOLOGY FOR ADVANCED HIGH PRESSURE (HP) COMPRESSOR FIRST STAGE

MARIUS GOUTINES In Von Karman Institute for Fluid Dynamics, Transonic Compressors, Volume 2 36 p Avail: NTIS HC A17/MF A01 1988

The design methodology used for the first stage of a one stage high pressure compressor whose rotor blades are supersonic (relative Mach number varies from 1.1 at hub to 1.3 at tip) is outlined. Improvements brought by three-dimensional Euler calculations and secondary flow prediction method are discussed. Theoretical computations and experimental data are compared. The method can be improved by full 3-D aerodynamic calculations on the blade rows, particularly on the supersonic rotor. A 3-D Euler solver is necessary to give the correct shock shape. This method cancels the spanwise compatibility problem between the different 3-D profiles that occurs on classical duasi three-dimensional design methods. Spanwise detailed secondary flow calculation method provides inlet axisymetric aerodynamic conditions of the various blade rows which are useful for the upstream end adaptations. This method can also give the outlet end adaptation effects on secondary losses and on the downstream row inlet conditions. ESA

N89-17599*# Adiabatics, Inc., Columbus, IN.

ADIABATIC WANKEL TYPE ROTARY ENGINE R. KAMO, P. BADGLEY, and D. DOUP Sep. 1988 208 p (Contract NAS3-24880)

(NASA-CR-182233; NAS 1.26:182233; AI-120) Avail: NTIS HC A10/MF A01 CSCL 21E

This SBIR Phase program accomplished the objective of advancing the technology of the Wankel type rotary engine for aircraft applications through the use of adiabatic engine technology. Based on the results of this program, technology is in place to provide a rotor and side and intermediate housings with thermal barrier coatings. A detailed cycle analysis of the NASA 1007R Direct Injection Stratified Charge (DISC) rotary engine was performed which concluded that applying thermal barrier coatings to the rotor should be successful and that it was unlikely that the rotor housing could be successfully run with thermal barrier coatings as the thermal stresses were extensive. Author

N89-17600*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA. THE EFFECT OF EXHAUST PLUME/AFTERBODY INTERACTION ON INSTALLED SCRAMJET PERFORMANCE

THOMAS ALAN EDWARDS Nov. 1988 86 p

(NASA-TM-101033; A-88293; NAS 1.15:101033) Avail: NTIS HC A05/MF A01 CSCL 21E

Newly emerging aerospace technology points to the feasibility of sustained hypersonic flight. Designing a propulsion system capable of generating the necessary thrust is now the major obstacle. First-generation vehicles will be driven by air-breathing scramjet (supersonic combustion ramjet) engines. Because of engine size limitations, the exhaust gas leaving the nozzle will be highly underexpanded. Consequently, a significant amount of thrust and lift can be extracted by allowing the exhaust gases to expand along the underbody of the vehicle. Predicting how these forces influence overall vehicle thrust, lift, and moment is essential to a successful design. This work represents an important first step toward that objective. The UWIN code, an upwind, implicit Navier-Stokes computer program, has been applied to hypersonic exhaust plume/afterbody flow fields. The capability to solve entire vehicle geometries at hypersonic speeds, including an interacting exhaust plume, has been demonstrated for the first time. Comparison of the numerical results with available experimental data shows good agreement in all cases investigated. For moderately underexpanded jets, afterbody forces were found to vary linearly with the nozzle exit pressure, and increasing the exit pressure produced additional nose-down pitching moment. Coupling a species continuity equation to the UWIN code enabled calculations indicating that exhaust gases with low isentropic exponents (gamma) contribute larger afterbody forces than high-gamma exhaust gases. Moderately underexpanded jets, which remain attached to unswept afterbodies, underwent streamwise separation on upswept afterbodies. Highly underexpanded jets produced altogether different flow patterns, however. The highly underexpanded jet creates a strong plume shock, and the interaction of this shock with the afterbody was found to produce complicated patterns of crossflow separation. Finally, the effect of thrust vectoring on vehicle balance has been shown to alter dramatically the vehicle pitching moment. Author

08

AIRCRAFT STABILITY AND CONTROL

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

A89-25008#

DEPARTURE RESISTANCE AND SPIN CHARACTERISTICS OF THE F-15 S/MTD

HERBERT L. TINGER (McDonnell Douglas Corp., Saint Louis, MO) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p.

(AIAA PAPER 89-0012)

High angle of attack analyses for the F-15 S/MTD aircraft using six degree-of-freedom time histories, manned flight simulations, and a tethered free flight test are reported. The results show that the departure and spin resistance objectives for the aircraft have been met, even with lateral weight asymmetries of 200 ft-lb. The aircraft possesses adequate nose-down pitch authority at high angles of attack which is greatly enhanced when thrust vectorizing is utilized. C.D.

A89-25011#

AGILE FIGHTER AIRCRAFT SIMULATION

JOSEPH A. ANDERSON (Wright State University, Dayton; USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs

(AIAA PAPER 89-0015)

The Agile Fighter Aircraft Simulation, which studies the improvement in turning performance obtained by using vectored thrust for increased control at low airspeeds, is examined. A general

description of the project is given, and the pitch rate flight control system (FCS) is analytically described. Results concerning flight characteristics and tactical utility evaluation using the simulation are discussed. C.D.

A89-25012#

INERTIAL ENERGY DISTRIBUTION ERROR CONTROL FOR OPTIMAL WIND SHEAR PENETRATION

K. KRISHNAKUMAR and J. E. BAILEY (Alabama, University, Tuscaloosa) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 15 p. refs

(AIAA PAPER 89-0016)

The principle of inertial energy distribution error control for optimal wind shear penetration is developed theoretically, and a controller based on this principle is experimentally tested for takeoff flight conditions using a Monte Carlo simulation. The trajectory results are compared with those of a controller based on inertial energy distribution error performance index. The results demonstrate the importance of distributing inertial energy error equally between potential energy and inertial kinetic energy of the aircraft system to minimize height losses. They also show that minimization of height loss results in maintaining an approximately constant inertial speed. C.D.

A89-25013#

AN ANALYSIS OF LATERAL-DIRECTIONAL HANDLING QUALITIES AND EIGENSTRUCTURE OF HIGH PERFORMANCE AIRCRAFT

MICHAEL J. COSTIGAN and ROBERT A. CALICO (USAF, Institute of Technology, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs (AIAA PAPER 89-0017)

This paper uses eigenstructure assignment to develop a lateral aircraft control system. The eigenstructure of the primary lateral modes was chosen so as to lead to good lateral handling qualities. Several candidate controllers were designed and tested on YA-7D Digitac aircraft. The results of these tests are presented and pilot ratings for the various controllers are shown. Author

A89-25014*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

FAST HALF-LOOP MANEUVERS FOR A HIGH ALPHA FIGHTER AIRCRAFT USING A SINGULAR PERTURBATION FEEDBACK CONTROL LAW

FREDERICK E. GARRETT, JR. (Virginia Polytechnic Institute and State University, Blacksburg) and HAROLD L. STALFORD (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 16 p. refs (Contract NAG1-873)

(AIAA PAPER 89-0018)

Singular perturbation analysis is used to derive an outer layer feedback control law for a high alpha fighter aircraft to perform the half-loop maneuver. Pitch rate and angle of attack are treated as fast variables in the derivation. Bang-bang controls are derived to transfer the aircraft state from trim to the outer layer and from the outer layer to specified final half-loop values. The pitch rate is treated as a varibale faster than the angle of attack in the transfer of the state to and from the outer layer. A simulation of the derived control law is conducted at Mach 0.6 and 15,000 feet altitude. The half-loop was performed in 13.12 seconds. It is compared with a NASA pilot simulated half-loop maneuver which took 22.42 seconds for the same initial conditions. Author

A89-25510#

MULTIPLE SOLUTIONS FOR AIRCRAFT SIDESLIP BEHAVIOUR AT HIGH ANGLES OF ATTACK

PETER J. LAMONT and ANDREW KENNAUGH (Manchester, Victoria University, England) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs

(AIAA PAPER 89-0645)

The advantages of using 'total incidence' plane aerodynamics to simplify problems of aircraft aerodynamics and flight dynamics at high angles of attack are demonstrated. Consideration is given

1

08 AIRCRAFT STABILITY AND CONTROL

to the problem of aircraft sideslip behavior at high angles of attack. It is shown how side force and yawing moment data at combined angles of attack can be synthesized from zero sideslip data.

K.K.

A89-25683

AIRCRAFT VERTICAL PROFILE IMPLEMENTATION USING DIRECTED-GRAPH METHODS

L. T. BREWSTER and P. D. STIGALL (Missouri-Rolla, University, Rolla) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. 24, Nov. 1988, p. 682-692. refs

Aircraft vertical profile simulation is realized using a demand-driven minimal-calculation directed graph structure to reduce calculation time and to force synchronization of the performance measurement functions with the system state variables. Performance-directed model adaptation makes dynamic vertical profile path corrections, in the presence of fixed drag variations, possible. Drag variations ranging from +10 percent to -10 percent yielded fuel consumption improvements of less than 1 percent in the majority of the cases. Calculation time improvement for path simulation ranges from a factor of 1.19 in the worst case to 1.5 in the best case.

A89-25692

CONTROL OF NEARLY SINGULAR DECOUPLING SYSTEMS AND NONLINEAR AIRCRAFT MANEUVER

SAHJENDRA N. SINGH (Nevada, University, Las Vegas) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. 24, Nov. 1988, p. 775-784. refs

(Contract DAAL03-87-G-0004)

The author treats the question of control of a class of nonlinear systems using state variable feedback whose input/output map is nearly singular. Although the existing decoupling theory is applicable to such systems, this requires a large amount of control, which may not be permissible. Considered here is decoupling approach using state variable feedback in an approximate sense, but requiring a small control magnitude. A decoupling scheme is presented that gives rise to a singularly perturbed system describing the fast dynamics of the control vector. The quasi-steady-state solution of the system gives a control law that decouples the system in an approximate way. The controller includes a servocompensator and a reference trajectory generator. Based on this result, a control law for approximate decoupling of roll angle, angle of attack, and sideslip in rapid, nonlinear airplane maneuvers is derived. Simulated responses of the closed-loop system show that large, simultaneous lateral and longitudinal maneuvers can be accurately performed in spite of uncertainty in stability derivatives. LE.

A89-25871

ACTIVE CONTROL OF AEROELASTIC SYSTEMS GOVERNED BY FUNCTIONAL DIFFERENTIAL EQUATIONS

SHYANG CHANG (National Tsing Hua University, Hsinchu, Republic of China) IN: International Conference on Advances in Communication and Control Systems, 1st, Washington, DC, June 18-20, 1987, Proceedings. New York, Optimization Software, Inc., 1988, p. 82-95. refs

The problem of modeling and control of aircraft flutter is studied in the framework of aeroelasticity theory. A time-domain model for unsteady aerodynamic loads is developed and coupled with a lumped model for the structural dynamics. The resulting input-output system, characterized by functional differential equations, can be endowed with a state space which is a reflexive Banach space. It is shown that the state equations have a unique semigroup solution. Moreover, the input-output stability for such an aeroelastic system is established. Author

A89-25934#

LONGITUDINAL STABILITY ANALYSIS FOR DEFORMABLE AIRCRAFT

RUIJUAN XU (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 6, Dec. 1988, p. 433-439. In Chinese, with abstract in English. refs The longitudinal stability of a deformable aircraft with and without a flight control system, involving interaction between rigid motion modes and elastic vibration shapes of the aircraft and between the flight control system and the airframe dynamics, is studied. A numerical example is used to show that the effect of the structural distortion of the aircraft with a flight control system on its longitudinal stability is considerable. This effect not only degrades the flying qualities of the aircraft, it also sometimes causes an unacceptable new type of instability referred to as coupling instability between the flight control system and the elastic structural dynamics. Thus, in aircraft stability analysis and the design of a flight control system, the aircraft has to be considered as a deformable body, and high-order small-disturbance equations involving elastic degrees of freedom of the aircraft must be used. C.D.

A89-26193

FEEDBACK CONTROL OF VIBRATIONS IN AN EXTENDIBLE CANTILEVER SWEPTBACK WING

P. K. C. WANG (California, University, Los Angeles) IN: Analysis and optimization of systems; Proceedings of the Eighth International Conference, Juan-les-Pins, France, June 8-10, 1988. Berlin and New York, Springer-Verlag, 1988, p. 494-506. refs (Contract AF-AFOSR-86-0132)

A cantilever wing which may extend or contract in flight is studied. A mathematical model for an extendible sweptback cantilever wing is presented, and the gualitative behavior of the motion-induced vibrations is examined. A Galerkin-type approximation based on an appropriate time-dependent basis is used to obtain an approximate finite dimensional model for the numerical solution of the system equations. Feedback controls for damping the motion-induced vibrations are derived by considering the time rate of change of the total vibrational energy of the wing. Numerical results for a typical straight extendible wing with specified and feedback-controlled translational motions are presented. The results show that an extensional motion has a destabilizing effects on the wing vibrations, while a contractional motion has a stabilizing effect. These effects are enhanced when the extension or contraction speed is increased. A simplified control law which reduces the peak amplitude of the vibrations is proposed. C.D.

A89-26688

MEASUREMENTS OF THE OSCILLATORY LATERAL DERIVATIVES OF A HIGH INCIDENCE RESEARCH MODEL (HIRM 1) AT SPEEDS UP TO M = 0.8C. O. O'LEARY and E. N. ROWTHORN (Royal Aerospace

C. O. O'LEARY and E. N. ROWTHORN (Royal Aerospace Establishment, Bedford, England) Aeronautical Journal (ISSN 0001-9240), vol. 93, Jan. 1989, p. 11-21. refs

Tests were made to investigate the effects of Mach number on the oscillatory lateral derivatives of a three-surface, high-incidence research model, HIRM 1. Effects of Reynolds number and frequency parameter were also investigated at low speed. A new flexible sting and hydraulic actuator system were designed for the tests in the 2.4 m x 2.4 m Pressurized Wind Tunnel. Results showed that the effects of Reynolds number and frequency parameter were not very significant at low speeds but there were quite large effects of Mach number on some derivatives, notably yawing and rolling moments due to sideslip and rate of yaw. Author

A89-27734*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

ANALYSIS OF WINDSHEAR FROM AIRLINE FLIGHT DATA

R. E. BACH, JR. and R. C. WINGROVE (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 103-109. Previously cited in issue 23, p. 3414, Accession no. A86-47690. refs

A89-27736*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA. REAL-TIME COMPARISON OF X-29A FLIGHT DATA AND SIMULATION DATA JOSEPH GERA (NASA, Ames Research Center, Moffett Field, CA), DOMINICK ANDRISANI, II (Purdue University, West Lafayette, IN), JEFFREY E. BAUER, and DAVID B. CRAWFORD Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 117-123. Previously cited in issue 08, p. 1052, Accession no. A87-22570.

A89-27737*# Massachusetts Inst. of Tech., Cambridge. DYNAMIC RESPONSE OF AIRCRAFT AUTOPILOT SYSTEMS TO ATMOSPHERIC DISTURBANCES

R. JOHN HANSMAN, JR. and JAMES L. STURDY (MIT, Cambridge, MA) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 124-130. Previously cited in issue 07, p. 952, Accession no. A88-22518.

(Contract DOT-FA03-86-C-00016; NGL-22-009-640)

A89-28185

ADVANCED FLIGHT CONTROL FOR THE FOKKER 100

L. G. LAFORGE (Rockwell International Corp., Collins Air Transport Div., Cedar Rapids, IA) and A. H. VAN GENT (Fokker Aircraft, Amsterdam, Netherlands) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 13 p. (SAE PAPER 881373)

The Automatic Flight Control and Augmentation System recently certified on the Fokker F28 - Mk0100, provides this aircraft with a full flight regime autoflight system including CAT IIIb autoland capability and a fully integrated autothrottle. The FCS-1000 is based upon a classical triplex architecture interfaced with dual electromechanical servos. Additional new features designed to decrease the flight crew's workload in critical flight phases and to achieve a higher level of flight safety include ultimate aircraft speed protection functions, coupled windshear escape, and a new flight mode annunciation philosophy.

A89-28205* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SIMULATION EVALUATION OF TRANSITION AND HOVER FLYING QUALITIES OF THE E-7A STOVL AIRCRAFT

JAMES A. FRANKLIN, MICHAEL W. STORTZ, RONALD M. GERDES, GORDON H. HARDY, JAMES L. MARTIN, and SHAWN A. ENGELLAND (NASA, Ames Research Center, Moffett Field, CA) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 15 p. refs

(SAE PAPER 881430)

The generalized simulation model developed for the E-7A STOVL fighter-type aircraft configuration has attempted to define the limits of acceptibility for a vertical-to-horizontal-to-vertical flight transition envelope. An effort was also made to determine the control power required during hover and transition, and to evaluate whether the integration of flight and propulsion controls thus far effected achieves good flying qualities throughout the low-speed flight envelope. The results thus obtained furnish a general view of the acceptable transition corridor, expressed in terms of the minimum-climb capability.

A89-28236

REAL-TIME SIMULATION FOR SURVIVABLE PENETRATION

V. P. BAGLIO (Grumman Corp., Aircraft Systems Div., Bethpage, NY) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 14 p. refs

(SAE PAPER 881515)

An initial terrain-following/terrain-avoidance (TF/TA) simulation is described, which combines the features of aggresive trajectory generation, control coupling for trajectory tracking, map navigation, and aircraft and flight control system dynamic elements. A typical scenario of an advanced low-level penetration and attack mission is described together with the components of the simulation. Finally, an integration approach to this real-time simulation problem is discussed, including the simulation set-up, functional partitioning between computers, information flow between simulation, the interface software, and data transfer. Functional block diagrams and flow diagrams are included. I.S.

A89-28396

DYNAMICS OF LONGITUDINAL MOTION OF AN AEROPLANE AFTER DROP OF LOADS

Z. DZYGADLO and K. SIBILSKI (Wojskowa Akademia Techniczna, Warsaw, Poland) Journal of Technical Physics (ISSN 0324-8313), vol. 28, no. 3, 1987, p. 365-379. refs

An analysis is presented of uncontrolled and controlled longitudinal motion of a jet aircraft after symmetric load drops. Both a single drop and a series of drops were considered assuming that the initial motion of the aircraft was steady and horizontal or that the initial motion was curvilinear in the vertical plane. The resulting motion of the aircraft was analyzed for a case of uncontrolled flight and for a case where the control surface was displaced and the thrust of the power plant was varied by the pilot in order to preserve the original parameters. A control law is proposed which, if applied for the case of uncontrolled flight, can minimize the disturbances; the motion of the aircraft can then be reduced to a steady motion, with the values of parameters approaching those before the drop of loads.

A89-28454*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DETERMINATION OF LONGITUDINAL AERODYNAMIC DERIVATIVES USING FLIGHT DATA FROM AN ICING RESEARCH AIRCRAFT

R. J. RANAUDO, A. L. REEHORST, T. H. BOND (NASA, Lewis Research Center, Cleveland, OH), J. G. BATTERSON (NASA, Langley Research Center, Hampton, VA), and T. M. O'MARA (NASA, Langley Research Center, Hampton, VA; George Washington University, Washington, DC) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 18 p. Previously announced in STAR as N89-15121. refs (AIAA 89-0754)

A flight test was performed with the NASA Lewis Research Center's DH-6 icing research aircraft. The purpose was to employ a flight test procedure and data analysis method, to determine the accuracy with which the effects of ice on aircraft stability and control could be measured. For simplicity, flight testing was restricted to the short period longitudinal mode. Two flights were flown in a clean (baseline) configuration, and two flights were flown with simulated horizontal tail ice. Forty-five repeat doublet maneuvers were performed in each of four test configurations, at a given trim speed, to determine the ensemble variation of the estimated stability and control derivatives. Additional maneuvers were also performed in each configuration, to determine the variation in the longitudinal derivative estimates over a wide range of trim speeds. Stability and control derivatives were estimated by a Modified Stepwise Regression (MSR) technique. A measure of the confidence in the derivative estimates was obtained by comparing the standard error for the ensemble of repeat maneuvers, to the average of the estimated standard errors predicted by the MSR program. A multiplicative relationship was determined between the ensemble standard error, and the averaged program standard errors. In addition, a 95 percent confidence interval analysis was performed for the elevator effectiveness estimates, C sub m sub delta e. This analysis identified the speed range where changes in C sub m sub delta e could be attributed to icing effects. The magnitude of icing effects on the derivative estimates were strongly dependent on flight speed and aircraft wing flap configuration. With wing flaps up, the estimated derivatives were degraded most at lower speeds corresponding to that configuration. With wing flaps extended to 10 degrees, the estimated derivatives were degraded most at the higher corresponding speeds. The effects of icing on the changes in longitudinal stability and control derivat Author

N89-16845*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

MODAL CONTROL OF AN OBLIQUE WING AIRCRAFT JAMES D. PHILLIPS Jan. 1989 49 p (NASA-TP-2898; A-88250; NAS 1.60:2898) Avail: NTIS HC A03/MF A01 CSCL 01C

A linear modal control algorithm is applied to the NASA Oblique

Wing Research Aircraft (OWRA). The control law is evaluated using a detailed nonlinear flight simulation. It is shown that the modal control law attenuates the coupling and nonlinear aerodynamics of the oblique wing and remains stable during control saturation caused by large command inputs or large external disturbances. The technique controls each natural mode independently allowing single-input/single-output techniques to be applied to multiple-input/multiple-output systems. Author

National Aeronautics and Space Administration, N89-18401*# Washington, DC.

CONTROLS AND GUIDANCE: AERONAUTICS

JOHN D. DIBATTISTA In its NASA Information Sciences and Human Factors Program p 83-103 Sep. 1988 Avail: NTIS HC A10/MF A01 CSCL 01C

The overall objective is to provide a validated technology base leading to the development and exploitation of new concepts, analysis and design methodologies, and flight systems for future civil and military aircraft. This will provide increased efficiency, effectiveness, reliability, and safety. The program is organized into generic elements and vehicle-specific elements. The generic elements are control theory, guidance and display concepts, and flight crucial systems. Vehicle-specific elements are generic hypersonics, subsonic transport/commuter/general aviation. rotorcraft, and fighter/attack. Research in the control theory element is directed toward the improved flight control analysis and design methodologies for highly integrated, robust flight control designs. Flight Crucial Systems research is directed toward the development of design, assessment, and validation methodologies for flight crucial systems. The generic hypersonics research concentrates on the integration of flight control, propulsion control, sensors, and displays. The Aeronautical Controls and Guidance Program involves analytical and experimental research by in-house, university, and industry personnel. Extensive use of ground-based simulation is a characteristic of the program with selected flight Author experiments in a variety of aircraft.

09

RESEARCH AND SUPPORT FACILITIES (AIR)

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

A89-25035#

MICROTUFT FLOW VISUALIZATION AT MACH 10 AND 14 IN THE NSWC HYPERVELOCITY WIND TUNNEL NO. 9

MARK E. KAMMEYER, JOHN F. LAFFERTY, and W. CHARLES SPRING, III (U.S. Navy, Naval Surface Warfare Center, Silver AIAA, Aerospace Sciences Meeting, 27th, Reno, Spring, MD) NV, Jan. 9-12, 1989. 9 p. refs

(AIAA PAPER 89-0041)

This paper describes efforts of the past year that have demonstrated the use of microtufts for flow visualization in a hypersonic, high Reynolds number, blow-down wind tunnel. A variation of the fluorescent method of Crowder using the standard nylon monofilament tuft material has been successful at both Mach 10 and 14 on leeward surfaces. An alternate high-temperature tuft material has been found which is capable of surviving the higher heat transfer rates associated with windward surfaces. A new method of viewing the high temperature tufts with an infrared camera has also been demonstrated at Mach 14. Author

A89-25036#

INFRARED THERMOGRAPHY IN BLOWDOWN AND INTERMITTENT HYPERSONIC FACILITIES

G. SIMEONIDES, J. F. WENDT (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium), P. VAN LIERDE, S.

VAN DER STICHELE, and D. CAPRIOTTI AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (AIAA PAPER 89-0042)

Some results and conclusions from the application of IR thermography to the measurement of heat transfer in two distinctly different short-duration hypersonic facilities are presented. First results from a blowdown tunnel are discussed; they demonstrate the advantage of the IR technique in providing two-dimensional heat-transfer maps as opposed to the zero-dimension measurements enabled by discrete-point gages. The spatial resolution characteristics of the IR scanning radiometer is sufficient to sense localized hot spots which may be quantified by concentrating the field of view onto the area of interest. Author

A89-25042#

THE DESIGN AND DEVELOPMENT OF A DYNAMIC PLUNGE-PITCH-ROLL MODEL MOUNT

SEUNGKI AHN, KWANG-YOON CHOI, and ROGER L. SIMPSON (Virginia Polytechnic Institute and State University, Blacksburg, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. Research supported by the Virginia State Council of Higher Education, Virginia Polytechnic Institute and State University, and U.S. Navy. refs

(AIAA PAPER 89-0048)

In this paper, a newly designed and developed dynamic model support system for the Stability Wind Tunnel of the Virginia Polytechnic Institute and State University is discussed. The design objectives of this new apparatus are the generation of a random motion of sting mounted model, a dynamic stability test using oscillation method, and an aircraft landing simulation. Details of the system are discussed along with hardware problems and their solutions faced during the development phase. Author

A89-25131*# Vigyan Research Associates, Inc., Hampton, VA. SIDEWALL BOUNDARY-LAYER REMOVAL EFFECTS ON WALL ADAPTATION IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL

A. V. MURTHY (Vigyan Research Associates, Inc., Hampton, VA) and E. J. RAY (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs (AIAA PAPER 89-0148)

This paper describes the Langley 0.3-m transonic cryogenic tunnel sidewall boundary-layer removal system and is integrated operation with the adaptive wall adjustment. Empty test section measurements show the sidewall boundary-layer displacement thickness at the model station is reduced from about 1.0 to 0.6 percent of the test section width when the maximum boundary-layer removal conditions are applied. Tests with a supercritical airfoil model show the iterative top and bottom wall adaptation process performs satisfactorily with sidewall boundary-layer removal.

Author

A89-25132# WIND TUNNEL WALL BOUNDARY LAYER CONTROL BY **COANDA WALL JETS**

N. J. WOOD, L. ROBERTS (Stanford University, CA), and S. AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, WARD Jan. 9-12, 1989. 7 p. refs

(AIAA PAPER 89-0149)

An experiment is described which evaluates the feasibility of using a Coanda wall jet boundary layer removal system for application to VSTOL testing in ground effect. This concept is particularly suited to large scale facilities where the alternatives, such as moving belts, are inadequate in terms of scale and robustness. In addition, the Coanda wall jet provides a significant improvement in the power required to maintain a negligible wall Author boundary layer.

National Aeronautics and Space Administration. A89-25135*# Langley Research Center, Hampton, VA. A SOLUTION TO WATER VAPOR IN THE NATIONAL TRANSONIC FACILITY
BLAIR B. GLOSS and ROBERT A. BRUCE (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs (AIAA PAPER 89-0152)

As cryogenic wind tunnels are utilized, problems associated with the low temperature environment are being discovered and solved. Recently, water vapor contamination was discovered in the National Transonic Facility, and the source was shown to be the internal insulation which is a closed-cell polyisocyanurate foam. After an extensive study of the absorptivity characteristics of the NTF thermal insulation, the most practical solution to the problem was shown to be the maintaining of a dry environment in the circuit at all times. Utilizing a high aspect ratio transport model, it was shown that the moisture contamination effects on the supercritical wing pressure distributions were within the accuracy of setting test conditions and as such were considered negligible for this model.

A89-25159#

FACILITY REQUIREMENTS FOR HYPERSONIC PROPULSION SYSTEM TESTING

M. G. DUNN, J. A. LORDI, C. E. WITTLIFF, and M. S. HOLDEN (Calspan Corp., Buffalo, NY) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 16 p. refs (AIAA PAPER 89-0184)

Facility requirements for hypersonic propulsion system testing are reviewed with attention given to significant contributions of previous and current studies. It is found that many of the current hypersonic flow problems are the same as those identified 20 yrs ago. Sample calculations performed to examine real-gas effects on the simulation of flows about hypersonuc vehicles are presented. Shock-tunnel testing of both scramjet combustor and exhaust nozzle configurations at conditions corresponding to flight at Mach numbers of 10-12 at altitudes of 100,000 ft are considered. K.K.

A89-25511*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DESIGN AND DEVELOPMENT OF A COMPRESSIBLE DYNAMIC STALL FACILITY

L. W. CARR (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) and M. S. CHANDRASEKHARA (U.S. Navy-NASA Joint Institute of Aeronautics, Monterey, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. Research supported by the U.S. Navy and USAF. refs

(AIAA PAPER 89-0647)

A dynamic stall facility offering a unique new capability for studies of compressibility effects on dynamic stall is described. This facility features complete visual access by mounting the test airfoil between optical-quality glass windows which are rotated in unison to produce the oscillating airfoil motion associated with helicopter rotor dynamic stall. By using the density gradients associated with the rapidly changing dynamic stall flow field, this facility permits simultaneous detailed investigation of the flow on the surface as well as in the flow field surrounding airfoils experiencing dynamic stall.

A89-25512*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DRAG MEASUREMENTS ON A MODIFIED PROLATE

SPHEROID USING A MAGNETIC SUSPENSION AND BALANCE SYSTEM

DAVID A. DRESS (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs

(AIAA PAPER 89-0648)

Low-speed wind tunnel drag force measurements were taken on a modified prolate spheroid free of support interference. This body was tested at zero incidence in the NASA Langley 13 inch Magnetic Suspension and Balance System. This shape was one of two bodies tested to determine the drag force measuring capabilities of the 13 inch MSBS. In addition, support interference on this shape at zero incidence was quantified by using a dummy sting. The drag force calibrations and wind-on repeatability data make it possible to assess the drag force measuring capabilities of the 13 inch MSBS. Comparisons with and without the sting showed differences in the drag coefficients with the dummy sting case resulting in lower drag coefficients. Author

A89-25591*# Massachusetts Inst. of Tech., Cambridge. COCKPIT DISPLAY OF HAZARDOUS WEATHER INFORMATION

R. JOHN HANSMAN, JR. and CRAIG WANKE (MIT, Cambridge, MA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. Research supported by MIT and FAA. refs (Contract NGL-22-009-640; NAG1-690)

(AIAA PAPER 89-0808)

Information transfer and display issues associated with the dissemination of hazardous-weather warnings are studied in the context of wind-shear alerts. Operational and developmental wind-shear detection systems are briefly reviewed. The July 11, 1988 microburst events observed as part of the Denver TDWR operational evaluation are analyzed in terms of information transfer and the effectiveness of the microburst alerts. Information transfer, message content, and display issues associated with microburst alerts generated from ground-based sources (Doppler radars, LLWAS, and PIREPS) are evaluated by means of pilot opinion surveys and part-task simulator studies.

A89-27653*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NATIONAL FULL-SCALE AERODYNAMIC COMPLEX INTEGRATED SYSTEMS TEST DATA SYSTEM

OSCAR JUNG and EVERETT MAYNARD (NASA, Ames Research Center, Moffett Field, CA) IN: International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 29-41.

The data acquisition system of the 80 by 120 foot wind tunnel of the National Full-Scale Aerodynamic Facility (NFAC) is described. How the various satellite data stations are connected to the data acquisition system is shown. As an illustrative example, a strain gage signal is traced from one of the satellite data locations to its final destination in the data system where the signal is processed, observed in real time on various parallel graphic displays, and stored on magnetic disks for postrun data reduction. C.D.

A89-27654*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

UTILIZATION OF WIND TUNNEL INSTRUMENTATION WITH SOFTWARE VERIFICATIONS

BETTY W. SILVA and NORMAN H. MICHAUD (NASA, Ames Research Center, Moffett Field, CA) IN: International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 43-53.

Software tools developed for the National Full-Scale Aerodynamic Complex (NFAC) for verifying data integrity and troublehooting problems are discussed. The Hardware Check verifies that the incoming signals are properly connected and are being acquired into the real time data system. The Zero/Cal Check program verifies the reliability of the wind tunnel instrumentation by checking the zero and calibration points. The Power Spectral Density Plots help to identify the frequency components of a signal. Drift Program and Thermal Plots tools are also described. C.D.

A89-27655#

A MICROPROCESSOR-BASED PROPORTIONAL-INTEGRAL CONTROLLER FOR HYDRAULICALLY ACTUATED MECHANISMS

MARC N. SMOTHERMAN (Calspan Corp., Arnold AFB, TN) IN: International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 55-64.

A microprocessor-based position servocontroller for

hydraulically actuated wind tunnel mechanisms is described. The servocontroller uses a part-time proportional-integral control algorithm, and its features include decreased setup and calibration, simplified operator interface, and increased positioning control accuracy. This servocontroller has decreased test installation times, decreased maintenance, and increased productivity when C.D. compared to previous analog servocontrollers.

National Aeronautics and Space Administration. A89-27674*# Ames Research Center, Moffett Field, CA.

A SIGNAL FILTER WITH ZERO PHASE LAG

T. J. FORSYTH and T. S. BURNETT (NASA, Ames Research IN: International Instrumentation Center, Moffett Field, CA) Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 417-427.

Rotorcraft and rotorcraft models are tested at the NASA Ames National Full-Scale Aerodynamics Complex (NFAC). The models tested in the NFAC wind tunnels are controlled by a remote control console located in a control room. Certain critical information must be displayed on the control console to monitor the rotor to insure that the rotor is within operational limits. The signal for these parameters is complex (with ac and dc components) and is derived from pitch and flapping transducers on the rotor head. The pitch and flapping cyclics are derived from resolver circuits that indicate the magnitude and phase of the cyclics. Conventional filter circuits used to separate the ac and dc components have a phase lag on the ac component, which will introduce an error in the cyclic vector. To overcome this error, a filter with zero phase lag needed to be developed. This paper discusses a rotorcraft circuit that was designed to have an ac/dc filter with zero phase lag over the Author frequency range.

National Aeronautics and Space Administration. A89-27675*# Ames Research Center, Moffett Field, CA.

A FREE-TRAILING VANE FLOW DIRECTION INDICATOR EMPLOYING A LINEAR OUTPUT HALL EFFECT TRANSDUCER

PETER T. ZELL and ROBERT D. MCMAHON (NASA, Ames Research Center, Moffett Field, CA) IN: International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 429-436.

The Hall effect vane (HEV) was developed to measure flow angularity in the NASA 40-by-80-foot and 80-by-120-foot wind tunnels. This indicator is capable of sensing flow direction at air speeds from 5 to 300 knots and over a + or - 40 deg angle range with a resolution of 0.1 deg. A free-trailing vane configuration employing a linear output Hall effect transducer as a shaft angle resolver was used. The current configuration of the HEV is designed primarily for wind tunnel calibration testing; however, other potential applications include atmospheric, flight or ground research testing. The HEV met initial design requirements. Author

A89-28193

AIRPORT ACCIDENT-POTENTIAL AND SAFETY AREAS

MAURICE A. GARBELL (M.A.G. Consultants, Inc., San Francisco, SAE, Aerospace Technology Conference and Exposition, CA) Anaheim, CA, Oct. 3-6, 1988. 10 p. refs

(SAE PAPER 881388) The present study sets forth criteria for the design of airport safety areas and land uses therein. The mainstay of this study in

identifying and defining airport safety areas is the avoidance of residential land use and any land use harboring large concentrations of people in certain accident-potential zones adjacent to the ends of airport runways. Two new developments are embodied in this study: (1) a separation within primary airport safety areas between those in which the number of people on the ground exposed to the impact of crashing or crash-landing airplanes is reduced to a minimum, while the value of the land is protected by judicious, less impact-sensitive use, and areas in which the safety of crashing or crash-landing airplanes and their occupants, as well as people on the ground, is safeguarded to

the highest extent possible; and (2) the tracing of other airport safety areas, termed, 'transitional airport safety areas,' in which mass assemblies of people should be proscribed. S.A.V.

National Aeronautics and Space Administration. A89-28196* Langley Research Center, Hampton, VA.

A SUMMARY OF RECENT AIRCRAFT/GROUND VEHICLE FRICTION MEASUREMENT TESTS

THOMAS J. YAGER (NASA, Langley Research Center, Hampton, SAE, Aerospace Technology Conference and Exposition, VA) Anaheim, CA, Oct. 3-6, 1988. 9 p. refs (SAE PAPER 881403)

Tests were carried out to evaluate a variety of runway surface types and wetness conditions, using specially instrumented NASA B-737 and B-727 aircraft and several ground friction measuring devices. The performance data for aircraft braking on dry, wet, snow-covered, and ice-covered runway conditions are presented and compared to ground-vehicle friction data obtained under similar runway conditions. The relationships between ground vehicles and the aircraft friction data are identified, and the effects on friction of major test parameters, such as the speed, the tire characteristics, and the type of surface-contaminant are discussed. The results demonstrated that properly maintained and calibrated ground vehicles can be used to monitor the runway friction conditions.

I.S.

A89-28219

PRELIMINARY TEST RESULTS OF NDA CRYOGENIC WIND TUNNEL AND ITS SYSTEM

YUTAKA YAMAGUCHI, HIDEKI KABA, NOBUMITSU KURI-BAYASHI (Defense Academy, Yokosuka, Japan), and SHIZUYUKI YOSHIDA (Japan Defense Agency, Tokyo) SAE, SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 16 p. (SAE PAPER 881449) refs

This paper presents the major design specifications of the National Defense Academy (NDA) cryogenic wind tunnel, together with the results on the preliminary calibration tests of the tunnel. The NDA tunnel designed for the two-dimensional airfoil testings, was constructed using the SUS 304 stainless steel as the material for pressure shell. The results of the operational and the calibration tests at ambient and cryogenic temperatures demonstrated that the NDA cryogenic tunnel has sufficient potential as a tunnel for performing low-temperature transonic flow experiments. 1.S.

National Aeronautics and Space Administration. A89-28220* Langley Research Center, Hampton, VA.

EMERGING TECHNOLOGY FOR TRANSONIC

WIND-TUNNEL-WALL INTERFERENCE ASSESSMENT AND CORRECTIONS

P. A. NEWMAN (NASA, Langley Research Center, Hampton, VA), W. B. KEMP, JR., and J. A. GARRIZ (Vigyan Research Associates, SAE, Aerospace Technology Conference Inc., Hampton, VA) and Exposition, Anaheim, CA, Oct. 3-6, 1988. 19 p. refs (SAE PAPER 881454)

Several nonlinear transonic codes and a panel method code for wind tunnel/wall interference assessment and correction (WIAC) studies are reviewed. Contrasts between two- and threedimensional transonic testing factors which affect WIAC procedures are illustrated with airfoil data from the NASA/Langley 0.3-meter transonic cyrogenic tunnel and Pathfinder I data. Also, three-dimensional transonic WIAC results for Mach number and angle-of-attack corrections to data from a relatively large 20 deg swept semispan wing in the solid wall NASA/Ames high Reynolds number Channel I are verified by three-dimensional thin-layer Navier-Stokes free-air solutions. R.B.

National Aeronautics and Space Administration. A89-28455*# Lewis Research Center, Cleveland, OH.

INVESTIGATION OF THE FLOW IN THE DIFFUSER SECTION OF THE NASA LEWIS ICING RESEARCH TUNNEL

HAROLD E. ADDY, JR. (NASA, Lewis Research Center, Cleveland, OH) and THEO G. KEITH, JR. (Toledo, University, OH) AIAA,

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs

(AIAA 89-0755)

The flow in the diffuser section of the Icing Research Wind Tunnel at NASA Lewis Research Center is investigated using both tunnel calibration measurements and numerical simulation techniques. Local pressure and temperature measurements are made to establish velocity and temperature profiles in the diffuser of the tunnel. These profiles are compared with similar measurements made prior to renovating the equipment which generates the tunnel's icing cloud. This comparison indicates the manner in which this change affected the flow. The measured data were also compared with a numerical simulation of the flow to help understand how such changes may favorably alter the tunnel flow. Author

A89-28457*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE DEVELOPMENT OF A CAPABILITY FOR AERODYNAMIC TESTING OF LARGE-SCALE WING SECTIONS IN A SIMULATED NATURAL RAIN ENVIRONMENT

GAUDY M. BEZOS, BRYAN A. CAMBELL (NASA, Langley Research Center, Hampton, VA), and W. EDWARD MELSON (NASA, Wallops Flight Center, Wallops Island, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs (AIAA 89-0762)

A research technique to obtain large-scale aerodynamic data in a simulated natural rain environment has been developed. A 10-ft chord NACA 64-210 wing section wing section equipped with leading-edge and trailing-edge high-lift devices was tested as part of a program to determine the effect of highly-concentrated, short-duration rainfall on airplane performance. Preliminary dry aerodynamic data are presented for the high-lift configuration at a velocity of 100 knots and an angle of attack of 18 deg. Also, data are presented on rainfield uniformity and rainfall concentration intensity levels obtained during the calibration of the rain simulation system. R.B.

A89-28458#

DEVELOPMENT OF A NEW SUBSONIC ICING WIND TUNNEL

GARY V. TENISON (BFGoodrich Co., Aerospace Div., Uniontown, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs

(AIAA 89-0773)

A new subsonic icing tunnel has been designed and constructed at the BFGoodrich De-Icing Systems facilities in Uniontown, Ohio. This tunnel has been three years in the research, design, building and calibration and was designated to be a medium sized world class icing facility for the use of BFGoodrich, BFGoodrich customers, select researchers and others to further the development of ice protection systems as well as the general understanding of ice formation and its removal. Presented here is background information, a description of the facility, and some preliminary calibration information. Diagrams and pictures of various tunnel components and calibration equipment are also shown, along with descriptions of how each are used. Author

N89-16848# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).

EXPRIMENTS ON THE DFVLR-F4 WING BODY

CONFIGURATION IN SEVERAL EUROPEAN WINDTUNNELS

G. REDEKER, R. MUELLER, P. R. ASHILL, A. ELSENAAR, and V. SCHMITT (Office National d'Etudes et de Recherches Aeronautiques, Paris, France) In AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 15 p Jul. 1988

Avail: NTIS HC A22/MF A01

Attempts are made to improve design methods for three-dimensional configurations in transonic flow and to increase the confidence in wind tunnel data. The selected configuration was the DFVLR-F4 wing-body combination incorporating a transonic wing of high aspect ratio and a fuselage of Airbus type. The experimental part of the exercise is examined, where the same model of the wing-body configuration was tested in three European Transonic wind tunnels. The tests followed an agreed test program comprised of force and moment measurement as well as measurements of pressure distribution on wing and fuselage. Selected test results from the three wind tunnel tests are compared. the main emphasis being placed on the comparison of results from different wind tunnels on physically the same model. The results show that the data of the three wind tunnels are in reasonable agreement, although the severe accuracy requirements of industry for judging performance data from different wind tunnels could not be met. Author

N89-16852# Naval Air Systems Command, Washington, DC. Aerodynamics and Flight Controls.

WIND TUNNEL PREDICTED AIR VEHICLE PERFORMANCE: A **REVIEW OF LESSONS LEARNED**

E. C. ROONEY and R. F. LAUER, JR. (Calspan Field Services, Inc., Arnold AFS, TN.) In AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing Jul. 1988 11 p

Avail: NTIS HC A22/MF A01

Air vehicle development programs continue to experience difficulty in preformache prediction of new aircraft configurations. Advances in the state-of-the-art in wind tunnel simulation techniques, flight performance measurements and computational fluid dynamics have provided the basis for investigating the accuracy of the aerodynamic element used in the performance prediction process. The force accounting procedures, model and wind tunnel simulation techniques and correction procedures are reviewed, along with full scale adjustments used to predict the performance of air vehicles. The lesson learned in this review should enhance the capability to predict aircraft performance for future air vehicle development programs. Author

N89-16855# Royal Aircraft Establishment, Bedford (England). THE ACCURATE MEASUREMENT OF DRAG IN THE 8 FT X 8 **FT TUNNEL**

M. N. WOOD and D. S. CAPPS In AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 9 p Jul. 1988 Previously announced as X88-72373

Avail: NTIS HC A22/MF A01

The techniques currently adopted in the 8 ft by 8 ft wind tunnel at RAE for the accurate measurement of drag are described in detail. Data are presented from three series of tests on a model of the A-310 aircraft and these demonstrate the level of accuracy which can be achieved. Author

N89-16856# British Aerospace Public Ltd. Co., Preston (England).

ACCURATE DRAG ESTIMATION USING A SINGLE COMPONENT DRAG MODEL TECHNIQUE

A. M. CASSIE In AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 16 p Jul. 1988

Avail: NTIS HC A22/MF A01

The design, development and operation of an advance afterbody drag rig at the high speed wind tunnel at Warton is reviewed. The rig has been extensively used over a 16 year period for minimization of modern combat aircraft afterbody drag. Accurate incremental drag data is produced by measurement of the axial force on a fully representative metric afterbody section. A full description of the rig is given along with techniques for data correction and presentation of typical data. Author

N89-16857# Aircraft Research Association Ltd., Bedford (England).

DEVELOPMENT OF TESTING TECHNIQUES IN A LARGE TRANSONIC WIND TUNNEL TO ACHIEVE A REQUIRED DRAG ACCURACY AND FLOW STANDARDS FOR MODERN CIVIL TRANSPORTS

E. C. CARTER and K. C. PALLISTER In AGARD, Aerodynamic

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 20 p Jul. 1988

Avail: NTIS HC A22/MF A01

Experience and results obtained in the ARA 9 ft by 8 ft transonic wind tunnel are used to address the questions of measurement and flow quality, data accuracy and achieved performance. The discussions relate primarily to experience with civil transports for which accurate drag prediction and efficient drag reduction through reliable experimental techniques is of major importance. The quality of results is studied via the definition of the problem areas, the correction methods and analysis of dynamics of the flow and the associated measurements. Techniques specific to a large development transonic tunnel are discussed in detail with a constant awareness of the cost and efficiency in relation to the required accuracy and repeatability standards. Author

N89-16863# National Aerospace Lab., Amsterdam (Netherlands). ACCURACY OF VARIOUS WALL-CORRECTION METHODS FOR 3D SUBSONIC WIND-TUNNEL TESTING

R. A. MAARSINGH, TH. E. LABRUJERE, and J. SMITH *In* AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 13 p Jul. 1988 Avail: NTIS HC A22/MF A01

On the basis of wind-tunnel measurements on a (simple, unpowered, but complete) transport aircraft model in a small and a very large solid-wall test section the accuracy of four measured-boundary-condition (MEC) methods, as well as two classical methods, was analyzed at low-speed conditions. Large reductions in the amount of in situ measured data are shown to be possible, yet yielding results which match almost with those of calculations using multiples of input data. Classical methods need not be abandoned at once in low-speed solid-wall testing. Higher priority should be given to the well-known interpretation problem: the determination of the actual model reaction upon the wall-induced flow field. Author

N89-16864*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

WIND TUNNEL-SIDEWALL-BOUNDARY-LAYER EFFECTS IN TRANSONIC AIRFOIL TESTING-SOME CORRECTABLE, BUT SOME NOT

F. T. LYNCH (Douglas Aircraft Co., Inc., Long Beach, CA.) and C. B. JOHNSON *In* AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 16 p Jul. 1988

Avail: NTIS HC A22/MF A01 CSCL 14B

The need to correct transonic airfoil wind tunnel test data for the influence of the tunnel sidewall boundary layers, in addition to the wall accepted corrections for the analytical investigation was carried out in order to evaluate sidewall boundary layer effects on transonic airfoil characteristics, and to validate proposed correction and the limit to their applications. This investigation involved testing of modern airfoil configurations in two different transonic airfoil test facilities, the 15 x 60 inch two-dimensional insert of the National Aeronautical Establishment (NAE) 5 foot tunnel in Ottawa, Canada, and the two-dimensional test section of the NASA Langley 0.3 m Transonic Cryogenic Tunnel (TCT). Results presented included effects of variations in sidewall-boundary layer bleed in both facilities, different sidewall boundary layer correction procedures, tunnel-to-tunnel comparisons of corrected results, and flow condi-Author tions with and without separation.

N89-16870# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.).

ACCURACY REQUIREMENTS FOR HIGH-SPEED TEST WITH ENGINE SIMULATION ON TRANSPORT AIRCRAFT MODELS IN THE NLR-HST

W. BURGSMUELLER, J. W. KOOI, and K MOELLER, W. (National Aerospace Lab., Amsterdam, Netherlands) In AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 16 p Jul. 1988 Avail: NTIS HC A22/MF A01

Air-driven turbo-powered simulators, so-called TPS units, are being used in wind tunnel testing to simulate the engine flow for an aircraft model. These simulators provide substantial improvement in testing as compared to simple through-flow nacelles used earlier. In order to fully explore the improvement potential in aerodynamic simulation it is mandatory to assure a high level of accuracy or in case of increment testing a good repeatability because the effects of engine interference drag are of the order of a few counts. For increment testing a repeatability of at least + or - 1 drag count must be achieved. The efforts made to demonstrate that this repeatability can be achieved in the NLR high speed wind tunnel (HST) for a half model with a wing-mounted TPS engine are described. The test was performed in a joint program of NLR and MBB-UT, where MBB delivered the model and TPS unit with engine cowlings, while NLR was responsible for engine calibration, wind tunnel instrumentation, and the test. To obtain the desired quality of the final test results the investigation was subdivided into several steps. These steps and the technical problems and questions encountered will be described in detail. Author

N89-16873# Technische Univ., Darmstadt (Germany, F.R.). BALANCE ACCURACY AND REPEATABILITY AS A LIMITING PARAMETER IN AIRCRAFT DEVELOPMENT FORCE MEASUREMENTS IN CONVENTIONAL AND CRYOGENIC WIND TUNNELS

B. EWALD *In* AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 12 p Jul. 1988

Avail: NTIS HC A22/MF A01

The success of a commercial transport development is heavily influenced by the accuracy of drag measurements during the aerodynamic development in the wind tunnel. It is shown, that the internal balance in one limiting factor of accuracy. The accuracy standard of modern internal balances is compared to the accuracy and repeatability requirement of the aerodynamicist. The comparison with high precision single component load cells promises a large improvement potential in multi-component balance design and calibration. The following fields of improvement are discussed: balance design, balance material selection and treatment, calibration methods, calibration software, and thermal effects. Perfect correction of the thermal effects is the key to the successful use of cryogenic tunnels. An approach for the crucial problem of balance body distortion due to temperature gradients Author is demonstrated.

N89-16877# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.).

ACCURACY PROBLEMS IN WIND TUNNELS DURING TRANSPORT AIRCRAFT DEVELOPMENT

GUENTER KRENZ In AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 9 p. Jul. 1988

Avail: NTIS HC A22/MF A01

Wind tunnel test data accuracy requirements for transport aircraft are derived. Airline performance guarantees, model and tunnel test techniques available and the quality of prediction methods used form the concept for wind tunnel test programs and set accuracy requirements for test data. Procedures which were followed in high speed cruise and low speed takeoff and landing are described. The accuracy of the wind tunnel tests is limited by several parameters, the most important being flow quality, model and model suspension quality, and balance accuracy. Problems which occurred during the test with small models in the transonic regime led to the concepts presented: the use of large models on a specific suspension with a range-limited balance and the improvement of small model test techniques in connection with the requirements for measurements in cryogenic facilities. Low speed tests are ambitious and extensive due to the many configurations at takeoff and landing. Furthermore, the work is complicated by the many details like closing plates and shutters, which can have a strong effect on the performance data. Some Author examples are presented.

N89-16878# National Aerospace Lab., Amsterdam (Netherlands). REQUIREMENTS AND CAPABILITIES IN UNSTEADY WINDTUNNEL TESTING

R. D. DENBOER, R. HOUWINK, and R. J. ZWAAN *In* AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 18 p Jul. 1988 Avail: NTIS HC A22/MF A01

The accuracy required for aeroelastic applications concerning full-scale aircraft is discussed, after which the accuracy in current unsteady wind tunnel testing is considered. Author

N89-16879# Institut de Mecanique des Fluides de Lille (France).

PARTICULAR FLIGHT MECHANICS SPECIFICATIONS RELATED TO WIND TUNNEL TEST RESULTS [SPECIFICATIONS PARTICULIERES CONCERNANT LES RESULTATS DES ESSAIS EN SOUFFLERIE POUR LA MECANIQUE DU VOL]

MARC PIANKO *In* AGARD, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing 19 p Jul. 1988 In FRENCH Original language document was announced in IAA as A88-28859

Avail: NTIS HC A22/MF A01

A flight mechanics analysis of requirements and recommendations for the quality and precision of wind tunnel measurements is presented. The effect of imprecision in modeling flight behavior is examined in order to determine the sensitivity of the individual aerodynamic coefficients. Problems in the characterization of flight at large angles of incidence and sideslip, where unsteady phenomena and perturbations play a large role, are considered. Difficulties in the use of the wind tunnel for aircraft design are also reviewed. Author

 N89-17601#
 Eidgenoessisches
 Flugzeugwerk,
 Emmen

 (Switzerland).
 Aerodynamik und Flugmechanik.
 NEW DESIGN OF THE NOZZLE SECTION OF A LARGE

SUBSONIC WIND TUNNEL FELIX HIRT 24 May 1988 112 p II

FELIX HIRT 24 May 1988 112 p In GERMAN; ENGLISH summary

(F+W-TF-1926; ETN-89-93539) Avail: NTIS HC A06/MF A01

The tunnel contraction of large subsonic wind tunnels was redesigned in order to optimize the nozzle contour with respect to length, wall pressure distribution, and boundary layer thickness development. The longitudinal contour was generated using a polynomial of high degree, such that all relevant boundary conditions can be fulfilled. The optimization shows that contours with a continuous wall curvature variation toward the exit of the contraction produce the smallest wall pressure peak. The analytically defined contour was realized with the help of longitudinal ribs and a rigid foam filling. Pressure measurements confirm the theoretical results quite well.

N89-18384*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE VERTICAL MOTION SIMULATOR

TODD HOSEIN *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers p 33-37 Sep. 1988

Avail: NTIS HC A07/MF A01 CSCL 14B

Today's flight simulators, such as NASA's multimillion dollar Vertical Motion Simulator (VMS), recreate an authentic aircraft environment, and reproduce the sensations of flight by mechanically generating true physical events. In addition to their application as a training tool for pilots, simulators have become essential in the design, construction, and testing of new aircraft. Simulators allow engineers to study an aircraft's flight performance and characteristics without the cost or risk of an actual test flight. Because of their practicality, simulators will become more and more important in the development and design of new, safer aircraft. Author **N89-18388*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE WIND TUNNELS OF THE NATIONAL FULL-SCALE AERODYNAMICS COMPLEX

JOHN MOON *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers p 55-61 Sep. 1988

Avail: NTIS HC A07/MF A01 CSCL 14B

A brief overview is given of the National Full-scale Aerodynamics Complex. Its geometry, design, construction and testing conditions and models are examined. E.R.

10

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.

A89-25208*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PRESSURE AND HEAT TRANSFER INVESTIGATION OF A MODIFIED NASP BASELINE CONFIGURATION AT M = 6

DAVID E. REUBUSH (NASA, Langley Research Center, Hampton, VA) and M. EMMETT OMAR (Boeing Advanced Systems, Seattle, WA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. refs

(AIAA PAPER 89-0246)

A cooperative NASA Langley-Boeing investigation was conducted in the Langley eight-Foot High Temperature Tunnel to obtain hypersonic pressure and heat transfer data. In this investigation a large scale (1/20), modified version of the National Aero-Space Plane configuration known as the 'Government Baseline' was tested at a nominal Mach number of 6; at two Reynolds numbers (0.6 and 1.6 million per foot); and at angles of attack from about 0 to 15 deg. There were several purposes for the investigation: to provide a windward and leeward pressure and heat transfer data base for a realistic configuration for verification of computational methods, to provide these data for a large-scale model, and to provide these data for methods. Author

A89-25568*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

NASP NATURAL ENVIRONMENT DEFINITIONS FOR DESIGN ORVEL E. SMITH, DALE L. JOHNSON, and ROBERT E. SMITH (NASA, Marshall Space Flight Center, Huntsville, AL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 3 p.

(AIAA PAPER 89-0764)

Problems that emerged during the development of the natural environment definitions for the design of the National Aerospace Plane (NASP) are discussed. The NASP program objectives are reviewed. It is found that some of the data needed to determine the environmental parameters for designing the aircraft are unavailable. It is suggested that this is due to a lack of technology for making the necessary measurements. R.B.

A89-26701

PLANS '88 - IEEE POSITION LOCATION AND NAVIGATION

SYMPOSIUM, ORLANDO, FL, NOV. 29-DEC. 2, 1988, RECORD Symposium sponsored by IEEE. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, 569 p. For individual items see A89-26702 to A89-26752.

The present conference discusses topics in state-of-the-art space-based navigation systems, land vehicle navigation and

10 ASTRONAUTICS

position reporting, digital map technology, integrated navigation and flight control systems, GPS applications and equipment, geodetic surveying, radio navigation systems, and the positioning and pointing of space systems. Attention is also given to topics in the fields of inertial systems and technologies, differential GPS, aircraft navigation and traffic control, Federal radio-navigation policy, GPS/inertial navigation, integrated communication and navigation systems, and marine navigation and harbor traffic advisory systems.

A89-26711

EURONAV - A STATE OF THE ART MILITARY GPS RECEIVER ANIL K. AGGARWAL (Magnavox Advanced Products and Systems Co., Torrance, CA) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 153-164.

Two- and five-channel EURONAV GPS receivers for military applications are presented. Both types of receivers have a wide range of features in addition to providing the basic GPS (Global Positioning System) navigation functions. These receivers provide high performance, selective availability/antispoofing, and high antijam GPS capabilities. By the use of advanced technology components, it was possible to reduce the size of a five-channel GPS receiver from the GPS Phase II qualified three-fourths ATR long to three-eights ATR short, with a corresponding weight and power reduction. The author describes the EURONAV product specifications, the hardware, and the software design. I.E.

A89-26738

RANGING AND PROCESSING SATELLITE (RAPSAT)

WILLIAM R. HERSHEY, THOMAS HSIAO, CURTIS A. SHIVELY, and KAREN J. VIETS (Mitre Corp., McLean, VA) IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 394-401.

The following features of RAPSAT are described: performance requirements, operations, onboard processor architecture, and power and spectrum requirements. The proposed RAPSAT would provide surveillance and data link services for aviation. A feasibility study conducted over the past year shows the system can serve 50,000 peak instantaneous users with a total aircraft-to-satellite bandwidth of 4-5 MHz. The results reflect realistic message sizes and frequencies, plus the projected geographic distribution of air traffic in the year 2010. The system offers both automatic dependent surveillance and cooperative independent surveillance services. It uses two or more geostationary satellites, a cross link for coordination between the satellites, and an onboard processor for each satellite. By carefully scheduling discrete polls to aircraft, the system prevents garbling of aircraft replies at the satellite receive antenna and thus achieves higher spectral efficiency than previously proposed satellite-based surveillance systems. LE.

A89-27175#

STRUCTURAL RELIABILITY IN AEROSPACE DESIGN

A. V. PATKI (ISRO, Satellite Centre, Bangalore, India) ESA Journal (ISSN 0379-2285), vol. 12, no. 3, 1988, p. 397-400.

The concept of a reliability figure is widely used in aerospace design. Though very common and well developed for electronics systems and components, it is not used directly for structural systems. This note attempts to show how reliability estimates can be incorporated in present aerospace design practice. A typical simple case is worked out to show the implicit reliability figures using these margins.

11

CHEMISTRY AND MATERIALS

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

A89-25190#

CORRELATIONS OF HIGH DENSITY FUEL EFFECTS

N. K. RIZK and H. C. MONGIA (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs (Contract F33615-86-C-2604)

(AIAA PAPER 89-0216)

An extensive testing of the T56-A-15 engine combustion system was carried out for a baseline JP-4 fuel and four high density fuels to evaluate the impact of the burning of high density fuel on combustor performance. The data evaluation phase involved the utilization of proven empirical correlations based on reaction rate, residence time, and mixing concepts. The prediction capability of the correlations was improved by incorporating detailed spray and evaluation calculation methods and the appropriate modifications to address the high-density fuel properties. K.K.

A89-25193#

3-D COMBUSTOR PERFORMANCE VALIDATION WITH HIGH DENSITY FUELS

N. K. RIZK and H. C. MONGIA (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract F33615-86-C-2604)

(AIAA PAPER 89-0219)

High-density fuel data were used to validate a combustor performance model that utilizes flow field representations based on analytical three-dimensional codes as well as empirical correlations. This performance model is capable of assessing the impact of systematic modifications to the combustor on its performance. In addition, it eliminates the need for engineering estimates of certain combustor parameters. K.K.

A89-25403#

EXPERIMENTAL AND ANALYTICAL STUDY ON EXIT RADIAL TEMPERATURE PROFILE OF EXPERIMENTAL 2D COMBUSTOR

JI-BAO LI (Chinese Gas Turbine Establishment, People's Republic of China) and JU-SHAN CHIN (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (AIAA PAPER 89-0493)

A semiempirical and semianalytical model was developed for predicting the exit radial temperature profile from gas turbine combustors. The model can predict the effect of a change in the dilution zone design or combustor operating conditions on the change in the combustor exit radial temperature profile on the basis of the exit temperature before the change. This model is shown to be instrumental in the adjustment of the temperature profile of the gas turbine combustor. K.K.

A89-25902

A NEW TECHNIQUE FOR THE PRODUCTION OF GAS ATOMIZED POWDER

CHRISTER ASLUND and TORBJORN TINGSKOG (Anval Nyby Powder AB, Torshalla, Sweden) IN: Modern developments in powder metallurgy; Proceedings of the International Powder Metallurgy Conference, Orlando, FL, June 5-10, 1988. Volume 20. Princeton, NJ, Metal Powder Industries Federation, 1988, p. 181-186.

A new principal of atomization, the vertical horizontal (VH) atomization technique, is described. The advantage of this technique is a low gas consumption and low gas pressures

combined with a fine screen cut ideal for applications such as spray powder and consolidated products where max grain sizes of about 100 microns are required. Author

A89-25915

SUPERPLASTICITY OF HIPPED PM SUPERALLOYS MADE FROM ATTRITED PREALLOY POWDER

N. UENISHI, Y. TAKEDA, and K. KUROISHI (Sumitomo Electric Industries, Ltd., Itami, Japan) IN: Modern developments in powder metallurgy; Proceedings of the International Powder Metallurgy Conference, Orlando, FL, June 5-10, 1988. Volume 20. Princeton, NJ, Metal Powder Industries Federation, 1988, p. 599-612. Research sponsored by the Agency of Industrial Science and Technology.

This paper describes a P/M process which was shown to enhance the superplasticity of Ni-base superalloys IN100, Astroloy, and TMP-3. The process involves the strain energizing of the prealloy powder, by using an attritor, and the HIP consolidation of the strain-energized powder. The mechanical properties measurements showed that the hardness of the strain-energized powders was above 600 mHv, which is 200 mHv higher than that of original powders. HIPped billets of strain-energized powder exhibited good superplasticity. The mechanical properties of HIPped and heat treated billets of strain-energized powder could be significantly improved eliminating oxygen and iron contamination. 1.5

A89-25919

MATERIAL DEFECTS IN A PM-NICKEL-BASE SUPERALLOY B. NOWAK, G. KOENIG, E. AFFELDT (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany), H. LAHODNY, and E. ARZT (Max-Planck-Institut fuer Metallforschung, Stuttgart, Federal Republic of Germany) ١N· Modern developments in powder metallurgy; Proceedings of the International Powder Metallurgy Conference, Orlando, FL, June 5-10, 1988. Volume 20. Princeton, NJ, Metal Powder Industries Federation, 1988, p. 745-750.

Procedures used in the determination of the type, the size, and the frequency of defects in the nickel-base superalloy U700 (Ni-16 Cr-18 Co-5.5 Mo-3.7 Ti-4.2 Al-0.04 C-0.03 B-0.06 Zr, in wt pct) are described, and the results of the analyses are presented. Eight different types of defects were documented in Viton-doped U700. These defects could be categorized among three classes, including pores, ellipsoid reactive inclusions, and Viton defects. The frequency of these defects as a function of size was determined. 1.5

A89-26361

THERMAL CONDUCTIVITY AND MICROSTRUCTURE STABILITY OF HEAT TREATED AMZIRC COPPER-BASED ALLOYS

CARL E. NEWBERG and WALTER W. WALKER (Hughes Aircraft Co., Tucson, AZ) IN: Metallography of advanced materials; Proceedings of the Twentieth Annual Technical Meeting of the International Metallographic Society, Monterey, CA, July 29, 30, 1987. Columbus/Metals Park, OH, International Metallographic Society/ASM International, 1988, p. 231-243. refs

Prompted by the need for microelectronic alloys that do not soften at brazing temperatures, two candidate copper-based alloys have been investigated: one involves Zr additions, the other Mg, Zr, and Cr. Both allovs are precipitation-hardenable and have high electrical and thermal conductivities; an attempt was made to obtain optimum thermal and mechanical properties. Optical microscopy, SEM, and energy-dispersive spectroscopy were used to ascertain the microstructures yielded by various heat treatments and cold working. The Zr-containing Cu alloy exhibits significantly higher thermal conductivity in every condition examined. O.C.

A89-27733#

LOCAL BUCKLING AND CRIPPLING OF THIN-WALLED COMPOSITE STRUCTURES UNDER AXIAL COMPRESSION

A. D. REDDY, L. W. REHFIELD, R. I. BRUTTOMESSO (Georgia Institute of Technology, Atlanta), and N. E. KREBS (Sikorsky

Aircraft, Stratford, CT) (Structures, Structural Dynamics, and Materials Conference, 26th, Orlando, FL, Apr. 15-17, 1985, Technical Papers. Part 1, p. 804-810) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 97-102. Research supported by Sikorsky Aircraft. Previously cited in issue 13, p. 1859, Accession no. A85-30314. refs

(Contract DAAG29-82-K-0094)

A89-28242

AN INVESTIGATION OF THE PHYSICAL AND CHEMICAL FACTORS AFFECTING THE PERFOMANCE OF FUELS IN THE JFTOT

RICHARD H. CLARK and LORRAINE THOMAS (Shell Research, Ltd., Thornton Research Centre, Chester, England) SAE. Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 15 p. Research supported by the Ministry of Defence, refs

(SAE PAPER 881533)

Using a jet fuel thermal oxidation tester (JFTOT), the physical and chemical factors which control the fuel performance were investigated in flow rate experiments in which seven different fuels. chosen to represent current refinery production, were used. Results on the flow-rate and the activation energy measurements indicated that the JFTOT response to a fuel depended on the relative roles of chemical reaction and physical transport, and that the contribution of the two effects was fuel dependent. IS

A89-28243

DEVELOPMENT OF A LABORATORY METHOD FOR STUDYING WATER COALESCENCE OF AVIATION FUEL

STEVEN T. SWIFT (Exxon Research and Engineering Co., Linden, NJ) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 11 p. refs

(Contract N00140-85-C-E184)

(SAE PAPER 881534)

A laboratory-scale coalescence test device is described, which makes it possible to investigate the water coalescence of aviation fuels under controlled conditions. The test device consists of a small-scale filter/separator unit incorporating both a coalescer and a separator stages and operating at a 800-fold reduction in flow rate from a full-scale filter/coalescer element. Using this device, the effects of various commercial fuel additives, including antioxidants, corrosion inhibitors, antiicing additives, and static dissipator additives, on the extent of water coalescence in the JP-5 aviation fuel were determined. The results were very similar to those obtained using conventional single-element tests.

A89-28244

BALL-ON-CYLINDER TESTING FOR AVIATION FUEL LUBRICITY

W. G. DUKEK SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 10 p. refs (SAE PAPER 881537)

The use of the ball-on-cylinder evaluator (BOCLE) to measure the lubrication properties of aviation fuels is described, summarizing the results of recent test evaluations. The fundamental problems of lubricity testing are reviewed, and the advantages offered by BOCLE are discussed: BOCLE measures lubricity in terms of mean ball wear and can detect the presence of lubrication-improvement additives and the abscence of natural lubricity agents in jet fuel. Typical results from comparative tests are presented in extensive graphs, with particular attention to Coordinating Research Council efforts to improve BOCLE. Significant improvements are obtained by using cylinders instead of rings. A.A.F.

A89-28344*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPOSITE MECHANICS FOR ENGINE STRUCTURES

CHRISTOS C. CHAMIS (NASA, Lewis Research Center, Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Mar.-Apr. 1989, p. 228-241. Previously announced in STAR as N88-12552. refs

Recent research activities and accomplishments at Lewis

11 CHEMISTRY AND MATERIALS

Research Center on composite mechanics for engine structures are summarized. The activities focused mainly on developing procedures for the computational simulation of composite intrinsic and structural behavior. The computational simulation encompasses all aspects of composite mechanics, advanced three-dimensional finite-element methods, damage tolerance, composite structural and dynamic response, and structural tailoring and optimization. Author

A89-28433

MATERIALS FOR INTERIORS - A BRIEF REVIEW OF THEIR CURRENT STATUS [MATERIALES PARA INTERIORES - UN BREVE REPASO A LA SITUACION ACTUAL]

JOSE A. MARTINEZ CABEZA Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), no. 309, 1989, p. 21-33. In Spanish.

An evaluation is made of the development status and characteristic products used in commercial aircraft interiors, pursuant to such flammability, smoke-generation, and smoke-toxicity minimization requirements as those set out in appendix F of FAR 25's section II. Intensive development has been prompted by FAR 25-59's call for materials applicable to passenger seating that would meet 'fire blocking layer' criteria while being as light as 300 g/sq m; also intensively sought have been seat cushion polymeric foams that could yield the requisite degree of inflammability without the use of a fire blocking layer material. FAR 25-61 and FAR 121 are also discussed. O.C.

N89-17017*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL VERIFICATION OF THE THERMODYNAMIC PROPERTIES FOR A JET-A FUEL

CARMEN M. GRACIASALCEDO, THEODORE A. BRABBS, and BONNIE J. MCBRIDE Sep. 1988 10 p Presented at the 196th National Meeting of the American Chemical Society, Los Angeles, CA, 25-30 Sep. 1988 Prepared in cooperation with Army Aviation Systems Command, Cleveland, OH; and Sverdrup Technology, Inc., Cleveland, OH

(NASA-TM-101475; E-4593; NAS 1.15:101475) Avail: NTIS HC A02/MF A01 CSCL 21D

Thermodynamic properties for a Jet-A fuel were determined by Shell Development Company in 1970 under a contract for NASA Lewis Research Center. The polynomial fit necessary to include Jet-A fuel (liquid and gaseous phases) in the library of thermodynamic properties of the NASA Lewis Chemical Equilibrium Program is calculated. To verify the thermodynamic data, the temperatures of mixtures of liquid Jet-A injected into a hot nitrogen stream were experimentally measured and compared to those calculated by the program. Iso-octane, a fuel for which the thermodynamic properties are well known, was used as a standard to calibrate the apparatus. The measured temperatures for the calculated reproduced the mixtures iso-octane/nitrogen temperatures except for a small loss due to the non-adiabatic behavior of the apparatus. The measurements for Jet-A were corrected for this heat loss and showed excellent agreement with the calculated temperatures. These experiments show that this process can be adequately described by the thermodynamic properties fitted for the Chemical Equilibrium Program. Author

N89-17325*# Engineering Science Software, Inc., Smithfield, RI.

CONSTITUTIVE MODELLING OF SINGLE CRYSTAL AND DIRECTIONALLY SOLIDIFIED SUPERALLOYS

KEVIN P. WALKER and ERIC H. JORDAN (Connecticut Univ., Storrs.) /n NASA, Lewis Research Center, Turbine Engine Hot Section Technology, 1987 p 299-301 Oct. 1987 (Contract NAG3-512)

Avail: NTIS HC A20/MF A01 CSCL 11F

Successful attempts were made to model the deformation behavior of nickel base superalloys to be used in gas turbine engines based on both a macroscopic constitutive model and a micromechanical formulation based on crystallographic slip theory. These models were programmed as FORTRAN subroutines, are currently being used to simulate thermomechanical loading predictions expected at the fatigue critical locations on a single crystal turbine blade. Such analyses form a natural precursor to the application of life prediction methods to gas turbine airfoils. Author

N89-17334*# Pratt and Whitney Aircraft, East Hartford, CT. HIGH TEMPERATURE CONSTITUTIVE AND CRACK INITIATION MODELING OF COATED SINGLE CRYSTAL SUPERALLOYS

THOMAS G. MEYER, DAVID M. NISSLEY, and GUSTAV A. SWANSON *In* NASA, Lewis Research Center, Turbine Engine Hot Section Technology, 1987 p 401-412 Oct. 1987 (Contract NAS3-23939)

Avail: NTIS HC A20/MF A01 CSCL 11B

The purpose of this program is to develop life prediction models for anisotropic materials used in gas turbine airfoils. In the base portion of the program, two coated single crystal alloys are being tested. They are PWA 286 overlay coated and PWA 273 aluminide coated PWA 1480 and PWA 286 overlay coated Alloy 185. Viscoplastic constitutive models for these materials are also being developed to predict the cyclic stress-strain histories required for life prediction of the lab specimens and actual airfoil designs. Author

N89-17681# Battelle Columbus Labs., OH. FUEL-ADDITIVE SYSTEM FOR TEST CELLS Final Report, 5 Aug. 1987 - 25 Feb. 1988

DALE W. FOLSOM Aug. 1988 34 p

(Contract F08635-85-C-0122)

(AD-A200801; AFESC/ESL-TR-88-17) Avail: NTIS HC A03/MF A01 CSCL 21E

The purpose of this project was to provide the U.S. Air Force with design data and a prototype of a fuel-additive system capable of reducing plume opacity during testing of a jet engine in a test cell. Jet engines are tested in a test cell after servicing and before placement in an aircraft. Certain jet engines, J-57, J-79, and TF-33 in particular, generate soot which exits the test cell in a plume of greater than 20 percent opacity (Ringelmann number of 1 or greater). This opacity exceeds the opacity limit (20 percent) set by the Environmental Protection Agency (EPA). The U.S. Air Force has previously funded projects that found two jet fuel additives, ferrocene and cerium octoate, that reduce the plum opacity. The scope of this project included the design, construction, and testing of a prototype fuel-additive system. The following report describes the fuel-additive system requirements, design parameters, design, fabrication, and testing of the prototype system. The prototype fuel-additive system, properly built and operated, will provide the U.S. Air Force a means of testing jet engines in test cells while staying within EPA opacity limits. GRA

N89-17696# Royal Armament Research and Development Establishment, Christchurch (England).

TEST SPECIMENS FOR BEARING AND BY-PASS STRESS INTERACTION IN CARBON FIBRE REINFORCED PLASTIC LAMINATES

M. B. SNELL and G. P. BURKITT *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures 21 p Mar. 1988 Original document contains color illustrations Avail: NTIS HC A14/MF A01

Compact test specimens for measuring the strength interaction behaviour of bolted joints subject to combined bearing and by-pass stresses have been studied. Multi-bolt specimens which have been successfully used to study these effects in aluminum alloy were found to be unsatisfactory because of the uncertainty in load transfer, and a new specimen based on parallel plates was developed. Bearing load at the holes is achieved through load transfer from the central carbon fiber reinforced plastic (CFRP) coupon to the parallel plates. The maximum ratio of bearing to bypass loads is limited by the initial fit of the bolt and by subsequent bolt/hole deformation under load. However the specimens recommended are capable of applying a wide range of bearing/bypass load ratios. Sample strength interaction envelopes were produced for a Hercules IM6 fiber and Ciba-Geigy Fibredux 6376 resin laminate of typical wing skin lay-up, 5.5 mm thick. Both tension and compression quadrants were studied, with two hole sizes, in both double shear and single shear. The interaction behavior was similar in both tension and compression for 6.35 mm holes in double shear, but in the case 0f 9.5 mm bolts there was less interaction in compression than in tension. Countersunk fasteners in tension appeared to suffer little reduction in net strength due to bearing stresses. Author

N89-17701# Aeritalia S.p.A., Naples (Italy). JOINING OF CARBON FIBER COMPOSITE WITH FASTENERS SALVATORE PAGLIUSO *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures 5 p Mar. 1988

Avail: NTIS HC A14/MF A01

This paper deals with the Aeritalia experience on drilling techniques and fastener selection for advanced composite assembly. Details are provided on fabrication techniques. Information is given on corrosion prevention. Author

N89-17702# Avions Marcel Dassault, Saint-Cloud (France). BOLTED SCARF JOINTS IN CARBON COMPOSITE MATERIALS. COMPARISON BETWEEN ASSEMBLIES WITH AN INTERFERENCE FIT AND THOSE WITH PLAY [ENTURES BOULONNEES EN MATERIAUX COMPOSITE CARBONE COMPARAISON ENTRE MONTAGES A INTERFERENCE ET MONTAGE A JEU]

DANIEL CHAUMETTE In AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures 10 p Mar. 1988 In FRENCH

Avail: NTIS HC A14/MF A01

Experimental results on the behavior of carbon assemblies with mechanical fasteners mounted with and without interference are presented. Interference tests have been conducted for the cases of unstressed joints and scarf joints. In contrast to the predictions of elastic stress theory, interference fit is not found to have a significant influence on the static strength of test specimens, even after fatigue loading. The present results can be explained by the fracture mode of the drilled composite parts which leads to delamination. Author

12

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.

A89-24995#

AUTOMATIC GENERATION OF COMPONENT MODES FOR ROTORDYNAMIC SUBSTRUCTURES

S. H. CRANDALL and N. A. YEH (MIT, Cambridge, MA) ASME, Transactions, Journal of Vibration, Acoustics, Stress, and Reliability in Design (ISSN 0739-3717), vol. 111, Jan. 1989, p. 6-10. refs

A program for the automatic generation of the component modes for substructures modeled as Timoshenko beams connected to other substructures by bearings, couplings, and localized structural joints is described. The method makes use of the singularity functions commonly used in beam analysis, and it has been applied to a simplified system with a single rotor structure and a single stator structure. The accuracy of the method is demonstrated by comparison of the results with those obtained by an exact analytical solution and by a component mode synthesis using true eigenfunctions as internal modes. R.R.

A89-25065*# Sundstrand Corp., Rockford, IL. AN EXPERIMENTAL STUDY AND PREDICTION OF A TWO-PHASE PRESSURE DROP IN MICROGRAVITY

I. Y. CHEN, R. S. DOWNING (Sundstrand Corp., Rockford, IL), E. KESHOCK, and M. M. AL-SHARIF (Tennessee, University, Knoxville) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 11 p. refs (Contract NAS9-17195)

(AIAA PAPER 89-0074)

Experimental two-phase pressure drop results obtained in normal gravity and in nearly zero-gravity aboard a NASA-JSC reduced-gravity KC-135 aircraft are used to evaluate several empirically based correlations and flow-regime dependent models. Pressure drops in reduced gravity and those in normal gravity are shown to be related to flow pattern models for each. Two annular flow models are developed which are found to accurately predict the reduced-gravity data. R.R.

A89-25082#

CFD APPLICATIONS - PROPULSION PERSPECTIVE

SAADAT A. SYED (United Technologies Corp., West Palm Beach, FL) and GORDON F. PICKETT (United Technologies Corp., East Hartford, CT) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 11 p. refs

(AIAA PAPER 89-0093)

The current status of Computational Fluid Dynamics (CFD) as applied to propulsion devices is discussed. The traditional code development cycle is described, and it is argued that this cycle needs to be improved if the explosive growth in CFD codes is to be harnessed profitably. It is also argued that the government funding agencies have to take a leading role in the modification of this cycle. The technical issues relating to internal flows in propulsion systems are discussed, and it is suggested that mesh generation, mesh adaptation, and turbulence model development require major emphasis in the future.

A89-25101#

A COMPARATIVE STUDY OF ITERATIVE ALGORITHMS FOR THE EULER EQUATIONS OF GASDYNAMICS

DANIEL J. DORNEY, GEORGE S. DULIKRAVICH (Pennsylvania State University, University Park), and KI D. LEE (Illinois, University, Urbana) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989, 14 p. refs

(AIAA PAPER 89-0114)

A comparative study for the solution of the Euler equations has been performed using four flux-vector-splitting (FVS) schemes and a central difference scheme with two different dissipation models. All schemes were tested for the case of steady, inviscid, transonic airfoil flow. Van Leer's FVS scheme was found to be robust and appears to generate little numerical dissipation. The FVS schemes of Deese (1983, 1985) and Steger-Warming (1981) yield results similar to Van Leer's, though not quite as robust. Whitfield's (1984) FVS scheme generates large amounts of numerical dissipation and causes delayed post-shock pressure recovery. A new, physically based dissipation model for central difference schemes has been compared to the artificial dissipation model of Jameson et al. (1981).

A89-25118*# Pennsylvania State Univ., University Park. DIVERGING BOUNDARY LAYERS WITH ZERO STREAMWISE PRESSURE GRADIENT

WAYNE R. PAULEY (Pennsylvania State University, University Park), JOHN K. EATON (Stanford University, CA), and ANDREW D. CUTLER (NASA, Langley Research Center; George Washington University, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 12 p. refs

(Contract DE-FG03-86ER-13608; NAGW-581)

(AIAA PAPER 89-0134)

The effects of spanwise divergence on the boundary layer forming between a pair of embedded streamwise vortices with the common flow between them directed toward the wall was studied. Measurements indicate that divergence controls the rate of development of the boundary layer and that large divergence

12 ENGINEERING

significantly retards boundary layer growth and enhances skin friction. For strongly diverging boundary layers, divergence accounts for nearly all of the local skin friction. Even with divergence, however, the local similarity relationships for two-dimensional boundary layers are satisfactory. Although divergence modifies the mean development of the boundary layer, it does not significantly modify the turbulence structure. In the present experiments with a zero streamwise pressure gradient, it was found that spanwise divergence dit not significantly affect the Reynolds stress and the turbulent triple product distributions. Author

A89-25119#

MEASUREMENTS OF A SUPERSONIC TURBULENT BOUNDARY LAYER WITH MASS ADDITION

WILLIAM J. YANTA, ARNOLD S. COLLIER, and TIMOTHY S. SMITH (U.S. Navy, Naval Surface Warfare Center, Silver Spring, MD) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 17 p. refs

(AIAA PAPER 89-0135)

Boundary-layer measurements were carried out on two 8-deg sphere-cones with mass addition at a Mach Number of 2.5 and a freestream Reynolds Number of 8.86 million/m). These cones were fabricated from two different grades of porous materials. Measurements were made with two-dimensional LDV, from which the mean velocity, turbulence intensities, Reynolds stresses, eddy viscosity and mixing length were determined. Measurements were carried out for four different mass-addition rates at two stations on the model. Air was used as the injection gas. Author

A89-25150#

SINGLE AND MULTIPLE JET IMPINGEMENT HEAT TRANSFER ON ROTATING DISKS

D. E. METZGER and V. A. PARTIPILO (Arizona State University, Tempe) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 p. refs

(AIAA PAPER 89-0174)

In some gas turbine engine designs cooling air jets are directed at the rotating disk in an atempt to enhance the convection coefficients and reduce the amount of gas flow required for cooling. The jet-impingement scheme is particularly attractive for achieving intense cooling at a specific radial location, such as the blade attachment region. In earlier single-jet studies, the interaction between an impinging jet and rotating disk has been found to involve a flow regime transition. The present study extends the previously acquired data base with new results from both heat-transfer and flow-visualization testing, including effects of hub size, jet travel distance, and the number of jets. Results include a superposition scheme for predicting heat transfer for multiple jets and a criterion for the minimum amount of flow required through each jet nozzle to assure enhancement of the disk convection.

Author

A89-25181*# Mississippi State Univ., Mississippi State. A SIMPLE TIME-ACCURATE TURBOMACHINERY ALGORITHM WITH NUMERICAL SOLUTIONS OF AN UNEVEN BLADE COUNT CONFIGURATION

J. MARK JANUS and DAVID L. WHITFIELD (Mississippi State University, Mississippi State) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 20 p. refs (Contract NAG3-767; NAG3-869)

(AIAA PAPER 89-0206)

The present computer algorithm for the time-accurate flow analysis of rotating turbomachines is based on the finite-volume method and employs a high-resolution approximate Riemann solver for interface flux definitions and an implicit numerical scheme that possesses apparent unconditional stability. Block-block interfaces, including dynamic ones, are treated in such a way as to mimic interior block communication. The turbomachine configurations treated by way of illustration are 8-8-bladed and 11-9-bladed versions of a contrarotating unducted fan engine. O.C.

A89-25183#

PASSAGE-AVERAGED NAVIER-STOKES EQUATIONS WITH FINITE ELEMENT APPLICATIONS

ANDRE GARON, DOMINIQUE PELLETIER, and RICARDO CAMARERO (Ecole Polytechnique, Montreal, Canada) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 26 p. Research supported by NSERC and Centre de Recherche Informatique de Montreal. refs

(AIAA PAPER 89-0208)

The passage-averaged formulation of the Navier-Stokes equations describing viscous flow over stationary or rotating blades in a turbomachine is investigated analytically. A closure model is developed for the case where the axial, radial, and peripheral components of the force on the volume swept by a single blade row are specified, and particular attention is given to the extension of this model to multiple blade rows and the applicability of weak Galerkin FEMs to the passage-averaged Navier-Stokes equations. Results from successful simulations of flow past a propeller and flow in a mixed-flow pump are presented graphically and briefly characterized.

A89-25191#

AIRBLAST ATOMIZATION AT CONDITIONS OF LOW AIR VELOCITY

J. BECK, A. LEFEBVRE, and T. KOBLISH (Thermal Science and Propulsion Center, West Lafayette, IN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs (AIAA PAPER 89-0217)

The process of prefilming airblast atomization under conditions of reduced air velocity is examined. Spray quality is determined by a series of measurements of drop size distribution and mean drop size. A two-dimensional atomizer which produces a flat liquid sheet of variable thickness between two coflowing nitrogen gas streams is used. The results confirm that spray quality improves when air velocity and air/liquid mass flow ratio are increased and liquid surface tension and viscosity are decreased. It is suggested that a threshold of relative velocity exists below which atomization is not possible for a given set of conditions. The dependence of the spray Sauter mean diameter on initial liquid film thickness is weak for the system studied. It is suggested that this is because the airstreams impinge on the liquid sheet at a 30 deg angle and extrude the sheet between the two colliding streams, thus nullifying the influence of the initial sheet thickness. B.B.

A89-25275#

INFLUENCE OF CLEARANCE LEAKAGE ON TURBINE HEAT TRANSFER AT AND NEAR BLADE TIPS - SUMMARY OF RECENT RESULTS

D. E. METZGER, K. RUED, and M. K. CHYU (Arizona State University, Tempe) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs

(AIAA PAPER 89-0327)

In gas turbine engines, the unshrouded blades of axial turbine stages rotate in close proximity to the stationary outer wall, or seal, of the turbine housing. The pressure difference between pressure and suction sides of the blade drives a leakage flow through the gap between the rotating blade tip and adjacent wall. Flow and heat transfer at the blade tips have long been subjects of interest to gas turbine engine designers because of effects on aerodynamic performance and because material failures are frequently observed in that region. However, until quite recently only a very incomplete and largely qualitative understanding existed of the clearance gap flowfield, and virtually no information was available on the heat transfer effects. In this paper, an overview is given of recent published efforts to elucidate more features of the leakage-related flowfield and convection heat transfer on and near unshrouded turbine blade tips. Author

A89-25307*# University of Wales, Swansea.

AN ADAPTIVE IMPLICIT/EXPLICIT FINITE ELEMENT SCHEME FOR COMPRESSIBLE VISCOUS HIGH SPEED FLOW

O. HASSAN, K. MORGAN, and J. PERAIRE (University of Wales, Swansea) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV,

Jan. 9-12, 1989. 10 p. refs (Contract NAGW-478; SERC-GR/E/64046) (AIAA PAPER 89-0363)

An adaptive implicit/explicit finite element procedure for the solution of three-dimensional problems of steady compressible viscous high-speed flows is presented. In the vicinity of solid walls, a grid-exhibiting structure in the normal direction is employed, while away from this region the grid is totally unstructured. The implicit form of the algorithm is used near solid walls, with the grid structure being utilized in an equation solution approach based upon line relaxation. The explicit form of the algorithm is used elsewhere. Grid adaptation is achieved by means of adaptive remeshing. To illustrate the performance of the proposed method, solutions are obtained for the problems of shock-boundary layer interaction and shock-shock interaction on a swept cylindrical leading edge. Comparisons are made with experimental observations.

A89-25337*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

HIGH-TEMPERATURE CONTAINERLESS AIRCRAFT FURNACE EXPERIMENTATION IN THE MICROGRAVITY ENVIRONMENT ABOARD A KC-135 AIRCRAFT

RICHARD M. POORMAN, BUDDY V. GUYNES, ROBERT SHURNEY, and JACK WEEKS (NASA, Marshall Space Flight Center, Huntsville, AL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 5 p.

(AIAA PAPER 89-0402)

This paper describes a materials processing research furnace, the High-Temperature Containerless Aircraft Furnace (HITCAF), which uses an electric arc to melt and resolidify materials in the microgravity environment aboard a KC-135 aircraft. The HITCAF is designed to process almost every electrically conductive material, including such high-melting-point materials as tungsten, within a 15 to 20 sec microgravity period. It operates on tungsten/inert gas welding principles, using an adapted commercially available tube welder. The HITCAF is fully operational and available for use by researchers representing the Government agencies, as well as industry and academia. I.S.

A89-25376*# Boeing Advanced Systems Co., Seattle, WA. A MODEL FOR 3-D SONIC/SUPERSONIC TRANSVERSE FUEL INJECTION INTO A SUPERSONIC AIR STREAM

THOMAS R. A. BUSSING and GARY L. LIDSTONE (Boeing Advanced Systems, Seattle, WA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs (Contract NAS1-18560)

(AIAA PAPER 89-0460)

A model for sonic/supersonic transverse fuel injection into a supersonic airstream is proposed. The model replaces the hydrogen jet up to the Mach disk plane and the elliptic parts of the air flow field around the jet by an equivalent body. The main features of the model were validated on the basis of experimental data.

K.K.

A89-25440*# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).

AN INVESTIGATION OF CELL CENTERED AND CELL VERTEX MULTIGRID SCHEMES FOR THE NAVIER-STOKES EQUATIONS

R. RADESPIEL (DFVLR, Institut fuer Entwurfsaerodynamik, Brunswick, Federal Republic of Germany) and R. C. SWANSON (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs (AIAA PAPER 89-0548)

Two efficient and robust finite-volume multigrid schemes for solving the Navier-Stokes equations are investigated. These schemes employ either a cell centered or a cell vertex discretization technique. An explicit Runge-Kutta algorithm is used to advance the solution in time. Acceleration techniques are applied to obtain faster steady-state convergence. Accuracy and convergence of the schemes are examined. Computational results for transonic airfoil flows are essentially the same, even for a coarse mesh. Both schemes exhibit good convergence rates for a broad range of artificial dissipation coefficients. Author

A89-25445#

THE INFLUENCE OF FREESTREAM VORTICITY ON PARTICLE LIFT, DRAG, AND HEAT TRANSFER

DAVID S. DANDY (Sandia National Laboratories, Livermore, CA) and HARRY A. DWYER (California, University, Davis) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. Research supported by DOE and U.S. Army. refs (AIAA PAPER 89-0555)

Numerical solutions have been obtained for steady, linear shear flow past a heated spherical particle for a wide range of Reynolds numbers and shear rates. The three-dimensional solutions for velocity, pressure and temperature calculated in this work will be the basis for future correlations for drag, lift, and heat transfer rate. The particle was kept at a fixed temperature different from the far-field temperature. It was found that although the dimensionless heat transfer (that is, the Nusselt number) increased with increasing Reynolds number for fixed shear rate, the rate of heat transfer was insensitive to changes in shear rate for fixed values of the Reynolds number.

A89-25450#

SHOCK CAPTURING USING A PRESSURE-CORRECTION METHOD

JAMES J. MCGUIRK and GARY J. PAGE (Imperial College of Science and Technology, London, England) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. Research supported by the Ministry of Defence Procurement Executive. refs

(AIAA PAPER 89-0561)

A pressure-correction scheme is presented which is applicable to the calculation of flows covering a wide range of Mach number. The method provides precise shock capturing results over two nodes with no overshoots or undershoots, and it is much faster than either the MacCormack (1969) or Jameson (1975) explicit schemes. Results are presented for a turbulent underexpanded axisymmetric impinging jet. R.R.

A89-25478#

A NOVEL INFRARED THERMOGRAPHY HEAT TRANSFER MEASUREMENT TECHNIQUE

HENRY M. EPPICH (Avco Research Laboratory, Inc., Everett, MA) and JOHN C. KREATSOULAS (Digital Equipment Corp., Marlboro, MA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs

(AIAA PAPER 89-0601)

This paper presents results of proof-of-concept experiments for a nonintrusive diagnostic technique capable of rapid measurement of convective heat transfer distributions over broad surface areas with high spatial resolution. IR thermography, based on video camera technology, is used to obtain surface temperature distributions. These distributions plus surface substrate temperatures obtained by a few thermocouples are all that is required to infer accurate, highly resolved distributions of local heat transfer coefficient behavior. Comparisons of heat transfer coefficient behavior measured by this technique with those by conventional techniques are presented to illustrate this technique's capabilities for convective heat transfer resulting from an air jet impinging on a heated plate.

A89-25526#

THE TURBULENT FREE JET ISSUING FROM A SHARP-EDGED ELLIPTICAL SLOT

W. R. QUINN (Saint Francis Xavier University, Antigonish, Canada) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs (Contract NSERC-A-5484)

(AIAA PAPER 89-0664)

Experimental results on the mean flow and turbulence characteristics of a turbulent free jet of air issuing from a sharp-edge elliptical slot of aspect ratio 5 are presented. Hot-wire anemometry was used to obtain such measurements as the mean streamwise velocity, turbulence intensities, and the Reynolds shear stress. It is found that the jet rotates counterclockwise about its central streamwise axis before attaining an axisymmetric shape at about 30 equivalent slot diameters downstream of the exit plane. R.R.

A89-25554*# Dayton Univ., OH. A NUMERICAL INVESTIGATION OF THE INFLUENCE OF SURFACE ROUGHNESS ON HEAT TRANSFER IN ICE ACCRETION

J. N. SCOTT and W. L. HANKEY (Dayton, University, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 10 p. refs

(Contract NAG3-665)

(AIAA PAPER 89-0737)

The flowfield and resulting heat transfer rate over a series of ice accretion shapes is obtained by solving the Navier-Stokes equations. The influence of surface roughness on surface heat transfer is examined by including blockage, form drag, and stagnation heating effects as source terms in the governing equations. The results indicate increases of a factor of three in cooling rates due to distributed roughness compared to smotth surfaces. In addition, droplet impingement efficiencies are studied for the same series of ice accretion shapes using a time-dependent solution procedure.

A89-25570*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PERFORMANCE OF THE FORWARD SCATTERING SPECTROMETER PROBE IN NASA'S ICING RESEARCH TUNNEL

EDWARD A. HOVENAC (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) and ROBERT F. IDE (NASA, Lewis Research Center; U.S. Army, Propulsion Directorate, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. Previously announced in STAR as N89-12845.

(AIAA PAPER 89-0769)

Two Forward Scattering Spectrometer Probes were used to measure droplet distributions in the NASA Lewis Icing Research Tunnel. The instruments showed good agreement when the median volume diameter (MVD) was approximately 16 micrometers. Coincidence events affected much of the data and caused the measured MVD to be about 2 to 3 micrometers larger than expected. Coincidence events were reduced by shutting down half of the spray bars in the tunnel during certain tests.

A89-25590#

TOWR DISPLAY EXPERIENCES

WAYNE R. SAND and CLEON BITER (National Center for Atmospheric Research, Boulder, CO) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. refs

(Contract DOT-FA01-82-Y-10513)

(AIAA PAPER 89-0807)

Displays developed for a prototype of the Terminal Doppler Weather Radar (TDWR) are discussed with reference to results of the operational demonstration of the TDWR display system. In particular, the discussion covers the manner in which data and information are handled in the TWDR system, specific displays that were developed and used in the demonstration, lessons learned from the operational use of these displays, and some future work to further develop the user interface. V.L.

A89-25608#

A STUDY OF TURBOMACHINE FLOW VELOCITIES

DAVID L. CEMAN AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 p. refs

(AIAA PAPER 89-0839)

A study of the air flows through a high-speed ducted fan was conducted, utilizing the laser Doppler velocimetry (LDV) technique. By precise orientation and positioning of the LDV probe volume, it was possible to survey the inlet and exit areas of the fan in operation. It was expected that detailed velocity component data would yield estimates of thrust and energy transfer for the turbomachine. Investigation into nonuniformities in the exit flow due to internal structures was attempted. Difficulties in the operation of the LDV system precluded the study of flow nonuniformities, although estimates of thrust and energy transfer were obtained.

Author

A89-25609#

A MODEL OF PRESSURE DISTRIBUTIONS ON IMPELLER BLADES FOR DETERMINING PERFORMANCE CHARACTERISTICS

MARK A. HINZ (Colorado, University, Boulder) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p. Research supported by the Undergraduate Research Opportunities Program. refs

(AIAA PAPER 89-0840)

A model for pressure distributions over an impeller blade is presented, which can be used to determine the structural integrity of a particular design and to provide performance data that can assist in the development of a new effective design. The model, developed as an interactive computer program, uses blade configuration data from an existing computer-aided design package in which the blade is divided into many panel elements; the resulting pressure distribution is determined by applying a conservation-of-momentum theory to each panel to determine the pressure. The model's output is provided in tabular form as well as in the form of a thee-dimensional representation of the pressure vectors. I.S.

A89-25860

BOUNDARY LAYER TRANSITION AND TURBULENCE MODELLING IN THREE-DIMENSIONAL FLOW

J. COUSTEIX and D. ARNAL (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) IN: Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987. Brunswick, Federal Republic of Germany, Friedr. Vieweg und Sohn, 1988, p. 122-138. refs

The first part of this paper is devoted to a survey on transition problems in three-dimensional flow. Emphasis is given on practical calculation methods which enable to predict transitions induced by streamwise instability, cross-flow instability or leading edge contamination. In the second part, the difficulties encountered when facing with turbulence modelling are examined. The attention is essentially focused on simple boundary layer flows such as those developing on swept wings. Author

A89-26171

ELECTRICAL EQUIPMENT OF AIRCRAFT [ELEKTROTEKHNICHESKIE USTROISTVA LETATEL'NYKH APPARATOV]

VLADIMIR P. TUZOV Moscow, Izdatel'stvo Vysshaia Shkola, 1987, 152 p. In Russian. refs

The general design and operation of various kinds of electrical equipment used on aircraft are reviewed. In particular, attention is given to the general requirements for the electrical equipment of aircraft, electromagnetic circuits and devices, transformers, asynchronous and synchronous motors, DC motors and generators, and static power supply devices. The discussion also covers electrical converters, electric drives for aircraft mechanisms, and electric power transmission and distribution systems for aircraft.

V.L.

A89-26273

VIBRATION AND FLUTTER ANALYSIS OF COMPOSITE WING PANELS

H. V. L. NARAYANA, P. RAJAGOPAL, T. S. RAMANI, and M. R. RAMAMURTHY (National Aeronautical Laboratory, Bangalore, India) IN: Composite materials and structures; Proceedings of the International Conference, Madras, India, Jan. 6-9, 1988. New Delhi, Tata McGraw-Hill Publishing Co., Ltd., 1988, p. 216-227.

Several composite wing panels are analyzed to predict their

vibration and flutter characteristics. The panels studied are used in a research project on aeroelastic tailoring which is being conducted by NAL. The NASTRAN (NASA STructural ANalysis program) was used to perform both vibration as well as flutter analysis. A thorough investigation is made of the free-vibration and flutter characteristics of three panel configurations with results compared to published data. Author

A89-26274

FREE VIBRATION AND PANEL FLUTTER OF QUADRILATERAL LAMINATED PLATES

B. J. C. BABU (Indian Institute of Technology, Madras, India) IN: Composite materials and structures; Proceedings of the International Conference, Madras, India, Jan. 6-9, 1988. New Delhi, Tata McGraw-Hill Publishing Co., Ltd., 1988, p. 228-237. refs

The present treatment of the free vibration and aeroelastic stability of flat plates with planform geometries of interest to aircraft designers gives attention to the effects of the orthotropicity ratio, panel dimensions, and the yaw angle, on flutter behavior boundaries. Two fourth-order governing differential equations were obtained from equations-of-equilibrium; the stress function and lateral displacements are used as variables. The study is confined to panels having cross-ply layup characteristics. It is found that the critical flow parameter increases significantly as modulus ratio increases. O.C.

A89-26281

AEROELASTIC FLUTTER OF LOW ASPECT RATIO CANTILEVER COMPOSITE PLATE

SRIJAYA MOHAN, V. P. RANGAIAH (Aeronautical Development Establishment, Bangalore, India), and S. DURVASULA (Indian Institute of Science, Bangalore, India) IN: Composite materials and structures; Proceedings of the International Conference, Madras, India, Jan. 6-9, 1988. New Delhi, Tata McGraw-Hill Publishing Co., Ltd., 1988, p. 295-304. refs

The aeroelastic flutter behavior of low-aspect-ratio trapezoidal composite cantilever plates is studied. Orthonormal polynomials as assumed modes are used in flutter analysis. The assumed modes are set up as product functions of orthonormal polynomials in the spanwise and chordwise directions. Numerical calculations for vibration frequencies are made for: (1) a graphite/epoxy rectangular plate, (2) a glass/epoxy swept tapered plate, and (3) a graphite/epoxy low-aspect-ratio trapezoidal plate. Vibration results obtained by varying ply orientation show the effect of lamination scheme and sweep on vibration and flutter. Author

A89-26284

FINITE ELEMENT ANALYSIS OF COMPOSITE RUDDER FOR DO 228 AIRCRAFT

K. GURUPRASAD, M. SUBBA RAO, and RAMESH CHANDRA (National Aeronautical Laboratory, Bangalore, India) IN: Composite materials and structures; Proceedings of the International Conference, Madras, India, Jan. 6-9, 1988. New Delhi, Tata McGraw-Hill Publishing Co., Ltd., 1988, p. 327-337.

This paper describes design and analysis of composite rudder for DO 228 aircraft. Stress analysis is carried out using finite element general purpose software ASKA. Automatic mesh generation and postprocessing are carried out using FEMGEN and FEMVIEW. Stress analysis of the existing metallic rudder is carried out to determine permissible deformations in composite rudder. Design variables considered are: geometrical parameters (widths and thicknesses of spar-flange and rib-flanges and thicknesses of spar-web and rib-webs) and lamination parameters (fiber orientation and stacking sequence) of spar, ribs, and leading edge. Many iterations on these design variables are attempted to match the stiffness of composite rudder to that of metallic rudder. Author

A89-26542

SOME NEW IDEAS IN RADAR ANTENNA TECHNOLOGY

BENITO PALUMBO (Selenia S.p.A., Rome, Italy) Microwave Journal (ISSN 0192-6225), vol. 32, Jan. 1989, p. 95, 96, 98 (3 ff.). An evaluation is presently made of emerging modular antenna design and construction technologies through which significant cost reductions may be realized in ATC and surveillance radars. The factor of modularity in design permits a specialized tailoring of operational characteristics for the given application. Extensive use of CAD techniques is recommended for these ends, from feasibility studies through design and development to production and performance testing. Attention is given to the design features of a dual-mode beamforming network for a three-dimensional surveillance radar. O.C.

A89-26548

TEMPERATURE COMPENSATION USING GAAS MMIC DEVICES

Microwave Journal (ISSN 0192-6225), vol. 32, Jan. 1989, p. 167, 168, 170, 172, 174.

A major problem faced by the designer of interceptor aircraft electronics in the EW environment context is the prevention of catastrophic system failures due to power dissipation or cooling system overloads. Attention is presently given to external-passive solutions to this problem that are predicated on the use of existing GaAs MMIC devices. All temperature-compensation components have been implemented on a single GaAs MMIC, the TCTC-0100 chip, which incorporates a diode ladder, tho GaAs operational amplifiers, a linear attenuator, and resistors. O.C.

A89-26721

EVALUATION OF A KALMAN FILTER FOR SAR MOTION COMPENSATION

DAVID J. DIFILIPPO, GEORGE E. HASLAM (Defence Research Establishment Ottawa, Canada), and WILLIAM S. WIDNALL IN: PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1988, p. 259-268. refs

A synthetic-aperture radar motion compensation system (SARMCS) is being developed at the Defence Research Establishment Ottawa to compensate an airborne SAR for spurious motions of the radar antenna that may be caused by air turbulence of aircraft maneuvers. A Kalman filter has been developed as part of this SAR motion compensation system which uses a low-cost strapdown IMU (inertial measurement unit), to measure antenna motion. The function of the Kalman filter is to control misalignments of the strapdown analytical platform, since analysis has indicated that these errors are dominant contributors to motion compensation error. Representative results from processing raw recorded flight data have verified the proper operation of all aspects of the Kalman filter and have indicated that the filter performance is consistent with the motion compensation requirements. Some examples of actual SAR strip-map imagery are shown in order to demonstrate the enhancement provided by the SARMCS. LE.

A89-27632

ENGINEERING CERAMICS - APPLICATIONS AND TESTING REQUIREMENTS

E. G. BUTLER (Rolls-Royce, PLC, Bristol, England) (National Physical Laboratory and Institute of Ceramics, Symposium on Mechanical Testing of Engineering Ceramics at High Temperatures, London, England, Apr. 11, 12, 1988) International Journal of High Technology Ceramics (ISSN 0267-3762), vol. 4, no. 2-4, 1988, p. 93-102. refs

The high stiffness and the damage-intolerant mechanical behavior of advanced engineering ceramics applicable to turbine engine hot section components, in conjunction with very high temperature testing requirements, pose severe difficulties for test method development. The generation of data base properties must be much more accurate than heretofore, while reflecting both intrinsic material properties and the turbine engine environment; both static and dynamic loading must be taken into account over a range of operating temperatures and stresses in a corrosive environment. Test equipment must be capable of operating at up to 1600 C.

A89-27651

INTERNATIONAL INSTRUMENTATION SYMPOSIUM, 34TH, ALBUQUERQUE, NM, MAY 2-6, 1988, PROCEEDINGS

Symposium sponsored by ISA. Research Triangle Park, NC, Instrument Society of America, 1988, 759 p. For individual items see A89-27652 to A89-27686.

Various papers on aerospace instrumentation are presented. The general topics addressed include: blast and shock, wind tunnel instrumentations and controls, digital/optical sensors, software design/development, special test facilities, fiber optic techniques, electro/fiber optical measurement systems, measurement uncertainty, real time systems, pressure. Also discussed are: flight test and avionics instrumentation, data acquisition techniques, computer applications, thermal force and displacement, science and government, modeling techniques, reentry vehicle testing, strain and pressure. C.D.

A89-27659*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MINIATURIZED COMPACT WATER-COOLED PITOT-PRESSURE PROBE FOR FLOW-FIELD SURVEYS IN HYPERSONIC WIND TUNNELS

GEORGE C. ASHBY (NASA, Langley Research Center, Hampton, VA) IN: International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 159-166. refs

An experimental investigation of the design of pitot probes for flowfield surveys in hypersonic wind tunnels is reported. The results show that a pitot-pressure probe can be miniaturized for minimum interference effects by locating the transducer in the probe support body and water-cooling it so that the pressure-settling time and transducer temperature are compatible with hypersonic tunnel operation and flow conditions. Flowfield surveys around a two-to-one elliptical cone model in a 20-inch Mach 6 wind tunnel using such a probe show that probe interference effects are essentially eliminated. C.D.

A89-27661

FIBER OPTIC TORQUEMETER DESIGN AND DEVELOPMENT

R. E. RUDD, B. R. KLINE, F. G. HOFF, and W. B. SPILLMAN, JR. (Hercules Aerospace Co., Aircraft Systems Div., Vergennes, VT) IN: International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings. Research Triangle Park, NC, Instrument Society of America, 1988, p. 199-204.

An optical torque measurement system has been developed that provides an accurate measurement of angular deflection over a known length of a torsionally loaded rotating shaft. The main advantages of this configuration, as compared to a conventional electromechanical system, are EMI immunity, reference sleeve elimination, and dc operation. Independent optical measurements of shaft speed are compared in phase. Shaft torque can then be computed from knowledge of phase difference and shaft spring constant in subsequent signal processing. System accuracy of 0.005 deg was demonstrated using a prototype device that had an operating range of + or - 15 deg of relative shaft twist.

Author

A89-27692#

EFFECTS OF A DOWNSTREAM DISTURBANCE ON THE STRUCTURE OF A TURBULENT PLANE MIXING LAYER

M. M. KOOCHESFAHANI and P. E. DIMOTAKIS (California Institute of Technology, Pasadena) AIAA Journal (ISSN 0001-1452), vol. 27, Feb. 1989, p. 161-166. Research supported by California Institute of Technology. Previously cited in issue 08, p. 1098, Accession no. A87-22476. refs (Contract AF-AFOSR-84-0120)

A89-27693*# General Motors Corp., Indianapolis, IN. EVOLUTION OF PARTICLE-LADEN JET FLOWS - A THEORETICAL AND EXPERIMENTAL STUDY

A. A. MOSTAFA, H. C. MONGIA (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN), V. G. MCDONELL, and G. S. SAMUELSEN (California, University, Irvine) AIAA Journal (ISSN 0001-1452), vol. 27, Feb. 1989, p. 167-183. Previously cited in issue 20, p. 3220, Accession no. A87-45457. refs (Contract NAS3-24350)

A89-27744*# National Central Univ., Chung-Li (Taiwan). TECHNIQUE FOR THE PREDICTION OF AIRFOIL FLUTTER CHARACTERISTICS IN SEPARATED FLOW

JIUNN-CHI WU (National Central University, Chung-Li, Republic of China), L. N. SANKAR (Georgia Institute of Technology, Atlanta), and K. R. V. KAZA (Structures, Structural Dynamics and Materials Conference, 28th, Monterey, CA, Apr. 6-8, 1987 and AIAA Dynamics Specialists Conference, Monterey, CA, Apr. 9, 10, 1987, Technical Papers. Part 2B, p. 664-673) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 168-177. Previously cited in issue 14, p. 2173, Accession no. A87-33719. refs (Contract NAG3-730)

A89-27745#

ALUMINUM QUALITY BREAKTHROUGH FOR AIRCRAFT STRUCTURAL RELIABILITY

C. R. OWEN, R. J. KEGARISE (Aluminum Company of America, Davenport, IA), and R. J. BUCCI (Alcoa Laboratories, Alcoa Center, PA) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 178-184. refs

A statistically designed experiment has been undertaken to evaluate effects of processing on thick plate metal quality. An outgrowth of this program is a breakthrough in quality and resultant property improvements that can be exploited for fatigue and fracture-critical structures. This paper describes the statistical quality control effort, and gives evidence of the improved capabilities typical of recently produced high-quality material. Among conventional mechanical property tests, the smooth fatigue test is shown to be the most discriminating for initial metal quality. Author

A89-27787

PHOTO-BASED THREE DIMENSIONAL GRAPHICS MODELS FOR MULTI-SENSOR SIMULATION

TIM M. WITTENBURG (Honeywell Systems and Research Center, Minneapolis, MN) IN: Recent advances in sensors, radiometry, and data processing for remote sensing; Proceedings of the Meeting, Orlando, FL, Apr. 6-8, 1988. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1988, p. 322-327. Research supported by USAF and Honeywell, Inc.

A methodology has been developed and demonstrated for semiautomated generation of high fidelity terrain databases suitable for flight simulator applications. The technique has been demonstrated using electro-optic (EO), IR, and Synthetic Aperture Radar (SAR) sensor imagery. Extensions of the methodology are described for the generation of sensor image-based representations of vegetation terrain features. In contrast to polygon based databases in use by many simulators today, the simulator databases described here are gridded in nature. Finally, a realtime image generation architecture capable of exploiting this new database technology is currently in development, and is briefly summarized here.

A89-28070* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A COMPUTATIONAL PROCEDURE FOR AUTOMATED FLUTTER ANALYSIS

DURBHA V. MURTHY (NASA, Lewis Research Center, Cleveland; Toledo, University, OH) and KRISHNA RAO V. KAZA (NASA, Lewis Research Center, Cleveland, OH) Communications in Applied Numerical Methods (ISSN 0748-8025), vol. 5, Jan. 1989, p. 29-37. refs

A direct solution procedure for computing the flutter Mach number and the flutter frequency is applied to the aeroelastic analysis of propfans using a finite element structural model and an unsteady aerodynamic model based on a three-dimensional subsonic compressible lifting surface theory. An approximation to the Jacobian matrix that improves the efficiency of the iterative process is presented. The Jacobian matrix is indirectly approximated from approximate derivatives of the flutter matrix. which are updated only in the direction of the last move. Examples are used to illustrate the convergence properties. The direct solution procedure facilitates the automated flutter analysis in addition to contributing to the efficient use of computer time as well as the analyst's time. Author

A89-28210

THE COMPARATIVE ANALYSIS AND DEVELOPMENT OF AN 8000 PSI ROTARY VANE ACTUATOR MAHMOUD A. ELZANKALY (Hydraulic Units, Inc., Duarte, CA)

SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 10 p.

(SAE PAPER 881435)

A study is described that was initiated to design and develop an 8000-psi rotary actuator which would meet high performance requirements and would have a configuration that would have minimal weight and envelope and be practical for manufacturing. Individual factors considered in the selection of the type of actuator configuration included weight, performance, complexity, reliability, envelope, survivability, maintainability, and stiffness. The results of this study show that the actuator performance depends mainly on the following parameters: the vane sealing system (seal and loading device), the diametrical clearance between the shaft vanes and the housing, the diametrical clearance between the housing vanes and the shaft, the diametrical clearance between bearing and the shaft, and the diametrical clearance between the bearing and the housing. 15

A89-28267

T-100 MULTIPURPOSE SMALL POWER UNIT - TECHNOLOGY FOR THE NEXT GENERATION AUXILIARY POWER UNITS

J. C. NAPIER and R. G. THOMPSON (Sundstrand Corp., Sundstrand Turbomach Div., San Diego, CA) IN: Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. Warrendale, PA, Society of Automotive Engineers, Inc., 1988, p. 115-121. refs

(SAE PAPER 881501)

This paper describes the features and capabilities of the T-100 Mulltipurpose Small Power Unit (MPSPU), an advanced technology gas turbine engine demonstrator sponsored by the U.S. Army. The MPSPU technology is intended to provide an improved acquisition outlook for users of small turbine power units for airborne and vehicular auxiliary power and ground power applications. This will be accomplished by applying the newest existing component technologies for improved performance and designing for versatility so a wide range of applications can be derived from the same frame. Author

A89-28345#

COMBUSTOR AIR FLOW PREDICTION CAPABILITY COMPARING SEVERAL TURBULENCE MODELS

D. L. RHODE (Texas A & M University, College Station) and S. T. STOWERS Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Mar.-Apr. 1989, p. 242-248. refs

A finite-difference computer program with reduced false diffusion was developed for use in an application-oriented study involving axisymmetric swirling flows. A prediction evaluation using four turbulence models was conducted via comparison of predictions with corresponding measurements. Measured inlet values were employed where possible to minimize approximations in specifying inlet boundary conditions. The k-e, algebraic Reynolds stress, and modified algebraic Reynolds stress are the turbulence models used in this investigation. A modified k-e model gave unrealistic results and was eliminated. Reasonable overall agreement with the measurements of mean flow quantities was generally obtained. However, the mean swirl velocity predictions were rather inaccurate. In addition, useful recommendations are given for a numerically stable implementation of an algebraic stress model into the widely used TEACH computing procedure. Author

N89-17069# Air Force Weapons Lab., Kirtland AFB, NM. FIELD ENHANCEMENT OF UHF-VHF AIRCRAFT ANTENNAS Final Report, 16 Oct. - 18 Nov. 1986

RAYMOND W. NETHERS, DAVID W. METZGER, and ALBERT B.

GRIFFIN Aug. 1988 11 p (AD-A200180; AFWL-TR-88-41) Avail: NTIS HC A03/MF A01 CSCL 09A

Results of high voltage electrical discharge tests of various electrode enhancement geometries are reported along with test conduct. Four antennas (collins, unknown 2- and 3-ft rods) were tested with both positive and negative voltages. It was found that on the negative electrode in large gaps, a large enhancement is needed to degrade the gap holdoff. GRA

N89-17215# Hughes Aircraft Co., El Segundo, CA. Electro-optical and Data Systems Group.

LASER COMMUNICATION TEST SYSTEM Final Report, Sep. 1986 - Sep. 1987

G. S. MECHERLE, A. K. RUE, G. T. POPE, P. T. BENGUHE, and M. A. TWETE Jun. 1988 73 p

(Contract F33615-86-C-1073)

(AD-A199612; AFWAL-TR-88-1042) Avail: NTIS HC A04/MF A01 CSCL 25C

A Hughes-developed laser communication terminal related to aircraft applications was delivered for Air Force testing. The terminals employ laser diode transmitters, PIN diode receivers. and provide automatic tracking with a gimbal-mounted video camera and off-gimbal video tracker. The terminals are capable of 20 Kbps full duplex operation over 8 to 10 miles at sea level. Video tracking offers a legitimate alternative to quadrant tracking. The terminals were modified to provide performance monitors for transmitted signal, received signal, AGC voltage, tracking error, tracker status, and angular position. An automatic acquisition capability with spiral scans was implemented and performed well. GRA

N89-17255# University Coll., London (England). Dept. of Mechanical Engineering.

REVIEW OF EXISTING NDT TECHNOLOGIES AND THEIR CAPABILITIES

LEONARD J. BOND In AGARD, AGARD/SMP Review: Damage Tolerance for Engine Structures. 1: Non-Destructive Evaluation 16 Nov. 1988

Avail: NTIS HC A06/MF A01

A review of selected nondestructive test (NDT) technologies is presented with regard to their reliability and capability to detect and characterize defects in critical aero-engine components such as discs and blisks (integrally bladed discs), both in production and after service. The performance of non-destructive testing is considered both at the time of manufacture and after service for parts fabricated from powder metals including AP1 and with particular consideration given to the needs of the European Fighter Aircraft (EFA). Various NDT technologies have been considered with the aim of establishing the current capability of each technology in terms of defect detection capability and probability of detection rates. The cause of the limits on performance are reviewed and areas where development can be expected in these and other NDT technologies within the next 5 to 10 years have been identified. Author

N89-17256# Pratt and Whitney Aircraft, West Palm Beach, FL. Dept. of Materials Engineering.

RELATIONSHIPS OF NONDESTRUCTIVE EVALUATION NEEDS AND COMPONENT DESIGN

JOHN A. HARRIS, JR. and M. C. VANWANDERHAM In AGARD, AGARD/SMP Review: Damage Tolerance for Engine Structures. 1: Non-Destructive Evaluation 8 p Nov. 1988

Avail: NTIS HC A06/MF A01

Several well publicized engine and airframe failures which occurred in the late 1960 to mid 1970's time frame resulted in emphasis on development, application and quantification of nondestructive evaluation (NDE) as opposed to reliance on a Zero Defects design philosophy. As the use of fracture mechanics as a

basis for damage tolerance and retirement analysis of components became established, additional emphasis was placed on screened flaw sizes, NDE and quantification of reliability. In the late 1970's a structural assessment was conducted on the design of the F100 engine which resulted in a series of relatively sophisticated safety inspections for selected critical components. The Retirement for Cause philosophy also coupled NDE and component lifing analyses to enable return to service decisions for engine components. These activities were (and are) performed usually after the component designs have been finalized. The establishment of Engine Structural Integrity Programs (ENSIP) for new U.S. military engine systems has now made NDE considerations an integral part of the design process. Classification of components, fracture mechanics analyses, critical flaw sizes, material quality, NDE and quantification of inspection reliability are now incorporated in the initial design process and directly influence the resultant component designs. Statistically based probabilistic approaches are supplementing the deterministic methods previously used. The relationships of NDE needs and component design in light of the evolution of the ENSIP approach for gas turbine engine component designs are Author discussed.

National Research Council of Canada, Ottawa N89-17257# (Ontario). Structures and Materials Lab.

IMPORTANCE OF SENSITIVITY AND RELIABILITY OF NDI TECHNIQUES ON DAMAGE TOLERANCE BASED LIFE PREDICTION OF TURBINE DISCS

A. K. KOUL, A. FAHR, G. GOULD, and N. BELLINGER (Carleton In AGARD, AGARD/SMP Review: Univ., Ottawa, Ontario) Damage Tolerance for Engine Structures. 1: Non-Destructive Evaluation 22 p Nov. 1988 Avail: NTIS HC A06/MF A01

The results of a demonstration program carried out to determine the influence of the sensitivity and reliability of nondestructive inspection (NDI) techniques on the damage tolerance based life assessment of aero engine turbine discs are discussed. The program was carried out on the 5th stage compressor discs of the J85-CAN40 engine, made from the AM-355 stainless steel. The sensitivity and reliability of several NDI techniques, in detecting service induced low cycle fatigue (LCF) cracks in the disc bolt hole regions, are assessed on the basis of detectable crack sizes at 90 percent probability of detection (POD) and 90 percent POD with 95 percent confidence level. The NDI techniques examined are the liquid penetrant inspection (LPI) technique, a manual eddy current inspection (ECI) technique using two gain settings and an ultrasonic leaky wave (ULW) technique using an automated C-scan system. The safe inspection intervals (SIIs) for the 5th stage compressor disc are calculated using deterministic fracture mechanics (DFM) and probabilistic fracture mechanics (PFM) principles. These calculations involve the use of the NDI data, finite element analysis and the experimental fatigue crack growth rate (FCGR) data generated on compact tension specimens machined from discs. The results indicate that the manual ECI technique with a high gain setting and the automated ULW technique are the most sensitive and reliable in detecting LCF Author cracks.

Societe Nationale d'Etude et de Construction de N89-17258# Moteurs d'Aviation, Evry Cedex (France).

SHORT TERM DEVELOPMENTS IN NON-DESTRUCTIVE EVALUATION APPLICABLE TO TURBINE ENGINE PARTS LES DEVELOPPEMENTS A COURT TERME DES CONTROLES NONDESTRUCTIFS APPLICABLES AUX PIECES DE TURBOMACHINES]

In AGARD, AGARD/SMP Review: Damage J. VAERMAN Tolerance for Engine Structures. 1: Non-Destructive Evaluation 29 Nov. 1988 In FRENCH D

Avail: NTIS HC A06/MF A01

An analysis of the principles forming the basis of non-destructive evaluation (NDE) techniques is presented. Excitation energy sources, medium interaction (perturbation), and sensors and signal processing are examined. Factors affecting the evolution and adaptation of NDE methods are discussed and recent developments in acoustic microscopy, ultrasonic techniques, Foucault current methods, and X-ray tomography are described. Author

N89-17259# Naval Air Development Center, Warminster, PA. LONG TERM POSSIBILITIES FOR NONDESTRUCTIVE EVALUATION FOR US NAVY AIRCRAFT

In AGARD, AGARD/SMP Review: Damage W. R. SCOTT Tolerance for Engine Structures. 1: Non-Destructive Evaluation 13 p Nov. 1988

Avail: NTIS HC A06/MF A01

The majority of nondestructive inspection (NDI) techniques currently in use for U.S. Navy aircraft are labor intensive, operator dependent and result in excessive aircraft down-time. For this reason NDI R and D efforts currently are directed toward developing rapid automated systems capable of remote or unattended inspection of large areas and inaccessible structures. Ongoing programs of this type that are discussed include laser ultrasonics, acoustic emission, and quantitative imaging. The primary thrust of the presentation will cover the advantages of each technique and the technical obstacles preventing its implementation. Author

Rolls-Royce Ltd., Derby (England). Dept. of N89-17260# Non-Destructive Testing Applications.

NEED FOR COMMON AGARD APPROACH AND ACTIONS

In AGARD, AGARD/SMP Review: Damage R. G. TAYLOR Tolerance for Engine Structures. 1: Non-Destructive Evaluation 3 p Nov. 1988

Avail: NTIS HC A06/MF A01

While there is no direct evidence that the different approaches used in nondestructive tests (NDT) have affected airworthiness, there are many pressures, both technical and commercial, for requiring a common approach within the community in the future. The technical pressures arise from a need to achieve the same technical standard of product, irrespective of the place of manufacture, in order to meet the stringent damage tolerance requirements now being placed on NDE, while the commercial pressures arise from the need for industry to rationalize the methodolgy, so that components are processed in the same way, irrespective of the customer. An example of the problems associated with the lack of a common approach, is shown in the differing requirements of the major aero engine manufactures, for the ultrasonic inspection of turbine discs. A study of the physics of the different methods demanded by the engine companies, shows that the same technical standard cannot be achieved, and the commercial problems are obvious when it is recognized that these different techniques are imposed on a common forging supplier. As a result of recent collaboration activities with a number of other engine manufacturers, Rolls-Royce has carried out a survey of the differences that currently exist and these are summarized. Author

Societe Nationale d'Etude et de Construction de N89-17261# Moteurs d'Aviation, Evry Cedex (France).

STATE-OF-THE-ART IN NON-DESTRUCTIVE EVALUATION OF TURBINE ENGINE PARTS [L'ETAT DE L'ART EN CONTROLE NONDESTRUCTIF DES PIECES DE TURBOMACHINE]

In AGARD, AGARD/SMP Review: Damage J. L. MEIFFREN Tolerance for Engine Structures. 1: Non-Destructive Evaluation 16 p Nov. 1988 In FRENCH

Avail: NTIS HC A06/MF A01

An overview of non-destructive evaluation (NDE) methods used in aeronautical engineering is presented. The use of NDE during the fabrication of turbine engine components is discussed with particular emphasis on the ultrasonic evaluation of compressor and turbine disks, thickness measurement of turbine blades, and the evaluation of welds in compressor rotors. In addition, the application of NDE techniques to the evaluation of in-service engines is discussed. The detection of fatigue cracks and ruptures in operational engine parts is addressed along with statistical approaches to NDE. Author

N89-17263 Purdue Univ., West Lafavette, IN. VIBRATION AND AEROELASTIC TAILORING OF ADVANCED COMPOSITE PLATE-LIKE LIFTING SURFACES Ph.D. Thesis RICHARD Y. L. LIU 1987 199 p

Avail: Univ. Microfilms Order No. DA8814556

Modern flight vehicles are often designed to meet requirements of high structural and aerodynamic performance. One way to attain this objective is to implement the techniques of aeroelastic tailoring. In this work, the lifting surface of a fighter aircraft is structurally idealized as a composite laminated plate element. By modifying the interactions between the surface deformation modes (e.g., bending and twisting), the elastic properties of the anisotropic plate can be controlled to satisfy a specific design criterion. The study is aimed at the conceptual understanding of the effect of elastic coupling upon the dynamic and aeroelastic behavior of a wing. The structural analysis is performed using the Rayleigh-Ritz method. A group of five non-dimensional parameters is identified to characterize the stiffness properties of a laminated plate. Three of these parameters measure the amount of elastic coupling present in the plate, and their influences on the vibration modes (natural frequencies and mode shapes) are evaluated in the vibration analysis. Dissert. Abstr.

N89-17298*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH. TURBINE ENGINE HOT SECTION TECHNOLOGY, 1987

Oct. 1987 464 p Workshop held in Cleveland, OH, 20-21 Oct. 1987

(NASA-CP-2493; E-3745; NAS 1.55:2493) Avail: NTIS HC A20/MF A01 CSCL 20K

Presentations were made concerning the development of design analysis tools for combustor liners, turbine vanes, and turbine blades Presentations were divided into six sections: instrumentation, combustion, turbine heat transfer, structural analysis, fatigue and fracture, surface protective coatings, constitutive behavior of materials, stress-strain response and life prediction methods. For individuals titles, see N89-17299 through N89-17337.

N89-17304*# General Motors Corp., Indianapolis, IN. Gas Turbine Div.

AEROTHERMAL MODELING PROGRAM. PHASE 2, ELEMENT B: FLOW INTERACTION EXPERIMENT

M. NIKJOOY, H. C. MONGIA, S. N. B. MURTHY, and J. P. SULLIVAN (Purdue Univ., West Lafayette, IN.) In NASA, Lewis Research Center, Turbine Engine Hot Section Technology, 1987 Oct. 1987 p 91-99

(Contract NAS3-24350)

Avail: NTIS HC A20/MF A01 CSCL 20D

NASA has instituted an extensive effort to improve the design process and data base for the hot section components of gas turbine engines. The purpose of element B is to establish a benchmark quality data set that consists of measurements of the interaction of circular jets with swirling flow. Such flows are typical of those that occur in the primary zone of modern annular combustion liners. Extensive computations of the swirling flows are to be compared with the measurements for the purpose of assessing the accuracy of current physical models used to predict such flows. Author

N89-17311*# United Technologies Research Center, East Hartford, CT.

MEASUREMENT OF AIRFOIL HEAT TRANSFER **COEFFICIENTS ON A TURBINE STAGE**

ROBERT P. DRING, MICHAEL F. BLAIR, and H. DAVID JOSLYN In NASA, Lewis Research Center, Turbine Engine Hot Section Technology, 1987 p 169-179 Oct. 1987 (Contract NAS3-23717)

Avail: NTIS HC A20/MF A01 CSCL 20D

A combined experimental and analytical program was conducted to examine the impact of a number of variables on the midspan heat transfer coefficients of the three airfoil rows in a one and one-half stage large scale turbine model. Variables included

stator/rotor axial spacing, Reynolds number, turbine inlet turbulence, flow coefficient, relevant stator 1/stator circumferential position, and rotation. Heat transfer data were acquired on the suction and pressure surfaces of the three airfoils. High density data were also acquired in the leading edge stagnation regions. Extensive documentation of the steady and unsteady aerodynamics was acquired. Finally, heat transfer data were compared with both a steady and an unsteady boundary layer analysis. Author

N89-17314*# Pratt and Whitney Aircraft, East Hartford, CT. COOLANT PASSAGE HEAT TRANSFER WITH ROTATION

T. J. HAJEK, J. H. WAGNER, and B. V. JOHNSON (United Technologies Research Center, East Hartford, CT.) In NASA, Lewis Research Center, Turbine Engine Hot Section Technology, 1987 p 211-223 Oct. 1987 (Contract NAS3-23691)

Avail: NTIS HC A20/MF A01 CSCL 20D

The objective is to develop a heat transfer and pressure drop data base, computational fluid dynamic techniques and heat transfer correlations for rotating multipass coolant passages, with and without flow tabulators. The experimental effort is focused on the simulation of configurations and conditions expected in the blades of advanced aircraft high pressure turbines. With the use of this data base, the effects of Coriolis and buoyancy forces on the coolant side flow can be included in the design of turbine blades. Author

N89-17316*# Pratt and Whitney Aircraft, East Hartford, CT. THREE-DIMENSIONAL INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS

E. S. TODD *In* NASA, Lewis Research Center, Turbine Engine Hot Section Technology, 1987 p 239-240 Oct. 1987 (Contract NAS3-23697)

Avail: NTIS HC A20/MF A01 CSCL 20K

The objective of this program is to produce a series of new computer codes that permit more accurate and efficient three-dimensional inelastic structural analysis of combustor liners, turbine blades, and turbine vanes. Each code embodies a progression of mathematical models for increasingly comprehensive representation of the geometrical features, loading conditions, and forms of nonlinear material response that distinguish these three groups of hot section components.

Author

N89-17329*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

STRUCTURAL RESPONSE OF AN ADVANCED COMBUSTOR LINER: TEST AND ANALYSIS

PAUL E. MOORHEAD, ROBERT L. THOMPSON, M. TONG, and M. HIGGINS (Sverdrup Technology, Inc., Cleveland, OH.) In its Turbine Engine Hot Section Technology, 1987 p 349-356 Oct. 1987

Avail: NTIS HC A20/MF A01 CSCL 20K

An advanced (segmented) combustor liner supplied by Pratt and Whitney Aircraft was tested in the structural component test rig at Lewis Research Center. It was found that the segmented liner operated at much lower temperatures than the conventional liner (about 400 F lower) for the same heat flux. At the lower temperatures and low thermal gradients, little distortion to the segments was observed. The operating conditions were not severe enough to distort or damage the segmented liner. Author

N89-17333*# Pratt and Whitney Aircraft, East Hartford, CT. THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT

J. T. DEMASI, S. L. MANNING, M. ORTIZ, and K. D. SHEFFLER In NASA, Lewis Research Center, Turbine Engine Hot Section Technology, 1987 p 385-399 Oct. 1987 (Contract NAS3-23944)

Avail: NTIS HC A20/MF A01 CSCL 20K

The objectives of this program are to increase understanding of thermal barrier coating (TBC) degradation and failure modes,

12 ENGINEERING

to generate quantitative ceramic failure life data under cyclic thermal conditions which simulate those encountered in gas turbine engine service, and to develop an analytical methodology for prediction of coating life in the engine. Observations of degradation and failure modes in plasma deposited ceramic indicate that spallation failure results from progressive cracking of the ceramic parallel to and adjacent to, but not coincident with the metal-ceramic interface. Author

N89-17336*# Pratt and Whitney Aircraft, East Hartford, CT. CREEP FATIGUE LIFE PREDICTION FOR ENGINE HOT SECTION MATERIALS (ISOTROPIC) FIFTH YEAR PROGRESS REVIEW

RICHARD S. NELSON and PETER R. HARVEY In NASA, Lewis Research Center, Turbine Engine Hot Section Technology, 1987 p 423-434 Oct. 1987

(Contract NAS3-23288)

Avail: NTIS HC A20/MF A01 CSCL 20K

The need for advanced life prediction methods for hot section components for gas turbine engines is becoming more and more evident. The complex local strain and temperature histories at critical locations must be accurately interpreted to account for the effects of various damage mechanisms and their possible interactions. This program is designed to investigate these fundamental damage processes, identify modeling strategies, and develop practical models which can be used to guide the early design and development of new engines and to increase the durability of existing engines. Author

N89-17700# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter and Airplane Div.

MECHANISM OF SINGLE SHEAR FASTENED JOINTS

J. BAUER *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures 6 p Mar. 1988 Avail: NTIS HC A14/MF A01

The problems arising with the strength of single shear fastened joints are considerably greater than those of double shear joints. The additional (or secondary) bending moment loads not only the cover plates, but also causes considerably bending in the fasteners. If one of the cover plates is of composite material its brittleness and relatively low bearing strength lead to new problems. Experimental data were produced with a 100 percent load transfer specimen using a carbon fiber reinforced plastic (CFRP) to metal joint. Taking the specimen configuration as a basis, the interaction of bolt bending and local load introduction into the two plates is

shown in form of diagrams based on theoretical investigations.

13

GEOSCIENCES

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

A89-25549*# Computer Sciences Corp., Huntsville, AL. ANALYSIS OF EXTREME WIND SHEAR

STANLEY I. ADELFANG and ORVEL E. SMITH (Computer Sciences Corp., Huntsville, AL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 6 p. Research supported by NASA.

(AIAA PAPER 89-0710)

New methods utilizing extreme value statistical theory are applied in the analysis of the largest wind component shear in a wind profile as a function of shear layer thickness and season. Seasonal variability of extreme shear decreases as the shear layer thickness decreases. Wind profile measurement system smoothing and its effect upon extreme wind shear statistics is simulated by application of digital low-pass filters to Jimsphere wind profiles. Author

A89-25562#

USE OF THE MEDIAN VOLUME DROPLET DIAMETER IN THE CHARACTERIZATION OF CLOUD DROPLET SPECTRA

KAREN J. FINSTAD, EDWARD P. LOZOWSKI (Alberta, University, Edmonton, Canada), and LASSE MAKKONEN (Technical Research Centre of Finland, Espoo) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 5 p. Research supported by NSERC, Finnish Broadcasting Co., Imatran Voima Co., and Finnish Post and Telecommunications Administration. refs (AIAA PAPER 89-0756)

A mathematical justification is presented for using the median volume diameter (MVD) to calculate the collision efficiency or liquid water content of a spectrum of cloud droplet sizes. The MVD is derived from a single-point numerical integration formula, which can be extended to derive approximation formulas using 2-4 droplet sizes. The spectrum weighted average collision efficiences for circular cylinders and NACA 0015 airfoils are calculated from several droplet size spectra (Finstad et al., 1986). The results are in good agreement with those using the MVD. It is shown that the MVD schemes introduced significantly improve accuracy.

R.B.

A89-25578#

NATIONAL LIGHTNING DETECTION - A REAL-TIME SERVICE TO AEROSPACE

KENNETH G. BAUER, WALTER A. LYONS, NOEL J. PETIT, and JEROME A. SCHUH (R-Scan Corp., Minneapolis, MN) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 9 p.

(AIAA PAPER 89-0787)

The National Lightning Detection Network (NLDN), which combines time-of-arrival lightning detection technology and computer resources to locate and track lightning, is examined. The importance of lightning detection for the aerospace community is reviewed. The network uses the time-of-arrival technology described by Casper et al. (1988). The products available from the Lightning Data and Information System, which distributes data from the NLDN are discussed, including the real-time location, time, and polarity of observed lightning strokes. R.B.

A89-25583#

Author

SEVERE WEATHER - IMPACT ON AVIATION AND FAA PROGRAMS IN RESPONSE

ERIC MANDEL (FAA, Washington, DC) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 p.

(AIAA PAPER 89-0794)

The involvement of the FAA in programs to improve the acquisition, synthesis, and dissemination of weather data to lessen the impact of severe weather on aviation operations is reviewed. The programs considered include the Automated Surface Observing Systems, the Low Level Wind Shear Alert System, the Terminal Doppler Weather Radar, and the Next Generation Weather Radar. In addition, the development of improved forecasting techniques is examined, including programs such as the Center and Central Flow Weather Service Units, the Meteorologist Weather Processor, the Real-Time Weather Processor, data links, flight service automation, and the Advanced Automation System for air traffic controllers.

A89-25593#

THE EFFECT OF A GROUND-BASED INVERSION LAYER ON AN IMPACTING MICROBURST

J. W. YOUNG, III, F. D. LANE (Colorado, University, Boulder), and A. J. BEDARD, JR. (NOAA, Wave Propagation Laboratory, Boulder, CO) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 8 p. refs

(AIAA PAPER 89-0810)

A scaled water tank experiment was performed in order to investigate the microburst interaction with stable layers, with special attention given to the influence of the ground-based inversion on

the impacting microburst. A buoyant puff equation is used to predict the path a particle will take when it interacts with an inversion interface. The results suggest that microburst events can be more complex, and possibly more dangerous, when strong inversion layers are involved. **RR**

A89-25594# AN UNSTEADY VORTEX-RING MODEL FOR MICROBURST SIMULATION

TUNG WAN (California Polytechnic State University, San Luis Obispo) and FRED R. PAYNE (Texas, University, Arlington) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 7 p. refs (AIAA PAPER 89-0811)

A microburst, or low-level wind shear, is generated by a thunderstorm or a small rain cloud, and presents hazardous condition for aircraft during take-off and landing maneuvers. An unsteady vortex-ring model of microburst is developed by first solving the trajectory equations via the DFI or Runge-Kutta methods, then the velocity field can be computed by using the primary and image inviscid vortex-ring equations in the outer region and the assumed profile in the viscous region. Also, the boundary layer profiles are added to the mean flow field. Results show that this model can produce physically realistic transient velocity profiles, and the CPU time of this model is efficient enough for real time flight simulation. Author

A89-25599#

NUMERICAL SIMULATION OF MICROBURST DOWNDRAFTS -APPLICATION TO ON-BOARD AND LOOK AHEAD SENSOR TECHNOLOGY

KELVIN K. DROEGEMEIER and MICHAEL R. BABCOCK (Oklahoma, University, Norman) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs (Contract NSF ATM-87-57013)

(AIAA PAPER 89-0821)

The subcloud structure of microburst downdrafts is simulated using a high-resolution, multidimensional numerical cloud model. The morphology of severe downflows in a variety of scenarios is studied by systematically varying the prescribed rainwater content of the microburst. Aircraft trajectories through the evolving model fields are constructed to provide guidance for the development of on-board windshear detection systems. The relationship of meterological conditions along the flight path to variations in time, location and speed of penetration is examined by systematically varying flight parameters. A measurable drop in air temperature at the aircraft location occurred in conjunction with an increasing headwind, but prior to the onset of performance-deteriorating tailwinds. It is found that the magnitude of meteorlogical variables measured at the aircraft location during descent are a function of the flight path relative to the microburst in some cases. **B**B

A89-26214* National Severe Storms Lab., Norman, OK. LIGHTNING INITIATION ON AIRCRAFT IN THUNDERSTORMS

VLADISLAV MAZUR (NOAA, National Severe Storms Laboratory, Norman, OK) IN: International Conference on Atmospheric Electricity, 8th, Uppsala, Sweden, June 13-16, 1988, Proceedings. Uppsala, Sweden, Institute of High Voltage Research, 1988, p. 347-356. Research supported by NASA. refs

A physical model of the initiation of lightning flashes by aircraft in thunderstorms is presented. The model is based on the 'bidirectional uncharged leader' concept of Kasemir, and is verified with airborne data from lightning strikes to instrumented airplanes (NASA F-106B and FAA CV-580). A triggered flash starts with either a negative corona or a positive leader that depends on the ambient electric field vector and the airplane form factor. The positive leader with continuous current that increases with time is followed in several milliseconds by the negative stepped leader with current pulses of several kA. The two leaders develop in space simultaneously and bidirectionally from the oppositely charged extremities of the airplane. Author

A89-26215

LIGHTNING TRIGGERED BY THE PRESENCE OF AEROSPACE VEHICLES

RODNEY A. PERALA and TERENCE H. RUDOLPH (Electro Magnetic Applications, Inc., Lakewood, CO) IN: International Conference on Atmospheric Electricity, 8th, Uppsala, Sweden, June 13-16, 1988, Proceedings. Uppsala, Sweden, Institute of High Voltage Research, 1988, p. 363-370, refs

The triggering of lightning by in-flight vehicles is investigated. Specific attention is placed on the NASA F-106B Thunderstorm Research Aircraft. Thunderstorm and vehicle parameters relevant to triggered lightning initiation are identified. A numerical simulation technique using finite difference techniques and an air chemistry model is applied to triggered lightning events. Results from this model's use in the F-106B program are shown and compared to measured data from actual lightning strikes to the aircraft. Conditions under which the F-106B triggers lightning are presented. Finally, questions still unresolved in the physics of triggered lightning are identified. Author

A89-28461#

IMPACT OF SEVERE WEATHER ON AVIATION - A PILOT VIEWPOINT

DON S. CORNWELL (Air Line Pilots Association, Washington, AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. DC) 9-12, 1989, 4 p.

(AIAA 89-0798)

The impact of severe weather avoidance on pilots and the safe operation of an aircraft in severe weather are discussed. The problems caused by fog and low ceiling are considered and airborne and ground deicing procedures are reviewed. Also, the impact of thunderstorms and windshear are examined. It is suggested that the problem of deicing aircraft might be solved by placing deicing stations near the end of the runway and spraying the aircraft just prior to take-off. R.B.

N89-17978 Wyoming Univ., Laramie. THE MEASUREMENT OF TEMPERATURE FROM AN AIRCRAFT IN CLOUD Ph.D. Thesis

R. PAUL LAWSON 1988 363 p

Avail: Univ. Microfilms Order No. DA8817691

The problem of wetting of thermometers used in research aircraft in cloud and precipitation has been previously recognized. Recently, a prototype radiometric thermometer became available for aircraft use which makes possible comprehensive evaluation of the immersion thermometers. This radiometer measures brightness temperature at 4.25 micron wavelength. At this wavelength, the fairly short path length and fast response of the sensing technique, makes comparisons with the immersion sensors meaningful. Based upon insights obtained in this research, a new immersion thermometer was designed to overcome the problems with the conventional sensors. The design is based upon the principle of inertial separation of the water, and allows predictable response characteristics. Preliminary tests show that water does not reach the sensing element. Dissert. Abstr.

15

MATHEMATICAL AND COMPUTER SCIENCES

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

A89-25305#

EFFICIENT APPLICATION TECHNIQUES OF THE EAGLE GRID CODE TO COMPLEX MISSILE CONFIGURATIONS

JOE F. THOMPSON, BOYD GATLIN (Mississippi State University, Mississippi State), and LAWRENCE E. LIJEWSKI (USAF, Armament

Laboratory, Eglin AFB, FL) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 19 p. refs (Contract F08635-84-C-02281)

(AIAA PAPER 89-0361)

New features incorporated in the 1988 version of the EAGLE algebraic/elliptic grid generation code are discussed, and examples of techniques of application to complex aircraft configurations are given. These new features allow changes in parameters to be localized, removing the need for corresponding changes throughout the input runstream. Applications to multiple-store configurations are shown. Author

A89-25310*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE DESIGN AND APPLICATION OF UPWIND SCHEMES ON UNSTRUCTURED MESHES

TIMOTHY J. BARTH and DENNIS C. JESPERSEN (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 13 p. refs (AIAA PAPER 89-0366)

Solution and mesh generation algorithms for solving the Euler equations on unstructured meshes consisting of triangle and quadrilateral control volumes are presented. Cell-centered and mesh-vertex upwind finite-volume schemes are developed which utilize multi-dimensional monotone linear reconstruction procedures. These algorithms differ from existing algorithms (even on structured meshes). Numerical results in two dimensions are presented. Author

A89-25385*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

TWO-DIMENSIONAL EULER COMPUTATIONS ON A TRIANGULAR MESH USING AN UPWIND, FINITE-VOLUME SCHEME

D. L. WHITAKER, B. GROSSMAN (Virginia Polytechnic Institute and State University, Blacksburg, VA), and R. LOHNER (U.S. Navy, Naval Research Laboratory, Washington, DC) AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 15 p. refs (Contract NAG1-776)

(AIAA PAPER 89-0470)

A numerical procedure was developed for the finite-volume solution of the Euler equations on unstructured triangular meshes based on a flux-difference split upwind method. Techniques for implementing Roe's (1985) approximate Reimann solver together with the preprocessing MUSCL differencing on unstructured grids are presented. Applications and comparisons with structured grid problems are carried out for a supersonic shock reflection problem, the supersonic flow over a blunt body, the transonic flow over NACA 0012 and RAE 2822 airfoils, and the flow about a double element Karman-Trefftz airfoil. K.K.

A89-25870

ON A DISTRIBUTED PARAMETER MODEL FOR DETECTING CRACKS IN A ROTOR

ROBERTO ARAYA (Universidad de Chile, Santiago) IN: International Conference on Advances in Communication and Control Systems, 1st, Washington, DC, June 18-20, 1987, Proceedings. New York, Optimization Software, Inc., 1988, p. 73-81.

The dynamic behavior of a cracked rotor is modeled analytically as a three-dimensional parameter-identification problem, extending and refining the results obtained by Davies and Mayes (1984) using a slotted-beam model. Expressions for the Green function, the frequency spectrum, and the variation of the fundamental frequencies are derived on the basis of three parameters (the crack width, the crack position, and the ratio of the polar moments of the rotor and the cracked area). The feasibility of detecting rotor cracks by applying this torsional-beam model to vibration data is discussed. T.K.

A89-26038

MODAL CONTROL IN SYSTEMS WITH AFTEREFFECT [MODAL'NOE UPRAVLENIE V SISTEMAKH S POSLEDEISTVIEM]

V. M. MARCHENKO Avtomatika i Telemekhanika (ISSN 0005-2310), Nov. 1988, p. 73-83. In Russian. refs

For linear stationary systems with many delays, effective necessary and sufficient conditions are determined for modal controllability in a class of linear controllers with control and state delays. The relationship between problems of modal and point control is clarified. The problem of modal control in systems with incomplete information is analyzed, and a flight control problem is examined as an example. V.L.

A89-26187

AN H(INFINITY) METHOD FOR THE DESIGN OF LINEAR TIME-INVARIANT MULTIVARIABLE SAMPLED-DATA CONTROL SYSTEMS

JIANN-SHIOU YANG and WILLIAM S. LEVINE (Maryland, University, College Park) IN: Analysis and optimization of systems; Proceedings of the Eighth International Conference, Juan-les-Pins, France, June 8-10, 1988. Berlin and New York, Springer-Verlag, 1988, p. 89-100. refs

(Contract NSF OIR-85-00108)

A procedure by which H(infinity) methods can be used to design a MIMO control system is described. A procedure to approximate the nearly optimal H(infinity) controller with a lower-order controller. These techniques are then used to produce a controller for a benchmark control problem. This controller, a version of the pitch axis control of the F-14 aircraft, is then compared with a design produced using LQ techniques and with a design using Delight. C.D.

A89-26196

AN ALTERNATIVE METHOD TO SOLVE A VARIATIONAL INEQUALITY APPLIED TO AN AIR TRAFFIC CONTROL EXAMPLE

GERARD B. M. HEUVELINK and HENK A. P. BLOM (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) IN: Analysis and optimization of systems; Proceedings of the Eighth International Conference, Juan-les-Pins, France, June 8-10, 1988. Berlin and New York, Springer-Verlag, 1988, p. 617-628. refs

Some important problems of air traffic control, such as collision avoidance, can mathematically be formuated as problems of optimal stopping a diffusion. An optimal stopping policy can be characterized by a Variational Inequality (VI). To compute the solution of such a VI, a new iteration scheme is developed. The simplicity of this scheme is explicitly due to the assumption that the cost of stopping is a sufficiently smooth function of the state, which often holds for stopping problems. The scheme is applied to a simple example of air traffic control. Author

A89-27405

DETERMINATION OF THE NUMERICAL INTEGRATION STEP DURING THE ANALOG-DIGITAL MODELING OF DYNAMIC SYSTEMS [OPREDELENIE SHAGA CHISLENNOGO INTEGRIROVANIIA PRI ANALOGO-TSIFROVOM MODELIROVANII DINAMICHESKIKH SISTEM]

ARKADII S. SHALYGIN and OLEG E. SLAVIANSKII (Leningradskii Mekhanicheskii Institut, Leningrad, USSR) Elektronnoe Modelirovanie (ISSN 0204-3572), vol. 11, Jan.-Feb. 1989, p. 84-88. In Russian. refs

A procedure for selecting the step and method of numerical integration is proposed which is based on the analysis of the total error and its approximation by an analytical relation. Computations are distributed between analog and digital processors by introducing reference traffic and using the linearization method. Equations of flight dynamics are considered as an example of a nonlinear nonstationary system. V.L.

A89-27602* Tennessee Univ., Tullahoma.

PATTERN-BASED FAULT DIAGNOSIS USING NEURAL NETWORKS

W. E. DIETZ, E. L. KIECH, and M. ALI (Tennessee, University, Tullahoma) IN: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 1. Tullahoma, TN, University of Tennessee, 1988, p. 13-23. refs (Contract NAGW-1195)

An architecture for a real-time pattern-based diagnostic expert system capable of accommodating noisy, incomplete, and possibly erroneous input data is outlined. Results from prototype systems applied to jet and rocket engine fault diagnosis are presented. The ability of a neural network-based system to be trained via the presentation of behavioral patterns associated with fault conditions is demonstrated.

A89-27609* Bolt, Beranek, and Newman, Inc., Cambridge, MA. INTEGRATING CAUSAL REASONING AT DIFFERENT LEVELS OF ABSTRACTION

EVA HUDLICKA and KEVIN CORKER (BBN Laboratories, Inc., Cambridge, MA) IN: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 1. Tullahoma, TN, University of Tennessee, 1988, p. 157-163. Research supported by BBN Laboratories, Inc. refs (Contract NAS1-17335)

In this paper, a problem-solving system which uses a multilevel causal model of its domain is described. The system functions in the role of a pilot's assistant in the domain of commercial air transport emergencies. The model represents causal relationships among the aircraft subsystems, the effectors (engines, control surfaces), the forces that act on an aircraft in flight (thrust, lift), and the aircraft's flight profile (speed, altitude, etc.). The causal relationships are represented at three levels of abstraction: Boolean, qualitative, and quantitative, and reasoning about causes and effects can take place at each of these levels. Since processing at each level has different characteristics with respect to speed, the type of data required, and the specificity of the results, the problem-solving system can adapt to a wide variety of situations. The system is currently being implemented in the KEE(TM) development environment on a Symbolics Lisp machine. Author

A89-27611

AN APPLICATION OF HEURISTIC SEARCH TECHNIQUES TO THE PROBLEM OF FLIGHT PATH GENERATION IN A MILITARY HOSTILE ENVIRONMENT

VERLYNDA S. DOBBS, HENRY W. DAVIS, and CARL LIZZA (Wright State University, Dayton, OH) IN: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 1. Tullahoma, TN, University of Tennessee, 1988, p. 273-280. refs

(Contract F49620-85-C-0013)

The effectiveness of heuristic search algorithms in generating flight paths is studied. The execution speed and solution quality are of particular importance due to the need to generate and revise paths dynamically. Extensive tests were carried out with three search algorithms in a simple threat model. On the basis of straight-forward heuristics, it is found that the A-asterisk algorithm and a bidirectional search perform well when their weights are appropriately adjusted. K.K.

A89-27614

FLIGHT MISSION SCENARIO GENERATION WITH KNOWLEDGE-BASED SYSTEM

SOWMYAN RAMAN (Boeing Computer Services, Seattle, WA) IN: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 1. Tullahoma, TN, University of Tennessee, 1988, p. 341-346.

The paper discusses the development and current status of ScenGen (flight mission scenario generator), a prototype knowledge-based expert system. The objective of ScenGen is to develop a full mission scenario for a given flight plan. The user input consists of the scenario type, aircraft model, crew member, and flight plan. The production system will shorten the crew workload analysis time in the evaluation of flight deck design. In effect, it will facilitate workload analysis time in the evaluation of flight deck design. K.K.

A89-27618

APPLICATIONS OF AN AI DESIGN SHELL ENGINEOUS TO ADVANCED ENGINEERING PRODUCTS

CAROL J. RUSSO (General Electric Co., Aircraft Engine Business Group, Lynn, MA) and DAVID J. POWELL (General Electric Co., Schenectady, NY) IN: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 1. Tullahoma, TN, University of Tennessee, 1988, p. 413-420.

This paper describes the most recent work on developing ENGINEOUS, an Artificial Intelligent (AI) shell that automates the iteration of existing analysis codes to produce designs that are optimized for multiple requirements. ENGINEOUS is product independent and has been applied to the design of advanced turbomachinery components for jet engines and electric motors among others. Initial productivity improvements of factors of 5-10 have been demonstrated. Author

A89-27622* Tennessee Univ., Tullahoma. HIERARCHICAL REPRESENTATION AND MACHINE LEARNING FROM FAULTY JET ENGINE BEHAVIORAL EXAMPLES TO DETECT REAL TIME ABNORMAL CONDITIONS

U. K. GUPTA and M. ALI (Tennessee, University, Tullahoma) IN: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 2. Tullahoma, TN, University of Tennessee, 1988, p. 710-720. refs

(Contract NAGW-1195)

The theoretical basis and operation of LEBEX, a machine-learning system for jet-engine performance monitoring, are described. The behavior of the engine is modeled in terms of four parameters (the rotational speeds of the high- and low-speed sections and the exhaust and combustion temperatures), and parameter variations indicating malfunction are transformed into structural representations involving instances and events. LEBEX extracts descriptors from a set of training data on normal and faulty engines, represents them hierarchically in a knowledge base, and uses them to diagnose and predict faults on a real-time basis. Diagrams of the system architecture and printouts of typical results are shown. T.K.

A89-27623

MLS, A MACHINE LEARNING SYSTEM FOR ENGINE FAULT DIAGNOSIS

MIN KE and M. ALI (Tennessee, University, Tullahoma) IN: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 2. Tullahoma, TN, University of Tennessee, 1988, p. 721-727.

The design and operation of MLS, a machine-learning system for jet-engine performance monitoring and fault prediction, are discussed. The behavior of the engine is modeled in terms of four parameters (the rotational speeds of the high- and low-speed sections and the exhaust and combustion temperatures). Data on these parameters are preprocessed and transformed into relational statements involving instances and events (the faults considered being fuel interruption and bearing failure). The MLS algorithm itself employs an inductive learning method similar to STAR (Michalsky, 1983); the preference criteria, the generalization rules, the use of domain knowledge to guide the learning process, and the generation of concept descriptions are characterized. T.K.

A89-27629

APPLYING EVIDENTIAL REASONING TO AVIONICS TROUBLESHOOTING

ASDRUBAL GARCIA-ORTIZ and PATRICIA A. CUNDIFF (Emerson Electric Co., Electronics and Space Div., Saint Louis, MO) IN:

International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, 1st, Tullahoma, TN, June 1-3, 1988, Proceedings. Volume 2. Tullahoma, TN, University of Tennessee, 1988, p. 940-945. Research supported by Emerson Electric Co. and Automatic Test Equipment Directorate. refs

The applicability of Dempster-Schafer evidential-reasoning theory (DSERT, an extension of Bayesian probability theory) to knowledge-based systems for avionics diagnostics is considered analytically. The current status of avionics maintenance problems is surveyed; the fundamental principles of DSERT are reviewed; and results from a sample application of DSERT (using simulated data from BIT and Failure Modes and Effects Analysis as the primary sources of evidence) are presented in tables and graphs. DSERT is shown to improve the diagnostic process by combining information from different sources and providing meaningful responses even when the limitations of the knowledge base are T.K. exceeded

A89-28215

RELIABLE INFORMATION FROM ENGINE PERFORMANCE MONITORING

D. A. FRITH (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 12 p. refs

(SAE PAPER 881444)

The use of uncertainty analysis in assessing aircraft engine performance during the system design stage provides reliable information for engine maintenance. An engine performance monitoring system in operation represents a dynamic situation, since information on the engine type is being continually acquired. The system should adapt to this changing situation if it is to maximize the use of the information obtained to indicate engine condition. Two design examples, the test cell system and the A.A.F. on-wing system, are discussed.

A89-28217

SUPPORTABILITY DESIGN REQUIREMENTS FOR ARMY AIRCRAFT AND EQUIPMENT

RAYMOND J. DROLL (Grumman Corp., Grumman Aircraft Systems Div., Bethpage, NY) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 8 p. (SAE PAPER 881447)

Design requirements for the tactical aircraft, vehicles, and equipment of the U.S. Army are determined primarily by the existing support structure, operational doctrine and the operating environments. The support structure is based on high-frequency on-aircraft maintenance tasks; aviation intermediate, and depot maintenance. Operational doctrine describes how aircraft and equipment will be used to emphasize worldwide deployment and maneuver as a combat multiplier. The operational environments include climatic extremes and operating requirements. The design approach must emphasize easy operation and maintenance of equipment, and minimization of operating and support resources. A.A.F.

A89-28382

PHASE-ONLY FILTERS WITH IMPROVED SIGNAL TO NOISE RATIO

B. V. K. VIJAYA KUMAR and ZOUHIR BAHRI (Carnegie-Mellon University, Pittsburgh, PA) Applied Optics (ISSN 0003-6935), vol. 28, Jan. 15, 1989, p. 250-257. refs

The notion of optimal phase-only filters (OPOFs) that yield improved SNRs is introduced. The improvement in SNR resulting from the use of OPOFs is illustrated with the help of several analytical examples and simulation results. Author

Illinois Univ., Urbana-Champaign. Coordinated N89-18046*# Science Lab.

IMPACT OF DEVICE LEVEL FAULTS IN A DIGITAL AVIONIC PROCESSOR

HO KIM SUK Jan. 1989 55 p

(Contract NAG1-602)

(NASA-CR-184783; NAS 1.26:184783; UILU-ENG-89-2210; CSG-99) Avail: NTIS HC A04/MF A01 CSCL 09B

This study describes an experimental analysis of the impact of gate and device-level faults in the processor of a Bendix BDX-930 flight control system. Via mixed mode simulation, faults were injected at the gate (stuck-at) and at the transistor levels and, their propagation through the chip to the output pins was measured. The results show that there is little correspondence between a stuck-at and a device-level fault model, as far as error activity or detection within a functional unit is concerned. In so far as error activity outside the injected unit and at the output pins are concerned, the stuck-at and device models track each other. The stuck-at model, however, overestimates, by over 100 percent, the probability of fault propagation to the output pins. An evaluation of the Mean Error Durations and the Mean Time Between Errors at the output pins shows that the stuck-at model significantly underestimates (by 62 percent) the impact of an internal chip fault on the output pins. Finally, the study also quantifies the impact of device fault by location, both internally and at the output Author pins.

16

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.

A89-26630* Iowa Univ., Iowa City.

MERGING OF AIRCRAFT VORTEX TRAILS - SIMILARITIES TO MAGNETIC FIELD MERGING

DONALD A. GURNETT (Iowa, University, Iowa City) Geophysical Research Letters (ISSN 0094-8276), vol. 16, Jan. 1989, p. 17-20. refs

(Contract NGL-16-001-043)

This paper discusses the phenomenological and formal similarities between the merging of aircraft vortex trails and the merging of magnetic field lines in a plasma. High-resolution photographs are shown of smoke trails from the wing tips of an airplane. These photographs show that the two vortex trails merge together downstream of the aircraft in a way similar to the merging of oppositely directed magnetic field lines in a plasma. Although there are some differences, this correspondence is apparently related to the fact that the vorticity equation in a fluid has the same mathematical form as the magnetic field equation in an MHD plasma. In both cases the merging proceeds at a rate considerably faster than would be predicted from classical estimates of the viscosity and resistivity. The enhanced merging rate in the fluid case appears to result from turbulence that increases the diffusion rate in the merging region. Author

A89-27741#

SOURCE LOCALIZATION TECHNIQUE FOR IMPULSIVE **MULTIPLE SOURCES**

BLACODON, M. CAPLOT, and G. ELIAS (ONERA, D Chatillon-sous-Bagneux, France) Journal of Aircraft (ISSN 0021-8669), vol. 26, Feb. 1989, p. 154-156. Previously cited in issue 04, p. 571, Accession no. A88-16579. refs

N89-18167*# Cornell Univ., Ithaca, NY. School of Mechanical and Aerospace Engineering.

HELICOPTER TAIL ROTOR BLADE-VORTEX INTERACTION NOISE Final Technical Report, 1 Feb. 1986 - 31 Mar. 1987 ALBERT R. GEORGE and S.-T. CHOU Mar. 1987 28 p (Contract NAG2-379) (NASA-CR-183178; NAS 1.26:183178) Avail: NTIS HC A03/MF

A01 CSCL 20A

A study is made of helicopter tail rotor noise, particularly that

due to the interactions with main rotor tip vortices. Summarized here are present analysis, the computer codes, and the results of several test cases. Amiet's unsteady thin airfoil theory is used to calculate the acoustics of blade-vortex interaction. The noise source is modelled as a force dipole resulting from an airfoil of infinite span chopping through a skewed line vortex. To analyze the interactions between helicopter tail rotor and main rotor tip vortices, we developed a two-step approach: (1) the main rotor tip vortex system is obtained through a free wake geometry calculation of the main rotor using CAMRAD code; (2) acoustic analysis takes the results from the aerodynamic interaction analysis and calculates the farfield pressure signatures for the interactions. It is found that under a wide range of helicopter flight conditions, acoustic pressure fluctuations of significant magnitude can be generated by tail rotors due to a series of interactions with main rotor tip vortices. This noise mechanism depends strongly on the helicopter flight conditions and the relative location and phasing of the main and tail rotors. fluctuations of significant magnitude can be generated by tail rotors due to a series of interactions with main rotor tip vortices. This noise mechanism depends strongly upon the helicopter flight conditions and the relative location and phasing of the main and tail rotors. Author

17

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.

A89-25513# AIRCRAFT DESIGN EDUCATION AT NORTH CAROLINA STATE UNIVERSITY

J. N. PERKINS, R. J. VESS (North Carolina State University, Raleigh), and R. A. MITCHELTREE AIAA, Aerospace Sciences Meeting, 27th, Reno, NV, Jan. 9-12, 1989. 6 p. (AIAA PAPER 89-0649)

This paper discusses one of the senior year design programs in Aerospace Engineering at North Carolina State University. The objectives, organization, and management of the final year group projects in aircraft design are described. Emphasis is placed on introducing some of the real world into the course by requiring the students to build and fly, by remote means, a scaled model of their design. Details of the design activities, construction techniques, and flight testing are discussed. Author

A89-26665

THE LAW: THE PILOT AND THE AIR TRAFFIC CONTROLLER - DIVISION OF RESPONSIBILITIES

HENK GEUT (Vereniging voor Nederlandse Verkeersvliegers, Amstelveen, Netherlands) Air Law (ISSN 0165-2079), vol. 13, Dec. 1988, p. 256-267. refs

The question of whether the pilot or the air traffic controller is responsible for the operation and safety of a flight is discussed. The duties of a pilot and an air traffic controller are reviewed. It is found that the law does not give a clear division of responsibilities. Several cases are examined, showing that the responsibility depends on the circumstances of each individual case. It is concluded that there is an interrelation between the duties of the pilot and the controller and that both are responsible for the safe operation of a flight.

A89-26666

SOME CONSIDERATIONS ON THE LIABILITY OF AIR TRAFFIC CONTROL AGENCIES

KIM DOO HWAN (Soong Jun University, Seoul, Republic of Korea) Air Law (ISSN 0165-2079), vol. 13, Dec. 1988, p. 268-272.

International law concerning the liability of air traffic control agencies is reviewed. Studies by the Legal Committee of ICAO are considered. The governmental agencies which control air traffic control in several countries are examined, including France, the U.S., the UK, West Germany, Japan, and Korea. It is suggested that rules concerning the air traffic control systems of various countries should be unified.

SUBJECT INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 240)

June 1989

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 document content, a 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.

Δ

A-300 AIRCRAFT

Comparison of the results of tests on A300 aircraft in the RAE 5 metre and the ONERA F1 wind tunnels p 300 N89-16849

A-310 AIRCRAFT

The accurate	measurement of	drag in the	∋8 ft x 8 ft
tunnel		p 337	N89-16855
A-320 AIRCRAFT			
Use of color displays in the A320 cockpit			
IGAE DADED 00	14161	- 010	400 00000

The CFM 56-5 on the A-320 at Air France p 320 N89-16793

ABLATION

Experimental research of flow separation, heat transfer and ablation on flat plate-wedges in supersonic, turbulent flow p 292 A89-25938 Nonequilibrium viscous hypersonic flows over ablating

Teflon surfaces [AIAA PAPER 89-0314] p 293 A89-26368

- **ACCELERATION (PHYSICS)**
- Boundary layer measurements on an airfoil at low Reynolds numbers in an accelerating flow from a nonzero base velocity

TAIAA PAPER 89-05691 p 288 A89-25458 ACCIDENT PREVENTION

- On design and projected use of Doppler radar and low-level windshear alert systems in aircraft terminal operations
- [AIAA PAPER 89-0704] p 302 A89-25545 Weather accident prevention using the tools that we

have [AIAA PAPER 89-0707] p 302 A89-25547 Enroute convective turbulence deviation considerations

- on short segments [AIAA PAPER 89-0738] p 302 A89-25555
- ACOUSTIC EMISSION Long term possibilities for nondestructive evaluation for
- US Navy aircraft p 350 N89-17259

ACOUSTIC EXCITATION

- Control of laminar separation over airfoils by acoustic excitation
- p 288 A89-25454
- and low-frequency oscillations in axisymmetric combustors --- of ramjet p 325 A89-28336
- Tip aerodynamics and acoustics test: A report and data
- survey [NASA-RP-1179] p 302 N89-17579
- Aircraft airframe cost estimating relationships: Bombers
- and transports [AD-A200264] p 270 N89-16721
- Aircraft airframe cost estimating relationships: Attack aircraft [AD-A200265] p 270 N89-16722
- ACTIVE CONTROL
- Active control of aeroelastic systems governed by functional differential equations p 332 A89-25871 ACTUATORS
 - The comparative analysis and development of an 8000 psi rotary vane actuator [SAE PAPER 881435] p 349 A89-28210
- ADAPTIVE FILTERS
- A self-adaptive computational method applied to transonic turbulent projectile aerodynamics
- [AIAA PAPER 89-0837] p 290 A89-25606 ADDITIVES Fuel-additive system for test cells
- [AD-A200801] p 342 N89-17681 ADIABATIC FLOW
- Adiabatic Wankel type rotary engine [NASA-CR-182233] p 330 N89-17599 AFRIAL RUDDERS
- Finite element analysis of composite rudder for DO 228 p 347 A89-26284 aircraft AEROASSIST
- Three-dimensional flow simulation about the AFE vehicle
- in the transitional regime --- Aeroassist Flight Experiment [AIAA PAPER 89-0245] p 278 A89-25207 AERODYNAMIC BALANCE
- Drag measurements on a modified prolate spheroid using a magnetic suspension and balance system p 335 A89-25512 [AIAA PAPER 89-0648]
- AERODYNAMIC CHARACTERISTICS Departure resistance and spin characteristics of the F-15
- S/MTD [AIAA PAPER 89-0012] p 331 A89-25008
- Scissor wing An alternative to variable sweep [AIAA PAPER 89-0013] p 310 A89 p 310 A89-25009
- Influence of wing geometry on leading-edge vortices and vortex-induced aerodynamics at supersonic speeds
- [AIAA PAPER 89-0085] p 274 A89-25075 Evaluation of an analysis method for low-speed airfoils by comparison with wind tunnel results
- p 278 A89-25224 [AIAA PAPER 89-0266] High-lift aerodynamics for transport aircraft by interactive
- experimental and theoretical tool development [AIAA PAPER 89-0267] p 278 A89-25225
- Moving surface boundary-layer control as applied to wo-dimensional airfoils [AIAA PAPER 89-0296] p 281 A89-25253
- Numerical simulation of high-incidence flow over the F-18 fuselage forebody
- [AIAA PAPER 89-0339] p 282 A89-25286 Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow
- [AIAA PAPER 89-0341] p 282 A89-25288 Efficient application techniques of the EAGLE grid code
- to complex missile configurations [AIAA PAPER 89-0361] p 353 A89-25305
- The design and application of upwind schemes on unstructured meshes [AIAA PAPER 89-0366] p 354 A89-25310
- Numerical simulation of the growth of instabilities in supersonic free shear layers
- [AIAA PAPER 89-0376] p 283 A89-25319

Nonequilibrium effects for hypersonic transitional flows using continuum approach

- TAIAA PAPER 89-04611 p 284 A89-25377 Characteristics of the ground vortex formed by a jet moving over a fixed ground plane
- [AIAA PAPER 89-0650] p 288 A89-25514 A model of pressure distributions on impeller blades for determining performance characteristics
- p 346 A89-25609 [AIAA PAPER 89-0840] Elevator deflection effects on the icing process
- [AIAA PAPER 89-0846] p 290 A89-25615 Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987 p 290 A89-25856
- Three-dimensional viscous flow simulations using an implicit relaxation scheme p 291 A89-25865 Simulation of the DFVLR-F5 wing experiment using a
- block structured explicit Navier-Stokes method p 291 A89-25866
- A prediction of the stalling of the multielement airfoils p 292 A89-25932
- A numerical method for calculating the low-speed aerodynamic characteristics of the the strake-wing p 292 A89-25941 configurations
- Asymptotics of stationary separated flow past a body at large Revnolds numbers p 293 A89-26163 Low speed aerodynamics of canard configurations
- p 294 A89-26689 National full-scale aerodynamic complex integrated
- systems test data system p 335 A89-27653 singularity methods for p 294 A89-27748 Investigation of internal
- multielement airfoils Dynamics of longitudinal motion of an aeroplane after
- p 333 A89-28396 drop of loads The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment
- [AIAA 89-0762] p 337 A89-28457 An experimental investigation of the aerodynamic characteristics of slanted base ogive cylinders using magnetic suspension technology
- [NASA-CR-184624] p 300 N89-16758 AFRODYNAMIC COFFEICIENTS
- Determination of aerodynamic sensitivity coefficients in the transonic and supersonic regimes
- p 286 A89-25426 [AIAA PAPER 89-0532] Yawing moment coefficient for plain ailerons at subonic
- speeds [ESDU-88029] p 298 N89-16734 **AERODYNAMIC CONFIGURATIONS**
 - CFD in design An airframe perspective
 - [AIAA PAPER 89-0092] p 310 A89-25081 Numerical simulation of vortex unsteadiness on slender bodies of revolution at large incidence
 - p 276 A89-25170 [AIAA PAPER 89-0195] Analysis of three-dimensional aerospace configurations using the Euler equations
 - [AIAA PAPER 89-0268] p 279 A89-25226 Aerodynamic prediction rationale hypersonic configurations for analyses of
 - [AIAA PAPER 89-0525] p 285 A89-25420 Effect of dynamic changes in body configuration on
- shock structure [AIAA PAPER 89-0526] p 285 A89-25421
- DFVLR-F5 test wing experiment for computational aerodynamics p 290 A89-25857
- DFVLR-F5 test wing configuration The boundary value p 290 A89-25858 problem Low-speed vortical flow over a 5-degree cone with tip
- geometry variations [SAE PAPER 881422] p 295 A89-28203
- Aerodynamic performance of wings of arbitrary planform in inviscid, incompressible, irrotational flow
- p 297 N89-16728 [AD-A2004361 Estimation of drag arising from asymmetry in thrust or airframe configuration
- [ESDU-88006] p 297 N89-16730 Study of the aerodynamic situation along the C 160
- aircraft in parachuting configuration [DAT-88-061 p 299 N89-16756

- [AIAA PAPER 89-0565] ACOUSTIC INSTABILITY Acoustic-vortex interactions
 - ACOUSTIC MEASUREMENT

 - ACQUISITION

AERODYNAMIC DRAG

p 272 A89-25028

of a

NASP

Development of a panel met	hod for modeling
configurations with unsteady compon	ient motions, phase
1 [AD_A200255]	n 315 N89-16775
A numerical simulation of flows abo	out two-dimensional
bodies of parachute-like configuration	1
[ISAS-629]	p 302 N89-17580
Thermodynamics and wave proce	sses in nigh Mach
	n 278 A89-25219
[AIAA PAPER 09-0201] Dragonfly unsteady aerodynamics -	The role of the wing
phase relations in controlling the proc	duced flows
[AIAA PAPER 89-0832]	p 289 A89-25602
The effects of aft-loaded airfoils of	on aircraft trim drag
[AIAA PAPER 89-0836]	p 312 A89-25605
Estimation of drag arising from asy	ymmetry in thrust or
aintrame configuration	n 207 N89-16730
[ESDU-66006]	p 299 N89-16747
Development of testing techniques	in a large transonic
wind tunnel to achieve a required dra	g accuracy and flow
standards for modern civil transports	
	p 337 N89-16857
Precision improvement of trans	sport aircraft drag
	p 300 Nos-10000
A flow viewalization and served	vnamic force data
evaluation of spanwise blowing on full	and half span delta
wings	·····
[AIAA PAPER 89-0192]	p 276 A89-25167
Multiple solutions for aircraft sides	lip behaviour at high
angles of attack	
[AIAA PAPER 89-0645]	p 331 A89-25510
Electro-impulse de-icing systems - I	ssues and concerns
for certification	
[AIAA 89-0761]	p 314 A89-28456
ERODYNAMIC HEAT TRANSFER	we and intermittant
Infrared thermography in blowdo	wh and intermittent
hypersonic facilities	p 334 A89-25036
	P 000 000 00000
Unsteady wall interference in rotan	v tests
[AIAA PAPER 89-0046]	p 273 A89-25040
Transonic Euler solutions on mutua	ally interfering finned
bodies	
[AIAA PAPER 89-0264]	p 278 A89-25222
Emerging technology for transoni	c wind-tunnel-wall
interference assessment and correct	ions
[SAE PAPER 881454]	p 336 A69-26220
AERODYNAMIC LOADS	al faras correlations
Flow-field characteristics and norm	BI-IOICE COILEIGUOUS
INIAA DADER 89-00261	p 272 A89-25022
Bronoller/wing interaction	P
[AIAA PAPER 89-0535]	p 311 A89-25429
Evaluation of three turbulence mod	els for the prediction
of steady and unsteady airloads	
[AIAA PAPER 89-0609]	p 288 A89-25485
Analysis of extreme wind shear	
[AIAA PAPER 89-0710]	p 352 A89-25549
Aeroelastic flutter of low aspe	ect ratio cantilever
composite plate	p 347 A89-26281
National full-scale aerodynamic	complex integrated
systems test data system	p 335 A89-2/653
Transonic store separation using	a three-dimensional
chimera grid scheme	D 296 AR0-28442
LAIAA PAPEN 89-003/ J	A 590 Y09-50445
The official of wells on a compl	ressible mixing laver
TALAA PAPER 89-03721	p 283 A89-25315
AEPODYNAMIC STALLING	F
An interactive boundary-layer proc	cedure for oscillating
airfoils including transition effects	
[AIAA PAPER 89-0020]	p 271 A89-25016
Compressible studies on dynamic	stall
[AIAA PAPER 89-0024]	p 271 A89-25020
An experimental evaluation of a k	ow-Reynolds number
high-lift airfoil with vanishingly sm	hall pitching moment
[AIAA PAPER 89-0538]	p 286 A89-25432
Vortex generator jets - A means for	or passive and active
control of boundary layer separation	n 287 A80-25452
[AIAA PAPEH 89-0504]	receible dynamic etall
Design and development of a comp	ressione dynamic stan
	p 335 A89-25511
Flow vieualization investigation of	f dvnamic stall on a
nitching airfoil	
[AIAA PAPER 89-0842]	p 290 A89-25611
A prediction of the stalling of the	multielement airfoils
	p 292 A89-25932

The effects of aspect ratio on the stall of a finite wing [AIAA PAPER 89-0570] p 296 A89-28434 AERODYNAMICS . On the structure of two- and three-dimensional

separation [AIAA PAPER 89-0287] p 280 A89-25244 Numerical solutions on a Pathfinder and other

configurations using unstructured grids and a finite element solver [AIAA PAPER 89-0362] p 282 A89-25306

Progress on a Taylor weak statement finite element algorithm for high-speed aerodynamic flows [AIAA PAPER 89-0654] p 289 A89-25517

Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies [AIAA PAPER 88-0460] p 295 A89-28251

Introduction to intake aerodynamics p 298 N89-16739

- Intake Aerodynamics, volume 2 --- conference [VKI-LS-1988-04-VOL-2] p 299 N89-16748 The wind tunnels of the national full-scale aerodynamics
- complex p 339 N89-18388 AEROELASTICITY
- A state-space model of unsteady aerodynamics in a compressible flow for flutter analyses [AIAA PAPER 89-0022] p 271 A89-25018
- Direct solution of unsteady transonic flow equations in frequency domain [AIAA PAPER 89-0641] p 288 A89-25507 Active control of aeroelastic systems governed by functional differential equations p 332 A89-25871 Longitudinal stability analysis for deformable aircraft p 332 A89-25934

An effective modeling method of unsteady aerodynamics for state-space aeroelastic models p 293 A89-25946 Free vibration and panel flutter of quadrilateral laminated plates p 347 A89-26274

- Aeroelastic flutter of low aspect ratio cantilever composite plate p 347 A89-26281 Analysis of structures with rotating, flexible substructures
- applied to rotorcraft aeroelasticity p 312 A89-27695 Unsteady transonic algorithm improvements for realistic aircraft applications p 312 A89-27738
 - aircraft applications p 312 A99-27738 Technique for the prediction of airfoil flutter characteristics in separated flow p 348 A89-27744 Some implications of warping restraint on the behavior of composite anisotropic beams p 312 A89-27747
 - A computational procedure for automated flutter analysis p 348 A88-28070 Aeroelastic optimization of a helicopter rotor p 316 N89-16778
 - Requirements and capabilities in unsteady windtunnel testing p 339 N89-16878 Vibration and aeroelastic tailoring of advanced composite plate-like lifting surfaces p 351 N89-17263
- AERONAUTICAL ENGINEERING
- Controls and guidance: Aeronautics p 334 N89-18401
- AEROSPACE PLANES Combined propulsion for hypersonic and space vehicles p 322 A89-24917 Numerical simulation of hypersonic flow around a space plane at high angles of attack using implicit TVD
- Navier-Stokes code [AIAA PAPER 89-0273] p 279 A89-25230 Computational design aspects of a NASP nozzle/atterbody experiment
- [AIAA PAPER 89-0446] p 284 A89-25364 A three-dimensional upwind finite element point implicit unstructured grid Euler solver
- [AIAA PAPER 89-0658] p 289 A89-25521 NASP natural environment definitions for design
- [AIAA PAPER 89-0764] p 339 A89-25568 Report of the Defense Science Board task force on the National Aerospace Plane (NASP)
- [AD-A201124] p 317 N89-17595 The national aero-space plane p 317 N89-18387 AEROSPACE SAFETY
- National lightning detection A real-time service to aerospace
- [AIAA PAPER 89-0787] p 352 A89-25578 AEROSPACE VEHICLES
- Lightning triggered by the presence of aerospace vehicles p 353 A89-26215 AEROTHERMOCHEMISTRY
- Scramjet analysis with chemical reaction using three-dimensional approximate factorization
- [AIAA PAPER 89-0672] p 323 A89-25533 AEROTHERMODYNAMICS
- Pressure and heat transfer investigation of a modified NASP baseline configuration at M = 6 --- National Aero-Space Plane
- [AIAA PAPER 89-0246]
 p 339
 A89-25208

 Aerothermal modeling program.
 Phase 2, element 8:

 Flow interaction experiment
 p 351
 N89-17304

 Measurement of airfoil heat transfer coefficients on a
 P 351
 N89-17304
- turbine stage p 351 N89-17311

nozzle/afterbody experiment p 284 A89-25364 [AIAA PAPER 89-0446] Accurate drag estimation using a single component drag p 337 N89-16856 model technique The effect of exhaust plume/afterbody interaction on installed Scramjet performance [NASA-TM-101033] p 330 N89-17600 AH-64 HELICOPTER Application of a Comprehensive Analytical Model of Rotor Aerodynamics and Dynamics (CAMRAD) to the McDonnell Douglas AH-64A helicopter p 301 N89-17578 [NASA-CR-177455] AILERONS Rolling moment derivative Lxi, for plain ailerons at subsonic speeds p 297 N89-16731 [ESDU-88013] Yawing moment coefficient for plain ailerons at subonic speeds [ESDU-88029] p 298 N89-16734 AIR BREATHING ENGINES Thermal-energy management for air breathing hyper-velocity vehicles p 310 A89-25158 ÁIAA PAPER 89-0183] AIR COOLING Single and multiple jet impingement heat transfer on rotating disks [AIAA PAPER 89-0174] p 344 A89-25150 AIR FLOW Combustor air flow prediction capability comparing p 349 A89-28345 several turbulence models Notes on a theoretical parachute opening force analysis applied to a general trajectory p 302 N89-17582 [AD-A201050] AIR INTAKES Estimates of oxides of nitrogen formed in an inlet air stream for high Mach number flight conditions p 277 A89-25172 [AIAA PAPER 89-0197] AIR LAW The law: The pilot and the air traffic controller - Division p 357 A89-26665 of responsibilities Some considerations on the liability of air traffic control p 357 A89-26666 adenci AIR NAVIGATION PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record p 339 A89-26701 VERDICT - A plan for gravity compensation of inertial p 307 A89-26724 navigation systems Causal probability model for transoceanic track separations with applications to automatic dependent p 308 A89-26735 surveillance A Kalman filter for an integrated Doppler/GPS navigation p 308 A89-26740 system

The effect of exhaust plume/afterbody interaction on

aspects

- GPS antennas for civil aviation p 308 A89-28296 GPS antenna problems for military aircraft
- p 309 A89-28297 An antenna for the GPS installation at DFVLR p 309 A89-28298
- A GPS receiver antenna with integrated down-mixer p 309 A89-28299
- AIR PIRACY

[AD-A200626]

AFTERBODIES

installed scramjet performance

Computational design

[AIAA PAPER 89-0032]

- Aviation security: A system's perspective [DE89-002020] p 306 N89-16766 AIR START
- Aerodynamic visualization for impulsively started airfoils p 270 A89-24925 AIR TRAFFIC CONTROL
- An alternative method to solve a variational inequality applied to an air traffic control example
- applied to an air traffic control example p 354 A89-26196 Some considerations on the liability of air traffic control
- agencies p 357 A89-2666
- Air traffic control automation concepts to optimize flight management system utilization p 307 A89-26733 The realization of microwave landing system benefits
- p 307 A89-26734 The integration of European flight-safety systems
- P 308 A89-28292 Ways to solve current flight-safety problems
- p 305 A89-28294 Design of automation tools for management of descent
- traffic [NASA-TM-101078] p 306 N89-17584
- Activities report in air traffic control [ETN-89-93513] p 309 N89-17586
- An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition input
 - p 309 N89-17588

SUBJECT INDEX

AIR TRAFFIC CONTROLLERS (PERSONNEL)

The law: The pilot and the air traffic	control	ler - Division
of responsibilities	p 357	A89-26665
AIR TRANSPORTATION		
Severe weather - Impact on aviation	n and FA	A programs
in response		
[AIAA PAPER 89-0794]	p 352	A89-25583
Impact of severe weather on a	viation	- An NWS
perspective		
[AIAA PAPER 89-0795]	p 304	A89-25584
The effects of inclement weather of	n airlin	

[AIAA PAPER 89-0797] p 304 A89-25585 AIRBORNE EQUIPMENT

Precision trajectory reconstruction

p 307 A89-26726 AIRBORNE/SPACEBORNE COMPUTERS

Ranging and Processing Satellite (RAPSAT)

p 340 A89-26738 AIRCRAFT ACCIDENT INVESTIGATION Research pressed to improve flight information

contribution to aircraft accident investigations p 318 A89-27247

Analysis of windshear from airline flight data p 332 A89-27734 Analysis of Arrow Air DC-8-63 accident Gander,

Newfoundland on 12 December 1985 [AIAA PAPER 89-0706] p 305 A89-28448

Aircraft accident/incident summary report, Travis Air orce Base, California, 8 April 1987

[PR88-9104141 p 306 N89-16768 AIRCRAFT ACCIDENTS Numerical and experimental study of the crash behavior

of helicopters and fixed-wing aircraft

p 309 A89-24919 Airport accident-potential and safety areas p 336 A89-28193 [SAE PAPER 8813881

Kinematics of U.S. Army helicopter crashes - 1979-85 p 306 A89-28486

AIRCRAFT ANTENNAS

Field enhancement of UHF-VHF aircraft antennas [AD-A200180] p 349 N89-17069 CRAFT BRAKES

Performance testing	of an electrically	actuated	aircraft
braking system	•		
ISAE DADED 9912001	-	242 400	00404

- A summary of recent aircraft/ground vehicle friction measurement tests [SAE PAPER 881403]
- p 336 A89-28196 AIRCRAFT CARRIERS

The effects of enroute turbulence reports on air carrier flight operations

[AIAA PAPER 89-0741] p 303 A89-25557 An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition input

[AD-A200626] p 309 N89-17588 AIRCRAFT COMMUNICATION

Ranging and Processin	g Satellite	(RAPSAT	D)
	-	p 340	A89-26738
The emergence of	satellite	commun	nication for
commercial aircraft			
[SAE PAPER 881370]		p 308	A89-28183

AIRCRAFT COMPARTMENTS Measurement of dynamic reactions in passenger seat

iega		
[SAE PAPER 881376]	p 305	A89-2818
Discussion of transport	passenger seat	performance

characteristics	-	-	
[SAE PAPER 881378]		p 305	A89-28190

Effects of aircraft size on cabin floor dynamic pulses [SAE PAPER 881379] p 305 A89-28191 Materials for interiors - A brief review of their current

status p 342 A89-28433 AIRCRAFT CONFIGURATIONS

A patched-grid algorithm for complex configurations ed towards the F-18 aircraft

[AIAA PAPER 89-0121] p 310 A89-25106 Navier-Stokes solutions about the F/A-18 forebody-LEX

configuration --- Leading Edge Extension [AIAA PAPER 89-0338] p 281 A89-25285 Feasibility study on the design of a laminar flow

nacelle [AIAA PAPER 89-0640]

p 311 A89-25506 Computational design of low aspect ratio wing-winglets for transonic wind-tunnel testing

[AIAA PAPER 89-0644] p 311 A89-25509 Unsteady transonic algorithm improvements for realistic aircraft applications p 312 A89-27738 Spanload optimization for strength designed lifting

[AIAA PAPER 88-2512] p 314 A89-28252 Estimation of drag arising from asymmetry in thrust or

airframe configuration [ESDU-88006] p 297 N89-16730 Wind tunnel predicted air vehicle performance: A review

of lessons learned p 337 N89-16852 AIRCRAFT CONSTRUCTION MATERIALS Properties of aircraft tire materials

[SAE PAPER 881358] p 313 A89-28177 Materials for interiors - A brief review of their current status p 342 A89-28433 AIRCRAFT CONTROL

Multiple solutions for aircraft sideslip behaviour at high angles of attack

[AIAA PAPER 89-0645] p 331 A89-25510 Control of nearly singular decoupling systems and nonlinear aircraft maneuver p 332 A89-25692 Active control of aeroelastic systems governed by functional differential equations p 332 A89-25871

Feedback control of vibrations in an extendible cantilever sweptback wing p 332 A89-26193

Dynamic response of aircraft autopilot systems to atmospheric disturbances p 333 A89-27737 Considerations of control authority requirements in STOVL propulsion system sizing [SAE PAPER 881432]

p 313 A89-28207 Results from NASA Langley experimental studies of multiaxis thrust vectoring nozzles

[SAE PAPER 881481] p 324 A89-28228 Dynamics of longitudinal motion of an aeroplane after p 333 A89-28396 drop of loads

Determination of longitudinal aerodynamic derivatives using flight data from an icing research aircraft

p 333 A89-28454 [AIAA 89-0754] AIRCRAFT DESIGN

Scissor wing - An alternative to variable sweep [AIAA PAPER 89-0013] p 310 A89 p 310 A89-25009 CFD in design - An airframe perspective

[AIAA PAPER 89-0092] p 310 A89-25081 High-lift aerodynamics for transport aircraft by interactive

perimental and theoretical tool development [AIAA PAPER 89-0267] p 278 A89-25225 Low speed wind tunnel investigation of the flow about delta wing, oscillating in pitch to very high angle of

attack [AIAA PAPER 89-0295] p 281 A89-25252 Recoverable test vehicle, an innovative approach to a

low cost composite airframe for aerospace application [AIAA PAPER 89-0378] p 311 A89-25320 The intelligent wing - Aerodynamic developments for future transport aircraft

[AIAA PAPER 89-0534] p 269 A89-25428

Aircraft design education at North Carolina State University

[AIAA PAPER 89-0649] p 357 A89-25513 NASP natural environment definitions for design

[AIAA PAPER 89-0764] p 339 A89-25568 Developments in expulsive separation ice protection blankets

[AIAA PAPER 89-0774] p 311 A89-25572 Finite element analysis of composite rudder for DO 228 aircraft

p 347 A89-26284 Aircraft landing gear design: Principles and practices Book p 312 A89-26950

Structural reliability in aerospace design p 340 A89-27175

Design and experimental results for a high-altitude, long-endurance airfoil

p 312 A89-27740 Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects

p 313 A89-27925 Advanced flight control for the Fokker 100 [SAE PAPER 881373] p 333 p 333 A89-28185

Simulation evaluation of transition and hover flying qualities of the E-7A STOVL aircraft [SAE PAPER 881430] p 333 A89-28205

Conceptual design of a STOVL fighter/attack aircraft [SAE PAPER 881431] p 313 A89-28206

The comparative analysis and development of an 8000 psi rotary vane actuator [SAE PAPER 881435] p 349 A89-28210

Mechanization, design and methodological lessons learned from a dynamic cockpit mock-up evaluation (SAE PAPER 881438) p 319 A89-28213

Reconfigurable cockpit development p 319 A89-28224 [SAE PAPER 881472]

Spanload optimization for strength designed lifting surfaces

[AIAA PAPER 88-2512] p 314 A89-28252 p 315 N89-16744 Intake-airframe integration p 315 N89-16744 Development of direct-inverse 3-D methods for applied

transonic aerodynamic wing design and analys [NASA-CR-184788] p 300 N89-16761

The design, construction and test of a postbuckled, carbon fibre reinforced plastic wing box

p 315 N89-16773 Wind tunnel predicted air vehicle performance: A review of lessons learned p 337 N89-16852 Requirements and capabilities in unsteady windtunnel testing p 339 N89-16878 Design synthesis for canard-delta combat aircraft, volumes 1 and 2 p 316 N89-17590

The wind tunnels of the national full-scale aerodynamics complex p 339 N89-18388 AIRCRAFT ENGINES

AIRCRAFT INDUSTRY

Combined propulsion for hypersonic and space phicles p 322 A89-24917 vehicles Performance potential of air turbo-ramjet employing

supersonic through-flow fan [AIAA PAPER 89-0010] p 322 A89-25006

CFD applications - Propulsion perspective [AIAA PAPER 89-0093] p 343 A89-25082

A novel infrared thermography heat transfer measurement technique [AIAA PAPER 89-0601] p 345 A89-25478

An experimental and computational investigation of isothermal swirling flow in an axisymmetric dump combustor

[AIAA PAPER 89-0620] p 323 A89-25491 Low frequency pressure oscillations in a model ramjet combustor - The nature of frequency selection

[AIAA PAPER 89-0623] p 323 A89-25493 Evidence of a strange attractor in ramjet combustion [AIAA PAPER 89-0624]

p 323 A89-25494 Thermal analysis of engine inlet an nti-icing systems [AIAA PAPER 89-0759] p 311 A89-25565

Reliable information from engine performance monitoring

[SAE PAPER 881444] p 356 A89-28215 Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition,

Anaheim, CA, Oct. 3-6, 1988 [SAE SP-758] p 324 A89-28254

Pneumatic link secondary power systems for military aircraft

[SAE PAPER 881499] p 325 A89-28265 Effect of heavy rain on aviation engines

[AIAA 89-0799] p 326 A89-28462 An overview of US Navy engine monitoring system

p 326 N89-16782 programs and user experience Engine usage condition and maintenance management

systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784

On board life monitoring system Tornado (OLMOS) p 319 N89-16785

Information management systems for on-board monitoring systems p 319 N89-16786

CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16788

Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring system p 320 N89-16789

Commercial engine monitoring status at GE Aircraft

p 320 N89-16799 Engines, Cincinnati, Ohio Fault management in aircraft power plant controls

p 327 N89-16809 Need for common AGARD approach and actions

p 350 N89-17260

Development of a laboratory method for studying water

The realization of microwave landing system benefits

Effect of simulated glaze ice on a rectangular wing NAA PAPER 89-0750] p 303 A89-25560

Selection of the critical icing/flight case for an

Distributed ice accretion sensor for smart aircraft

Lightning triggered by the presence of aerospace

Problems in understanding aircraft icing dynamics [AIAA PAPER 89-0735] p 302 A89-2

Lightning initiation on aircraft in thunderstorms

Need for common AGARD approach and actions

p 314 A89-28255

p 349 N89-17215

p 340 A89-25190

p 341 A89-28243

p 307 A89-26734

p 302 A89-25553

p 303 A89-25563

p 311 A89-25571

p 353 A89-26214

p 353 A89-26215

p 350 N89-17260

A-3

State-of-the-art in non-destructive evaluation of turbine engine parts p 350 N89-17261 Turbine Engine Hot Section Technology, 1987 ASA-CP-2493] p 351 N89-17298

Topics of aircraft thermal management [SAE PAPER 881381] p 3

Correlations of high density fuel effects

Laser communication test system

[NASA-CP-2493] AIRCRAFT EQUIPMENT

[AIAA PAPER 89-0216]

[SAE PAPER 881534]

AIRCRAFT GUIDANCE

AIRCRAFT HAZARDS

inprotected airfoil

AIRCRAFT INDUSTRY

structure

vehicles

[AIAA PAPER 89-0750]

(AIAA PAPER 89-0757)

[AIAA PAPER 89-0772]

coalescence of aviation fuel

[AD-A199612]

AIRCRAFT FUELS

AIRCRAFT INSTRUMENTS

AIRCRAFT INSTRUMENTS

Distributed ice accretion sensor for smart aircraft structures p 311 A89-25571

[AIAA PAPER 89-0772] Lightning initiation on aircraft in thunderstorms p 353 A89-26214

Avionics display systems p 318 A89-28184 [SAF PAPER 881371] Sensor consideration in the design of a windshear

detection and guidance system p 319 A89-28201 (SAF PAPER 881417)

AIRCRAFT LANDING Airport accident-potential and safety areas

A89-28193 [SAF PAPER 881388] p 336 Overview of optimal trajectories for flight in a vindshear

[AIAA 89-0812] p 306 A89-28464 AIRCRAFT MAINTENANCE

Improved reliability and maintainability for fighter aircraft Environmental Control Systems p 312 A89-27808 [SAE PAPER 880999]

Supportability design requirements for army aircraft and equipment

p 356 A89-28217 [SAE PAPER 881447] Maintenance aid system for wide body aircraft p 327 N89-16805

Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study p 270 N89-17564 [AD-A200665]

AIRCRAFT MANEUVERS Fast half-loop maneuvers for a high alpha fighter aircraft

using a singular perturbation feedback control la p 331 A89-25014 [AIAA PAPER 89-0018]

Control of nearly singular decoupling systems and p 332 A89-25692 nonlinear aircraft maneuver Evaluation of a Kalman filter for SAR motion pmpensation p 347 A89-26721 compensation

Correction for deflections of the vertical at the runup p 307 A89-26725 site Air traffic control automation concepts to optimize flight

p 307 A89-26733 management system utilization The realization of microwave landing system benefits p 307 A89-2673 A89-26734

Dynamics of longitudinal motion of an aeroplane after p 333 A89-28396 drop of loads

AIRCRAFT MODELS Agile Fighter Aircraft Simulation

p 331 A89-25011 [AIAA PAPER 89-0015] Lateral oscillations of sting-mounted models at high

[AIAA PAPER 89-0047] p 310 A89-25041 using profile implementation Aircraft vertical directed-graph methods p 332 A89-25683 AIRCRAFT NOISE

Source localization technique for impulsive multiple sources --- microphone arrays for helicopter rotor noise p 356 A89-27741 measurement

AIRCRAFT PERFORMANCE

An analysis of lateral-directional handling qualities and eigenstructure of high performance aircraft p 331 A89-25013 [AIAA PAPER 89-0017]

- Effect of simulated glaze ice on a rectangular wing [AIAA PAPER 89-0750] p 303 A89-25560 Aircraft vertical profile implementation using directed-graph methods p 332 A89-25683 Analysis of windshear from airline flight data p 332 A89-27734
- A dynamic model for vapor-cycle cooling systems --for aircraft
- p 313 A89-27809 [SAE PAPER 881001] Fore-and-aft stiffness and damping characteristics of 30
- x 11.5-14.5, Type VIII, bias-ply and radial-belted aircraft tiroe p 313 A89-28176 [SAE PAPER 881357]
- An overview of the current NASA program on aircraft research

[SAE PAPER 881386] p 305 A89-28192 Performance testing of an electrically actuated aircraft braking system

[SAE PAPER 881399] p 313 A89-28194 Analytical wing weight prediction/estimation using computer based design techniques p 316 N89-17589

AIRCRAFT PILOTS The law: The pilot and the air traffic controller - Division p 357 A89-26665 of responsibilities Impact of severe weather on aviation - A pilot viewpoint [AIAA 89-0798] p 353 A89-28461

AIRCRAFT POWER SUPPLIES

Electrical equipment of aircraft --- Russian book p 346 A89-26171 Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition,

Anaheim, CA, Oct. 3-6, 1988 p 324 A89-28254 (SAF SP-758)

The all electric airplane revisited

p 314 A89-28256 [SAE PAPER 881407] A highly reliable DC power source for avionic subsystem

[SAF PAPER 881408] n 324 A89-28257 Experimental cascaded doubly fed variable speed

constant frequency generator system [SAE PAPER 881409] n 324 A89-28258

Parallel operation of VSCF electrical power generators p 324 A89-28259 [SAF PAPER 881410] Overview on the evolution of aircraft battery systems

used in Air Force aircraft [SAE PAPER 881411] n 324 A89-28260

Unbalanced and nonlinear loads in aircraft electrical systems

[SAE PAPER 881413] p 325 A89-28262 High reliability aircraft generator system

[SAE PAPER 881414] p 325 A89-28263 Secondary power - Benefits of digital control and vehicle management system integration

[SAE PAPER 881498] p 325 A89-28264 Pneumatic link secondary power systems for military aircraft

[SAE PAPER 881499] p 325 A89-28265 Emergency power combined with auxiliary power unit

- in aircraft p 325 A89-28266 [SAE PAPER 881500]

T-100 Multipurpose Small Power Unit - Technology for the next generation auxiliary power units [SAF PAPER 881501] p 349 A89-28267

X-29A subsystems integration - An example for future aircraft

[SAE PAPER 881504] p 314 A89-28269 AIRCRAFT PRODUCTION

Building aircraft assembly tools from a 3-D database p 269 A89-28204 [SAE PAPER 881428] AIRCRAFT PRODUCTION COSTS

Aircraft airframe cost estimating relationships: All mission types

p 269 N89-16719 [AD-A200262] AIRCRAFT RELIABILITY

Improved reliability and maintainability for fighter aircraft Environmental Control Systems p 312 A89-27808

[SAE PAPER 8809991 Comparative tests of aircraft radial and bias plv tires [SAE PAPER 881359] p 313 A89-28178 AIRCRAFT SAFETY

Electric charge acquired by airplanes penetrating p 304 A89-26231 thunderstorms Effects of aircraft size on cabin floor dynamic pulses [SAE PAPER 881379] p 305 A89-28191 Electro-impulse de-icing systems - Issues and concerns

for certification [AIAA 89-0761] p 314 A89-28456

Aviation security: A system's perspective p 306 N89-16766 [DE89-002020]

Development of new redundant flight safety system using inertial sensors p 306 N89-17585 [ISAS-634]

AIRCRAFT SPIN

Departure resistance and spin characteristics of the F-15 S/MTD

[AIAA PAPER 89-0012] p 331 A89-25008 AIRCRAFT STABILITY

Inertial energy distribution error control for optimal wind shear penetration

p 331 A89-25012 [AIAA PAPER 89-0016] Lateral oscillations of sting-mounted models at high aloha

[AIAA PAPER 89-0047] p 310 A89-25041 Multiple solutions for aircraft sideslip behaviour at high angles of attack

[AIAA PAPER 89-0645] p 331 A89-25510 Longitudinal stability analysis for deformable aircraft

p 332 A89-25934 Real-time comparison of X-29A flight data and simulation p 332 A89-27736 data

Active suppression of aerodynamic instabilities in p 295 A89-28341 turbomachines Determination of longitudinal aerodynamic derivatives

using flight data from an icing research aircraft p 333 A89-28454 AIAA 89-0754 AIRCRAFT STRUCTURES

Distributed ice accretion sensor for smart aircraft structures

[AIAA PAPER 89-0772] p 311 A89-25571 Analysis of structures with rotating, flexible substructures p 312 A89-27695 applied to rotorcraft aeroelasticity p 312 A89-27695 Local buckling and crippling of thin-walled composite structures under axial compression p 341 A89-27733 Aluminum quality breakthrough for aircraft structural p 348 A89-27745 reliability Some implications of warping restraint on the behavior p 312 A89-27747 of composite anisotropic beams

Comparative tests of aircraft radial and bias ply tires [SAE PAPER 881359] p 313 A89-28178 AIRCRAFT WAKES The effect of Mach number on the stability of a plane supersonic wave p 280 A89-25242 [AIAA PAPER 89-0285] Merging of aircraft vortex trails - Similarities to magnetic p 356 A89-26630 field meraina

Design of an all boron/epoxy doubler reinforcement for

Fore-and-aft stiffness and damping characteristics of 30

x 11.5-14.5, Type VIII, bias-ply and radial-belted aircraft

the F-111C wing pivot fitting - Structural aspects

AIRCRAFT SURVIVABILITY

[SAF PAPER 881515]

[SAE PAPER 881357]

[SAE PAPER 881358]

Properties of aircraft tire materials

AIRCRAFT TIRES

tires

Joining of carbon fiber composite with fasteners

Real-time simulation for survivable penetration

SUBJECT INDEX

p 313 A89-27925

p 343 N89-17701

p 333 A89-28236

p 313 A89-28176

p 313 A89-28177

AIRFIELD SURFACE MOVEMENTS LIRAS - A proposal for an airport traffic safety system p 308 A89-28293

AIRFOIL FENCES Tip vortex/airfoil interaction for a canard//wing configuration at low Reynolds numbers p 286 A89-25430 AIAA PAPER 89-05361

AIRFOIL OSCILLATIONS An interactive boundary-layer procedure for oscillating airfoils including transition effects [AIAA PAPER 89-0020] n 271 A89-25016

Theoretical and numerical studies of oscillating airfoils [AIAA PAPER 89-0021] p 271 A89-25017 Flow visualization studies of the Mach number effects

on the dynamic stall of an oscillating airfoil p 271 A89-25019 [AIAA PAPER 89-0023]

Compressible studies on dynamic stall p 271 A89-25020 [AIAA PAPER 89-0024]

Extended pitch axis effects on flow about a pitching airfoil [AIAA PAPER 89-0025] p 272 A89-25021

Unsteady Navier-Stokes computations past oscillating delta wing at high incidence

[AIAA PAPER 89-0081] p 273 A89-25071 Low speed wind tunnel investigation of the flow about delta wing, oscillating in pitch to very high angle of attack

[AIAA PAPER 89-0295] p 281 A89-25252 Study of the vortical wake patterns of an oscillating airfoil

[AIAA PAPER 89-0554] p 287 A89-25444 Design and development of a compressible dynamic stall

facility [AIAA PAPER 89-0647] p 335 A89-25511

Flow visualization investigation of dynamic stall on a pitching airfoil [AIAA PAPER 89-0842]

p 290 A89-25611 Experimental investigation of transonic oscillating cascade aerodynamics

[AIAA PAPER 89-0321] p 293 A89-26369 Measurements of the oscillatory lateral derivatives of

a high incidence research model (HIRM 1) at speeds up

p 332 A89-26688 to M = 0.8Technique for the prediction of airfoil flutter

p 348 A89-27744 characteristics in separated flow AIRFOIL PROFILES Aerodynamic visualization for

impulsively started p 270 A89-24925 airfoils Flow measurements of an airfoil with single-slotted

[AIAA PAPER 89-0533] p 286 A89-25427

An experimental evaluation of a low-Reynolds number airfoil with vanishingly small pitching moment hiah-lift

[AIAA PAPER 89-0538] p 286 A89-25432

Design and experimental results for a high-altitude, p 312 A89-27740 long-endurance airfoil

Reynolds number effects in transonic flow [AGARD-AG-303] p 300 N89-16760

A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16847

Precision improvement of transport aircraft drag p 300 N89-16858 measurements AIRFOILS Unsteady Euler airfoil solutions using unstructured

Moving surface boundary-layer control as applied to

Application of direct solvers to unstructured meshes for

the Euler and Navier-Stokes equations using upwind

p 275 A89-25102

p 281 A89-25253

p 283 A89-25308

dynamic meshes

[AIAA PAPER 89-0115]

o-dimensional airfoils

[AIAA PAPER 89-0296]

[AIAA PAPER 89-0364]

SUBJECT INDEX

Determination of aerodynamic sensitivity coefficients in the transonic and supersonic regimes [AIAA PAPER 89-0532] p 286 A89-25426

An investigation of cell centered and cell vertex multigrid schemes for the Navier-Stokes equations

[AIAA PAPER 89-0548] p 345 A89-25440 A one equation turbulence model for transonic airfoil flows

[AIAA PAPER 89-0557] p 287 A89-25446 Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic

[AIAA PAPER 89-0562] p 287 A89-25451 Control of laminar separation over airfoils by acoustic excitation

[AIAA PAPER 89-0565] p 288 A89-25454 Prop-fan airfoil icing characteristics

[AIAA PAPER 89-0753] p 303 A89-25561 Use of the median volume droplet diameter in the characterization of cloud droplet spectra

p 352 A89-25562 [AIAA PAPER 89-0756] Selection of the critical icing/flight case for an upprotected airfoil

[AIAA PAPER 89-0757] p 303 A89-25563 The effects of aft-loaded airfoils on aircraft trim drag

AIAA PAPER 89-08361 p 312 A89-25605 A prediction of the stalling of the multielement airfoils p 292 A89-25932

Testing on two dimensional vertical models in a conventional wind tunnel p 292 A89-25939

Applications of AF3 efficient iteration scheme to transonic nonconservative full-potential flow past airfoils p 292 A89-25940

Effects of a downstream disturbance on the structure p 348 A89-27692 of a turbulent plane mixing layer Investigation of surface water behavior during glaze ice

accretion p 304 Å89-27739

Investigation of internal singularity methods for nultielement airfoils p 294 A89-27748 multielement airfoils Preliminary test results of NDA cryogenic wind tunnel and its system

[SAE PAPER 881449] p 336 A89-28219

Emerging technology for transonic wind-tunnel-wall interference assessment and corrections [SAE PAPER 881454] p 336 A89-28220

An experimental investigation of multi-element airfoil ice accretion and resulting performance degradation

p 297 A89-28453 I AIAA 89-07521 Development of direct-inverse 3-D methods for applied transonic aerodynamic wing design and analysis

N89-16761 [NASA-CR-184788] p 300 Wind tunnel-sidewall-boundary-layer effects in transonic

airfoil testing-some correctable, but some not p 338 N89-16864 Measurement of airfoil heat transfer coefficients on a

p 351 N89-17311 turbine stage High temperature constitutive and crack initiation

modeling of coated single crystal superalloys p 342 N89-17334

Full-potential integral solutions for steady and unsteady transonic airfoils with and without embedded Euler p 301 N89-17566 domains

An experimental investigation of the perpendicular vortex-airfoil interaction at transonic speeds p 301 N89-17569

AIRFRAME MATERIALS

Recoverable test vehicle, an innovative approach to a low cost composite airframe for aerospace application

[AIAA PAPER 89-0378] p 311 A89-25320 Superplastic formed aluminum-lithium aircraft structure p 316 N89-17591

[AD-A200245] AIRFRAMES

CFD in design - An airframe perspective [AIAA PAPER 89-0092] p 31

p 310 A89-25081 Aircraft airframe cost estimating relationships: All mission types

- [AD-A2002621 p 269 N89-16719 Aircraft airframe cost estimating relationships: Fighters p 270 N89-16720 [AD-A200263] Aircraft airframe cost estimating relationships: Bombers
- nd transports p 270 N89-16721 (AD-A2002641

Aircraft airframe cost estimating relationships: Attack aircraft

- AD-A200265] p 270 N89-16722 Damage tolerance behavior of fiber reinforced [AD-A2002651 composite airframes p 316 N89-17278
- Superplastic formed aluminum-lithium aircraft structure [AD-A200245] p 316 N89-17591
- AIRLINE OPERATIONS

Severe weather - Impact on aviation and FAA programs in response [AIAA PAPER 89-0794] p 352 A89-25583

The effects of inclement weather on airline operations [AIAA PAPER 89-0797] p 304 A89-25585

Flight mission scenario generation with p 355 A89-27614 knowledge-based system Ways to solve current flight-safety problems p 305 A89-28294 AIRPORT SECURITY Aviation security: A system's perspective

[DE89-002020] p 306 N89-16766 AIRPORTS

- Airport accident-potential and safety areas [SAE PAPER 881388] p 336 p 336 A89-28193 AIRSPEED
- Derivation of primary air-data parameters for hypersonic fliaht
- [ESDU-88025] p 298 N89-16732 ALGORITHMS
- An efficient, explicit finite-rate algorithm to compute flows in chemical nonequilibrium
- p 285 A89-25418 [AIAA PAPER 89-0522] Navier-Stokes simulation of wind-tunnel flow using LU-ADI factorization algorithm p 291 A89-25864
- Advanced Fighter Technology Integration/Sandia Inertial Terrain-Aided Navigation (AFTI/SITAN) p 309 [DE89-004000] N89-17587
- ALTERNATING DIRECTION IMPLICIT METHODS A numerical method for unsteady transonic flow about
- pered wings p 291 A89-25929 ALUMINUM ALLOYS Aluminum quality breakthrough for aircraft structural
- reliability p 348 A89-27745 Superplastic formed aluminum-lithium aircraft structure
- p 316 N89-17591 [AD-A200245] Test specimens for bearing and by-pass stress

interaction in carbon fibre reinforced plastic laminates p 342 N89-17696 ANALOG SIMULATION

- Determination of the numerical integration step during the analog-digital modeling of dynamic systems p 354 A89-27405
- ANGLE OF ATTACK
- Lateral oscillations of sting-mounted models at high alpha [AIAA PAPER 89-0047] p 310 A89-25041
- Large-angle-of-attack viscous hypersonic flows over complex lifting configurations
- [AIAA PAPER 89-0269] p 279 A89-25227 Low speed wind tunnel investigation of the flow about delta wing, oscillating in pitch to very high angle of attack
- [AIAA PAPER 89-0295] p 281 A89-25252 Multiple solutions for aircraft sideslip behaviour at high angles of attack
- p 331 A89-25510 [AIAA PAPER 89-0645] Measurements of the oscillatory lateral derivatives of
- a high incidence research model (HIRM 1) at speeds up p 332 A89-26688 to M = 0.8The current status of the flight test of the ASKA
- [SAE PAPER 881433] p 314 A89-28208 LDV surveys over a fighter model at moderate to high
- angles of attack [SAE PAPER 881448]
- p 295 A89-28218 Intakes for high angle of attack ANISOTROPIC PLATES p 315 N89-16745
- Vibration and aeroelastic tailoring of advanced composite plate-like lifting surfaces p 351 N89-17263 ANNULAR NOZZLES
- Subcritical swirling flows in convergent, annular ozzles p 323 A89-27694 nozzies ANTENNA DESIGN
 - Some new ideas in radar antenna technology
 - p 347 A89-26542 GPS antennas for civil aviation p 308 A89-28296
 - GPS antenna problems for military aircraft p 309 A89-28297
 - An antenna for the GPS installation at DFVLR p 309 A89-28298
 - A GPS receiver antenna with integrated down-mixer p 309 A89-28299
 - Field enhancement of UHF-VHF aircraft antennas p 349 N89-17069 [AD-A200180]
- **ANTENNA RADIATION PATTERNS**

Some new ideas in radar antenna technology

p 347 A89-26542 EURONAV - A state of the art military GPS receiver p 340 A89-26711

- ARTIFICIAL INTELLIGENCE
- Applications of an Al design shell ENGINEOUS to dvanced engineering products p 355 A89-27618
- MLS, a machine learning system for engine fault p 355 A89-27623 diagnosis ASPECT RATIO
- The effects of aspect ratio on the stall of a finite wing [AIAA PAPER 89-0570] p 296 A89-28434 ASSEMBLIES
- Building aircraft assembly tools from a 3-D database [SAE PAPER 881428] p 269 A89-28204 p 269 A89-28204

ATMOSPHERIC CIRCULATION Numerical simulation of microburst downdrafts -Application to on-board and look ahead sensor

AVIATION METEOROLOGY

technology [AIAA PAPER 89-0821] p 353 A89-25599 ATMOSPHERIC ELECTRICITY

- National lightning detection A real-time service to erospace
- [AIAA PAPER 89-0787] p 352 A89-25578 Lightning initiation on aircraft in thunderstorms
- p 353 A89-26214 Lightning triggered by the presence of aerospace
- p 353 A89-26215 vehicles ATMOSPHERIC PRESSURE
- Derivation of primary air-data parameters for hypersonic
- fliaht [ESDU-88025] p 298 N89-16732
- ATMOSPHERIC TEMPERATURE Derivation of primary air-data parameters for hypersonic
- fliaht [ESDU-88025] p 298 N89-16732
- ATMOSPHERIC TURBULENCE
- Enroute convective turbulence deviation considerations on short segments
- [AIAA PAPER 89-0738] p 302 A89-25555 Enroute turbulence avoidance procedures
- [AIAA PAPER 89-0739] p 303 A89-25556 The effects of enroute turbulence reports on air carrier flight operations
- [AIAA PAPER 89-0741] p 303 A89-25557 Do pilots let aircraft operations schedules influence nroute turbulence avoidance procedures?
- [AIAA PAPER 89-0743] p 303 A89-25558
- Dynamic response of aircraft autopilot systems to p 333 A89-27737 atmospheric disturbances ATTACK AIRCRAFT
- Conceptual design of a STOVL fighter/attack aircraft SAE PAPER 881431] p 313 A89-28206 AUGMENTATION
- Field enhancement of UHF-VHF aircraft antennas

[SAE PAPER 881373]

[SAE PAPER 881449]

[NASA-TM-101078]

spheric disturbances

evidential

the next generation auxiliary power units

characterization of cloud droplet spectra

AUTOMATIC TEST EQUIPMENT

troubleshooting

[SAE PAPER 881498]

[SAE PAPER 881499]

[SAE PAPER 881500]

[SAE PAPER 881501]

AVIATION METEOROLOGY

[AIAA PAPER 89-0707]

[AIAA PAPER 89-0738]

[AIAA PAPER 89-0756]

[AIAA PAPER 89-0794]

[AIAA PAPER 89-0795]

[AIAA PAPER 89-0797]

on short segments

in response

perspective

AUTOMATIC PILOTS

surveillance

monitoring

aircraft

have

in aircraft

Applying

and its system

traffic

AD-A2001801 p 349 N89-17069 AUTOMATIC CONTROL Advanced flight control for the Fokker 100

Preliminary test results of NDA cryogenic wind tunnel

Design of automation tools for management of descent

Air traffic control automation concepts to optimize flight

management system utilization p 307 A89-26733 Causal probability model for transoceanic track

separations with applications to automatic dependent

Dynamic response of aircraft autopilot systems to

The development of an automated flight test management system for flight test planning and

Secondary power - Benefits of digital control and vehicle management system integration

Pneumatic link secondary power systems for military

Emergency power combined with auxiliary power unit

T-100 Multipurpose Small Power Unit - Technology for

Weather accident prevention using the tools that we

Enroute convective turbulence deviation considerations

Use of the median volume droplet diameter in the

Severe weather - Impact on aviation and FAA programs

Impact of severe weather on aviation - An NWS

The effects of inclement weather on airline operations

reasoning

p 333 A89-28185

p 336 A89-28219

p 306 N89-17584

p 307 A89-26733

p 308 A89-26735

p 333 A89-27737

p 312 A89-27613

p 355 A89-27629

p 325 A89-28264

p 325 A89-28265

p 325 A89-28266

p 349 A89-28267

p 302 A89-25547

p 302 A89-25555

p 352 A89-25562

p 352 A89-25583

p 304 A89-25584

p 304 A89-25585

A-5

avionics

to

AVIATION PSYCHOLOGY

[AIAA PAPER 89-0808]

- Cockpit display of hazardous weather information p 335 A89-25591 Weather data dissemination to aircraft
- p 304 A89-25592 [AIAA PAPER 89-0809] The effect of a ground-based inversion layer on an impacting microburst
- [AIAA PAPER 89-0810] p 352 A89-25593 Dynamic response of aircraft autopilot systems to p 333 A89-27737 atmospheric disturbances An overview of the current NASA program on aircraft
- icing research p 305 A89-28192 [SAE PAPER 881386] Impact of severe weather on aviation - A pilot
- viewnoint p 353 A89-28461 [AIAA 89-07981
- Cockpit display of ground-based weather data during thunderstorm research flights [AIAA 89-0806] p 269 A89-28463
- AVIATION PSYCHOLOGY
- Do pilots let aircraft operations schedules influence enroute turbulence avoidance procedures? p 303 A89-25558 AIAA PAPER 89-0743]
- AVIONICS evidential reasoning to avionics Applying p 355 A89-27629 troubleshooting
- Avionics display systems [SAE PAPER 881371] p 318 A89-28184
- An avionics diagnostics system for regional airlines and business aircraft applied in the Beech Starship 1 p 318 A89-28186 [SAE PAPER 881374]
- Aircraft automation with an electronic library system --high capacity data storage and high resolution display system for commercial avionics
- [SAE PAPER 881415] p 318 A89-28199 Topics of aircraft thermal management
- p 314 A89-28255 [SAE PAPER 881381] The all electric airplane revisited
- [SAE PAPER 881407] p 314 A89-28256 A highly reliable DC power source for avionic subsystems
- [SAE PAPER 881408] p 324 A89-28257 Overview on the evolution of aircraft battery systems used in Air Force aircraft
- p 324 A89-28260 [SAE PAPER 881411] X-29A subsystems integration - An example for future aircraft
- p 314 A89-28269 [SAE PAPER 881504] Impact of device level faults in a digital avionic
- processor p 356 N89-18046 [NASA-CR-184783]
- AXIAL COMPRESSION LOADS Local buckling and crippling of thin-walled composite structures under axial compression p 341 A89-27733
- AXIAL FLOW Axial velocity density ratio influence on exit flow angle
- in transonic/supersonic cascades AXIAL FLOW PUMPS p 329 N89-16830 A study of turbomachine flow velocities
- p 346 A89-25608 [AIAA PAPER 89-0839] AXIAL LOADS
- Accurate drag estimation using a single component drag p 337 N89-16856 model technique
- AXISYMMETRIC BODIES Effects of energy release on high-speed flows in an axisymmetric combustor
- p 283 A89-25326 [AIAA PAPER 89-0385] Effect of dynamic changes in body configuration on shock structure
- p 285 A89-25421 [AIAA PAPER 89-0526]

В

- B-1 AIRCRAFT
- p 319 N89-16788 B-1B CITS engine monitoring BACKWARD FACING STEPS
- Supersonic sudden-expansion flow with fluid injection -An experimental and computational study p 284 A89-25328 [AIAA PAPER 89-0389]
- BALANCE
- Balance accuracy and repeatability as a limiting parameter in aircraft development force measurements in conventional and cryogenic wind tunnels p 338 N89-16873
- BALLISTICS
- A self-adaptive computational method applied to transonic turbulent projectile aerodynamics p 290 A89-25606 [AIAA PAPER 89-0837]
- BALLOON FLIGHT Recent results in the NASA research balloon program p 269 A89-25199 [AIAA PAPER 89-0233]
- BEECHCRAFT AIRCRAFT An avionics diagnostics system for regional airlines and business aircraft applied in the Beech Starship 1
- p 318 A89-28186 [SAE PAPER 881374]
- A-6

- BENDING MOMENTS
- Mechanism of single shear fastened joints p 352 N89-17700
- BLADE TIPS Influence of clearance leakage on turbine heat transfer at and near blade tips - Summary of recent results p 344 A89-25275 [AIAA PAPER 89-0327]
- Tip aerodynamics and acoustics test: A report and data SURVAV
- [NASA-RP-1179] p 302 N89-17579 BLADE-VORTEX INTERACTION
- Measurement of transient vortex-surface interaction phenomena
- [AIAA PAPER 89-0833] p 289 A89-25603 An experimental investigation of the perpendicular vortex-airfoil interaction at transonic speeds p 301 N89-17569
- Helicopter tail rotor blade-vortex interaction noise p 356 N89-18167 [NASA-CR-183178]
- BLANKETS
- Developments in expulsive separation ice protection hlankote [AIAA PAPER 89-0774] p 311 A89-25572
- **BLOWDOWN WIND TUNNELS**
- Microtuft flow visualization at Mach 10 and 14 in the NSWC hypervelocity wind tunnel No. 9 [AIAA PAPER 89-0041] p p 334 A89-25035
- Infrared thermography in blowdown and intermittent hypersonic facilities
- p 334 A89-25036 [AIAA PAPER 89-0042] BLOWING
- An experimental investigation of delta wing vortex flow rith and without external jet blowing p 273 A89-25074
- [AIAA PAPER 89-0084] Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow
- p 282 A89-25288 [AIAA PAPER 89-0341] BLUNT BODIES
- Effect of nose bluntness on flow field over slender bodies in hypersonic flows
- [AIAA PAPER 89-0270] n 279 A89-25228 Effect of dynamic changes in body configuration on shock structure
- [AIAA PAPER 89-0526] p 285 A89-25421 An experimental investigation of the aerodynamic characteristics of slanted base ogive cylinders using magnetic suspension technology
- [NASA-CR-184624] p 300 N89-16758 BODY-WING AND TAIL CONFIGURATIONS
- The effects of aft-loaded airfoils on aircraft trim drag [AIAA PAPER 89-0836] p 312 A89-25605
- BODY-WING CONFIGURATIONS Computation of turbulent incompressible wing-body iunction flow
- [AIAA PAPER 89-0279] p 310 A89-25236
- A transonic computational method for an aft-mounted nacelle/pylon configuration with propeller power effect AIAA PAPER 89-05601 p 311 A89-25449
- Wing rock generated by forebody vortices p 312 A89-27735
- Expriments on the DFVLR-F4 wing body configuration p 337 in several European windtunnels N89-16848 BOEING AIRCRAFT
- Overview of optimal trajectories for flight in a windshear p 306 A89-28464 [AIAA 89-0812]
- BOEING 727 AIRCRAFT
- A summary of recent aircraft/ground vehicle friction measurement tests [SAE PAPER 881403] p 336 A89-28196
- BOEING 737 AIRCRAFT A summary of recent aircraft/ground vehicle friction
- measurement tests p 336 A89-28196 [SAE PAPER 881403]
- Flow measurement on the fuselage of a Boeing 737 airplane [AIAA PAPER 89-0209] p 295 A89-28404
- BOLTED JOINTS
- An analysis method for bolted joints in primary composite aircraft structure p 317 N89-17691 Bolted scarf joints in carbon composite materials. Comparison between assemblies with an interference fit p 343 N89-17702 and those with play BOLTS
- Mechanism of single shear fastened joints p 352 N89-17700 BOMBS
- IFM applications to cavity flowfield predictions p 285 A89-25390 [AIAA PAPER 89-0477]
- BORON FIBERS Design of an all boron/epoxy doubler reinforcement for
- the F-111C wing pivot fitting Structural aspects p 313 A89-27925

SUBJECT INDEX

- BOUNDARY LAYER CONTROL
- Wind tunnel wall boundary layer control by Coanda wall iets p 334 A89-25132 [AIAA PAPER 89-0149]
- Flow quality measurements for the Langley 8-foot transonic pressure tunnel LFC experiment p 276 A89-25133 [AIAA PAPER 89-0150]
- Moving surface boundary-layer control as applied to two-dimensional airfoils
- p 281 A89-25253 [AIAA PAPER 89-0296] p 330 N89-16836 Supersonic compressors
- BOUNDARY LAYER FLOW An interactive boundary-layer procedure for oscillating
- airfoils including transition effects [AIAA PAPER 89-0020] p 271 A89-25016
- Diverging boundary layers with zero streamwise pressure aradienť
- [AIAA PAPER 89-0134] p 343 A89-25118 Sidewall boundary-layer removal effects on wall adaptation in the Langley 0.3-meter transonic cryogenic tunnel
- [AIAA PAPER 89-0148] p 334 A89-25131 The design and use of a temperature-compensated hot-film anemometer system for boundary-layer flow transition detection on supersonic aircraft
- p 318 A89-27668 Euler flow solutions for transonic shock wave-boundary layer interaction yer interaction p 295 A89-28074 Wind tunnel-sidewall-boundary-layer effects in transonic
- airfoil testing-some correctable, but some not p 338 N89-16864
- BOUNDARY LAYER SEPARATION panels in
- Application of continuous vorticity panels three-dimensional lifting flows with partial separation p 275 A89-25104 [AIAA PAPER 89-0117] On the structure of two- and three-dimensional
- eenaration [AIAA PAPER 89-0287] p 280 A89-25244
- Mach number dependence of flow separation induced normal shock-wave/turbulent boundary-layer interaction at a curved wall
- p 282 A89-25298 [AIAA PAPER 89-0353] p 282 A89-25298 Vortex generator jets - A means for passive and active control of boundary layer separation
- p 287 A89-25453 [AIAA PAPER 89-0564] Boundary layer measurements on an airfoil at low Reynolds numbers in an accelerating flow from a nonzero base velocity
- [AIAA PAPER 89-0569] p 288 A89-25458 Unsteady separation wave in a supersonic boundary p 293 A89-26011 laver

Stability and transition of two-dimensional laminar

Evolution of perturbations near a surface in supersonic

Stability and transition of two-dimensional laminar

Boundary layer measurements on an airfoil at low

boundary layers in compressible flow over an adiabatic

Reynolds numbers in an accelerating flow from a nonzero

[AIAA PAPER 89-0569] p 288 A89-25458 Feasibility study on the design of a laminar flow

Boundary layer transition and turbulence modelling in

NASA SC(2)-0714 airfoil data corrected for sidewall

DFVLR-F5 test wing configuration - The boundary value

Numerical analysis of flow through oscillating cascade

The measurement of temperature from an aircraft in

Miniature PCM compatible wideband spectral analyzer

boundary-layer effects in the Langley 0.3-meter transonic

Ball-on-cylinder testing for aviation fuel lubricity

Wing rock generated by forebody vortices

p 270 A89-24922

layer on a SST

p 272 A89-25031

p 294 A89-27384

p 270 A89-24922

p 311 A89-25506

p 346 A89-25860

p 312 A89-27735

p 301 N89-17568

p 341 A89-28244

p 290 A89-25858

p 296 A89-28413

p 353 N89-17978

p 318 A89-27664

boundary layers in compressible flow over an adiabatic

BOUNDARY LAYER STABILITY

[AIAA PAPER 89-0036]

[AIAA PAPER 89-0640]

three-dimensional flow

BOUNDARY LAYERS

cryogenic tunnel

[NASA-TP-2890]

problem

sections

cloud

BROADBAND

BOUNDARY LUBRICATION

[SAE PAPER 881537]

[AIAA PAPER 89-0437]

BRIGHTNESS TEMPERATURE

for hypersonic flight research

BOUNDARY VALUE PROBLEMS

BOUNDARY LAYER TRANSITION

Stability of 3D wing boundary

wali

flow

wall

configuration

base velocity

nacelle

SUBJECT INDEX

BUCKLING

Local buckling and crippling of thin-walled composite structures under axial compression p 341 A89-27733 The design, construction and test of a postbuckled, carbon fibre reinforced plastic wing box p 315 N89-16773

BUFFETING

Some difficulties in the wind tunnel prediction of modern civil aircraft buffeting: Proposed remedies

- p 301 N89-16869 BURNING RATE Flowfield modifications of combustion rates in unstable
- ramjets [AIAA PAPER 89-0105]
- p 322 A89-25092 **BUS CONDUCTORS**
- Parallel operation of VSCF electrical power generators p 324 A89-28259 [SAE PAPER 881410]

С

C-135 AIRCRAFT

- An experimental study and prediction of a two-phase pressure drop in microgravity p 343
- [AIAA PAPER 89-0074] A89-25065 aircraft furnace High-temperature containerless experimentation in the microgravity environment aboard a KC-135 aircraft
- p 345 A89-25337 [AIAA PAPER 89-0402] C-160 AIRCRAFT
- Study of the aerodynamic situation along the C 160 aircraft in parachuting configuration p 299 N89-16756
- [DAT-88-06]
- CALIBRATING The measurement of temperature from an aircraft in p 353 N89-17978 cloud
- CAMBERED WINGS
- Evaluation of leading- and trailing-edge flaps on flat and
- cambered delta wings at supersonic speeds [AIAA PAPER 89-0027] p 272 A89-25023 Boundaries of linear characteristics of cambered and isted wings at subcritical Mach numbers
- p 298 N89-16735 [ESDU-880301 CANARD CONFIGURATIONS
- Tip vortex/airfoil interaction for a canard//wing configuration at low Reynolds numbers
- [AIAA PAPER 89-0536] p 286 A89-25430 Low speed aerodynamics of canard configurations
- p 294 A89-26689 Design synthesis for canard-delta combat aircraft. olumes 1 and 2 p 316 N89-17590 CANTILEVER MEMBERS
- Aeroelastic flutter of low aspect ratio cantilever
- p 347 A89-26281 omposite plate CAPTURE EFFECT Full-potential integral solutions for steady and unsteady
- transonic airfoils with and without embedded Euler p 301 N89-17566 domains
- CARBON FIBER REINFORCED PLASTICS Vibration and flutter analysis of composite wing panels p 346 A89-26273
- The design, construction and test of a postbuckled, carbon fibre reinforced plastic wing box
- p 315 N89-16773 Typical joints in a wing structure p 317 N89-17693 Test specimens for bearing and by-pass stress
- interaction in carbon fibre reinforced plastic laminates p 342 N89-17696
- Mechanism of single shear fastened joints
- p 352 N89-17700 Joining of carbon fiber composite with fasteners
- p 343 N89-17701 CARBON-CARBON COMPOSITES
- Bolted scarf joints in carbon composite materials. Comparison between assemblies with an interference fit and those with play p 343 N89-17702
- CASCADE CONTROL
- Experimental cascaded doubly fed variable speed constant frequency generator system [SAE PAPER 881409]
- p 324 A89-28258 CASCADE FLOW
- Relation between diffusor losses and the inlet flow conditions of turbojet combustors p 322 A89-24916 Prediction of 3D multi-stage turbine flow field using a multiple-arid Euler solver
- [AIAA PAPER 89-0203] p 277 A89-25178 Adaptive grid embedding Navier-Stokes technique for cascade flows
- [AIAA PAPER 89-0204] p 277 A89-25179 A simple time-accurate turbomachinery algorithm with numerical solutions of an uneven blade count
- configuration p 344 A89-25181 [AIAA PAPER 89-0206] Evaluation of an OH grid formulation for viscous cascade
- [AIAA PAPER 89-0207] p 277 A89-25182

Passage-averaged Navier-Stokes equations with finite application

- p 344 A89-25183 Oscillating aerodynamics and flutter of an erodynamically detuned cascade in an incompressible flow [AIAA PAPER 89-0289] p 280 A89-25246 Computations of 3D viscous flows in rotating turbomachinery blades
- [AIAA PAPER 89-0323] p 281 A89-25273 Experimental investigation of transonic oscillating cascade aerodynamics
- [AIAA PAPER 89-0321] p 293 A89-26369 Unsteady Euler cascade analysis
- [AIAA PAPER 89-0322] p 295 A89-28406 Numerical analysis of flow through oscillating cascade sections
- [AIAA PAPER 89-0437] p 296 A89-28413 --- conference
- Transonic Compressors, volume 1 [VKI-LS-1988-03-VOL-1] p 328 N89-16825 Loss development in transonic compressor cascades p 328 N89-16826
- Incidence angle rules in supersonic cascades p 328 N89-16827 Exit angle rules in supersonic cascades
- p 329 N89-16828
- Shock losses in transonic and supersonic compressor p 329 N89-16829 cascades Axial velocity density ratio influence on exit flow angle
- in transonic/supersonic cascades p 329 N89-16830 Inverse methods for blade design, controlled diffusion
- blading for supercritical compressor flow p 329 N89-16832
- CATHODE RAY TUBES

(AIAA PAPER 89-02081

- Avionics display systems [SAE PAPER 881371] p 318 A89-28184 CAUCHY PROBLEM
- Accuracy of various wall-correction methods for 3D p 338 N89-16863 subsonic wind-tunnel testing
- **CENTRAL PROCESSING UNITS** Impact of device level faults in a digital avionic processor
- [NASA-CR-184783] p 356 N89-18046
- CERAMICS Engineering ceramics - Applications and testing aquirements p 347 A89-27632 requirements
- Thermal barrier coating life prediction model p 351 N89-17333 development CERTIFICATION
- Electro-impulse de-icing systems Issues and concerns for certification [AIAA 89-0761] p 314 A89-28456
- CHAOS
- Low Reynolds number numerical solutions of chaotic flow
- p 275 A89-25108 [AIAA PAPER 89-0123] CHEMICAL ENERGY
- Effects of energy release on high-speed flows in an axisymmetric combustor [AIAA PAPER 89-0385]
- p 283 A89-25326 CHEMICAL EQUILIBRIUM
- NNEPEQ Chemical equilibrium version of the Navy/NASA Engine Program [ASME PAPER 88-GT-314] p 322 A89-24989
- Experimental verification of the thermodynamic properties for a jet-A fuel
- p 342 N89-17017 [NASA-TM-101475] CHEMICAL REACTIONS Efficient finite-volume parabolized Navier-Stokes
- solutions for three-dimensional, hypersonic, chemically reacting flowfields
- [AIAA PAPER 89-0103] p 274 A89-25090 A set of strongly coupled, upwind algorithms for
- computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 27 p 277 A89-25174 CIRCUIT RELIABILITY
- Overview on the evolution of aircraft battery systems used in Air Force aircraft
- [SAE PAPER 881411] p 324 A89-28260 CIRCULAR CYLINDERS
- Measurement of transient vortex-surface interaction nhenomena [AIAA PAPER 89-0833]
- p 289 A89-25603 **CIRCULATION CONTROL AIRFOILS** Extended pitch axis effects on flow about a pitching
- airfoil [AIAA PAPER 89-0025] p 272 A89-25021
- CIVIL AVIATION
- The intelligent wing Aerodynamic developments for future transport aircraft **TAIAA PAPER 89-05341** p 269 A89-25428
- The integration of European flight-safety systems p 308 A89-28292
- LIRAS A proposal for an airport traffic safety system p 308 A89-28293

COMBUSTION CHAMBERS

- Ways to solve current flight-safety problems p 305 A89-28294
- GPS antennas for civil aviation p 308 A89-28296 MPC-75 feeder civil aircraft p 317 N89-17594 (AD-A200907) CLASSICAL MECHANICS Composite mechanics for engine structures
- p 341 A89-28344 CLOUD PHYSICS
 - Use of the median volume droplet diameter in the characterization of cloud droplet spectra p 352 A89-25562 [AIAA PAPER 89-0756]
- CLOUDS (METEOROLOGY) An overview of the current NASA program on aircraft
- icing research [SAE PAPER 881386] p 305 A89-28192
- COALESCING
- Development of a laboratory method for studying water coalescence of aviation fuel
- p 341 A89-28243 [SAE PAPER 881534] COANDA FEFECT
- Wind tunnel wall boundary layer control by Coanda wall jets
- p 334 A89-25132 AIAA PAPER 89-01491 COCKPITS
- Cockpit display of hazardous weather information [AIAA PAPER 89-0808] p 335 A89-25591
- Use of color displays in the A320 cockpit [SAE PAPER 881416] p 319 A89-28200
- Mechanization, design and methodological lessons learned from a dynamic cockpit mock-up evaluation
- [SAE PAPER 881438] p 319 A89-28213 Computer-generated map display for the pilot/vehicle interface
- [SAE PAPER 881440] p 319 A89-28214 Reconfigurable cockpit development [SAE PAPER 881472]

thunderstorm research flights

[AIAA 89-0806]

COLD GAS

COLOR

ramiets

monitoring system

heat-flux distributions

COLLISION AVOIDANCE

[SAE PAPER 881416]

[AIAA PAPER 89-0105]

axisymmetric combustor

[AIAA PAPER 89-0385]

[AIAA PAPER 89-0461]

[AIAA PAPER 89-0672]

several turbulence models

COMBUSTION CHAMBERS

[AIAA PAPER 89-0219]

axisymmetric combustor

[AIAA PAPER 89-0385]

[AIAA PAPER 89-0493]

[AIAA PAPER 89-0622]

[AIAA PAPER 89-0623]

flow

engines

[AD-A199768]

COMBUSTION

using continuum approach

COMBUSTIBLE FLOW

Cockpit display of ground-based weather data during

COMPASS (Trademark): A generalized ground-based

Influence of vane/blade spacing and injection on stage

LIRAS - A proposal for an airport traffic safety system

Flowfield modifications of combustion rates in unstable

Effects of energy release on high-speed flows in an

Nonequilibrium effects for hypersonic transitional flows

Scramjet analysis with chemical reaction using three-dimensional approximate factorization

Combustor air flow prediction capability comparing

Turbine Engine Hot Section Technology, 1987 [NASA-CP-2493] p 351 N89-17298

3-D combustor performance validation with high density

Turbulent mixing in supersonic combustion systems [AIAA PAPER 89-0260] p 323 A89-25218

Experimental and analytical study on exit radial temperature profile of experimental 2D combustor

Combined tangential-normal injection into a supersonic

Low frequency pressure oscillations in a model ramjet

Acoustic-vortex interactions and low-frequency

Measurements of gas turbine combustor and engine

oscillations in axisymmetric combustors --- of ramiet

combustor - The nature of frequency selection

augmentor tube sooting characteristics

Effects of energy release on high-speed flows in an

Modular analysis of scramjet flowfields

Use of color displays in the A320 cockpit

p 319 A89-28224

p 269 A89-28463

p 321 N89-16819

p 325 A89-28342

p 308 A89-28293

p 319 A89-28200

p 322 A89-25092

p 283 A89-25326

p 284 A89-25377

p 323 A89-25533

p 325 A89-28337

p 349 A89-28345

p 340 A89-25193

p 323 A89-25218

p 283 A89-25326

p 340 A89-25403

p 288 A89-25492

p 323 A89-25493

p 325 A89-28336

p 328 N89-16821

A-7

COMBUSTION EFFICIENCY

p 351 N89-17329 Test and analysis COMBUSTION EFFICIENCY

Correlations of high density fuel effects

p 340 A89-25190 [AIAA PAPER 89-0216] 3-D combustor performance validation with high density fuels

[AIAA PAPER 89-0219] p 340 A89-25193 An investigation of the physical and chemical factors affecting the perfomance of fuels in the JFTOT --- Jet Fuel Thermal Oxidation Tester

[SAE PAPER 881533] p 341 A89-28242 COMBUSTION PHYSICS

Evidence of a strange attractor in ramjet combustion p 323 A89-25494 [AIAA PAPER 89-0624] COMBUSTION STABILITY

Flowfield modifications of combustion rates in unstable ramjets

[AIAA PAPER 89-0105] p 322 A89-25092 Acoustic-vortex interactions and low-frequency oscillations in axisymmetric combustors --- of ramjet p 325 A89-28336 enaines COMMERCIAL AIRCRAFT

CFD in design - An airframe perspective [AIAA PAPER 89-0092] p 31 p 310 A89-25081 The intelligent wing - Aerodynamic developments for future transport aircraft

p 269 A89-25428 [AIAA PAPER 89-0534] Enroute convective turbulence deviation considerations on short segments

[AIAA PAPER 89-0738] p 302 A89-25555 Problems of ensuring civil-aircraft fire safety

p 304 A89-27249 Integrating causal reasoning at different levels of abstraction --- in problem-solving system functioning as pilot assistant in commercial air transport emergencies p 355 A89-27609

The emergence of satellite communication for commercial aircraft

p 308 A89-28183 [SAE PAPER 881370] An avionics diagnostics system for regional airlines and business aircraft applied in the Beech Starship 1 [SAE PAPER 881374] p 318 A89-28186 Aircraft automation with an electronic library system --high capacity data storage and high resolution display

system for commercial avionics [SAE PAPER 881415] p 318 A89-28199

COMPATIBILITY Inlet-engine compatibility COMPENSATORS p 314 N89-16741

Evaluation of a Kalman filter for SAR motion p 347 A89-26721 compensation

COMPONENT RELIABILITY

High reliability aircraft generator system p 325 A89-28263 [SAE PAPER 881414] Relationships of nondestructive evaluation needs and p 349 N89-17256 mponent desig

COMPOSITE MATERIALS

Properties of aircraft tire materials p 313 A89-28177 [SAE PAPER 881358] Composite mechanics for engine structures

p 341 A89-28344 Nonlinear dynamic responses of composite rotor blades

[AD-A200145] p 315 N89-16774 COMPOSITE STRUCTURES

Recoverable test vehicle, an innovative approach to a low cost composite airframe for aerospace application [AIAA PAPER 89-0378] p 311 A89-25320 Vibration and flutter analysis of composite wing panels p 346 A89-26273

Aeroelastic flutter of low aspect ratio cantilever proposite plate p 347 A89-26281 p 347 composite plate Finite element analysis of composite rudder for DO 228

aircraft p 347 A89-26284 Local buckling and crippling of thin-walled composite structures under axial compression p 341 A89-27733

Composite mechanics for engine structures p 341 A89-28344

Nonlinear dynamic responses of composite rotor hlades p 315 N89-16774

[AD-A200145] An analysis method for bolted joints in primary composite p 317 N89-17691 aircraft structure

Joining of carbon fiber composite with fasteners p 343 N89-17701

COMPRESSIBILITY Compressible studies on dynamic stall

p 271 A89-25020 [AIAA PAPER 89-0024] COMPRESSIBLE BOUNDARY LAYER

Three-dimensional compressible boundary laver calculations to fourth order accuracy on wings and

fuselages [AIAA PAPER 89-0130] n 275 A89-25115

A-8

Modification of compressible turbulent boundary layer structures by streamlined devices p 277 A89-25186

[AIAA PAPER 89-0212] The compressible mixing layer - Linear theory and direct simulation

p 283 A89-25314

AIAA PAPER 89-03711

An integral method for calculating turbulent boundary p 292 A89-25942 laver flow on practical wings COMPRESSIBLE FLOW

Stability and transition of two-dimensional laminar boundary layers in compressible flow over an adiabatic p 270 A89-24922 wall

A state-space model of unsteady aerodynamics in a compressible flow for flutter analyses

[AIAA PAPER 89-0022] p 271 A89-25018 Unsteady Navier-Stokes computations past oscillating delta wing at high incidence p 273 A89-25071

[AIAA PAPER 89-0081] Structure of the compressible turbulent shear layer p 275 A89-25111 [AIAA PAPER 89-0126]

An adaptive implicit/explicit finite element scheme for compressible viscous high speed flow p 344 A89-25307 [AIAA PAPER 89-0363]

The effects of walls on a compressible mixing layer p 283 A89-25315 [AIAA PAPER 89-0372] A multigrid and upwind viscous flow solver on 3-D

embedded and overlapped grids p 285 A89-25379 [AIAA PAPER 89-0464]

Design and development of a compressible dynamic stall facility [AIAA PAPER 89-0647] p 335 A89-25511

Progress on a Taylor weak statement finite element algorithm for high-speed aerodynamic flows p 289 A89-25517 [AIAA PAPER 89-0654]

Simple turbulence models for supersonic and hypersonic flows - Bodies at incidence and compression corners p 289 A89-25530 [AIAA PAPER 89-0669]

Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987 p 290 A89-25856 COMPRESSOR BLADES

The effects of a compressor rebuild on gas turbine

p 327 N89-16803 engine performance COMPRESSOR BOTORS

p 330 N89-16839 Axial supersonic inlet compound Design methodology for advanced High Pressure (HP) COMPUTATIONAL FLUID DYNAMICS Fast laminer nost

Fast laminar near wake flow calculation by an implicit

method solving the Navier-Stokes equations p 270 A89-24923 Adaptive computations of multispecies mixing between

scramjet nozzle flows and hypersonic freestream [AIAA PAPER 89-0009] p 322 A89-25005

Compressible studies on dynamic stall p 271 A89-25020 [AIAA PAPER 89-0024]

Prediction of supersonic/hypersonic viscous flows over RVs and decovs

[AIAA PAPER 89-0028] p 272 A89-25024 Heat transfer and pressure comparisons between computation and wind tunnel for a research hypersonic aircraft

p 272 A89-25025 [AIAA PAPER 89-0029] CFD simulation of square cross-section, contoured nozzle flows - Comparison with data

p 273 A89-25039 [AIAA PAPER 89-0045] CFD in design - An airframe perspective

p 310 A89-25081 [AIAA PAPER 89-0092] CFD applications - Propulsion perspective

p 343 A89-25082 [AIAA PAPER 89-0093] Convergence acceleration through the use of time for inviscid flow computation inclining -

[AIAA PAPER 89-00961 p 274 A89-25085 An interactive three-dimensional boundary-layer method for transonic flow over swept wings

n 274 A89-25099 (AIAA PAPER 89-01121 Unsteady Euler airfoil solutions using unstructured dynamic meshes

p 275 A89-25102 (ÁIAA PAPER 89-0115) Low Reynolds number numerical solutions of chaotic

flow p 275 A89-25108 [AIAA PAPER 89-0123] Computational studies of a localized supersonic shear

p 275 A89-25110 boundary layer AIAA PAPER 89-0125] Three-dimensional compressible calculations to fourth order accuracy on wings and

fuselages [AIAA PAPER 89-0130] p 275 A89-25115 Adaptive grid embedding Navier-Stokes technique for cascade flows

[AIAA PAPER 89-0204] p 277 A89-25179

A simple time-accurate turbomachinery algorithm with numerical solutions of an uneven blade configuration [AIAA PAPER 89-02061 p 344 A89-25181 Passage-averaged Navier-Stokes equations with finite element applications p 344 A89-25183 [AIAA PAPER 89-0208] TranAir and Euler computations of a generic fighter including comparisons with experimental data full-potential equations for transonic flow p 310 A89-25221 [AIAA PAPER 89-0263] Analysis of three-dimensional aerospace configurations using the Euler equations p 279 A89-25226 [AIAA PAPER 89-0268] An implicit flux-vector splitting s computation of viscous hypersonic flow scheme for the p 279 A89-25231 [AIAA PAPER 89-0274] Viscous swirling nozzle flow [AIAA PAPER 89-0280] p 279 A89-25237 Vortical flows past normal plate and spoiler of time dependent height p 280 A89-25248 [AIAA PAPER 89-0291] Computations of 3D viscous flows in rotating turbomachinery blades [AIAA PAPER 89-0323] p 281 A89-25273 An adaptive implicit/explicit finite element scheme for compressible viscous high speed flow p 344 A89-25307 [AIAA PAPER 89-0363] The compressible mixing layer - Linear theory and direct simulation p 283 A89-25314 nozzle/afterbody experiment [AIAA PAPER en accession] p 283 A89-25314 Modifications to transonic flow codes for unsteady perturbations around an experimental mean [AIAA PAPER 89-0447] p 284 A89-25365 A numerical study of the contrarotating vortex pair associated with a jet in a crossflow p 284 A89-25366 [AIAA PAPER 89-0448] Numerical study of single impinging jets through a crossflow [AIAA PAPER 89-0449] p 284 A89-25367 A multigrid and upwind viscous flow solver on 3-D embedded and overlapped grids [AIAA PAPER 89-0464] p 285 A89-25379 A cell-vertex multigrid Euler scheme for use with multiblock grids p 285 A89-25387 [AIAA PAPER 89-0472] The influence of freestream vorticity on particle lift, drag, and heat transfer p 345 A89-25445 [AIAA PAPER 89-0555] Comparison of two different Navier-Stokes methods for the simulation of 3-D transonic flows with separation A89-25448 [AIAA PAPER 89-0559] p 287 A transonic computational method for an aft-mounted nacelle/pylon configuration with propeller power effect [AIAA PAPER 89-0560] p 311 A89-25449 Shock capturing using a pressure-correction method [AIAA PAPER 89-0561] p 345 A89-25450 Integral equation solution of the full potential equation or transonic flows [AIAA PAPER 89-0563] n 287 A89-25452 Modeling of subsonic flow through a compact offset inlet [AIAA PAPER 89-0639] p 288 A89-25505 Progress on a Taylor weak statement finite element algorithm for high-speed aerodynamic flows [AIAA PAPER 89-0654] p 289 p 289 A89-25517 On the solution of nonequilibrium hypersonic inviscid steady flows [AIAA PAPER 89-0671] p 289 A89-25532 Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, p 290 A89-25856 Sept. 30-Oct. 2, 1987 DFVLR-F5 test wing experiment for computational p 290 A89-25857 aerodynamics A numerical method for unsteady transonic flow about tapered wings p 291 A89-25929 Applications of an efficient algorithm to transonic conservative full-potential flow past 3-D wings p 291 A89-25930 Computation for supersonic and turbulent separated flow p 292 A89-25931

over a compression corner

layer flow on practical wings

configurations

A prediction of the stalling of the multielement airfoils

Applications of AF3 efficient iteration scheme to

A numerical-method for calculating the low-speed

An integral method for calculating turbulent boundary

transonic nonconservative full-potential flow past airfoils

aerodynamic characteristics of the

p 292 A89-25932

p 292 A89-25941

p 292 A89-25942

A89-25940

strake-wing

p 292

SUBJECT INDEX

SUBJECT INDEX

Derivation of an integral equation for large disturbing transonic flow and its numerical method of undercritical p 293 A89-25944 An effective modeling method of unsteady aerodynamics for state-space aeroelastic models p 293 A89-25946 Turbulence modeling in separated flow behind strong p 294 A89-27746 shocks Euler flow solutions for transonic shock wave-boundary p 295 A89-28074 layer interaction Modular analysis of scramjet flowfields p 325 A89-28337 Combustor air flow prediction capability comparing p 349 A89-28345 several turbulence models Unsteady Euler cascade analysis [AIAA PAPER 89-0322] p 295 A89-28406 Numerical analysis of flow through oscillating cascade sections [AIAA PAPER 89-0437] p 296 A89-28413 Aerodynamic performance of wings of arbitrary planform in inviscid, incompressible, irrotational flow p 297 N89-16728 [AD-A200436] Intake Aerodynamics, volume 2 --- conference [VKI-LS-1988-04-VOL-2] p 299 N89-16748 CFD application to subsonic inlet airframe integration - computational fluid dynamics (CFD) p 299 N89-16753 CFD application to supersonic/hypersonic inlet airframe integration --- computational fluid dynamics (CFD) p 299 N89-16754 Transonic Compressors, volume 1 --- conference [VKI-LS-1988-03-VOL-1] p 328 N89-16825 Incidence angle rules in supersonic cascades p 328 N89-16827 Exit angle rules in supersonic cascades p 329 N89-16828 Analysis of 3D viscous flows in transonic compressors p 329 N89-16831 Transonic Compessors, volume 2 --- conference [VKI-LS-1988-03-VOL-2] p 329 N89-16833 The design and development of transonic multistage page N89-16834 compressors Supersonic compressors p 330 N89-16836 Design methodology for advanced High Pressure (HP) compressor first stage p 330 N89-16840 p 330 N89-16840 The accurate measurement of drag in the 8 ft x 8 ft p 337 N89-16855 tunnel A numerical simulation of flows about two-dimensional bodies of parachute-like configuration [ISAS-629] p 302 N89-17580 COMPUTATIONAL GRIDS Supersonic inlet calculations using an upwind finite-volume method on adaptive unstructured grids [AIAA PAPER 89-0113] p 274 A89-25100 Unsteady Euler airfoil solutions using unstructured dynamic meshes [AIAA PAPER 89-0115] p 275 A89-25102 An acceleration method for solving the Euler equations on an unstructured mesh by applying multigrid on an auxiliary structured mesh [AIAA PAPER 89-0116] AIAA PAPER 89-0116] p 275 A89-25103 A patched-grid algorithm for complex configurations directed towards the F-18 aircraft p 310 A89-25106 [AIAA PAPER 89-0121] Low Reynolds number numerical solutions of chaotic fios [AIAA PAPER 89-0123] p 275 A89-25108 Numerical simulation of vortex unsteadiness on slender bodies of revolution at large incidence [AIAA PAPER 89-0195] p 276 A89-25170 Adaptive grid embedding Navier-Stokes technique for cascade flows [AIAA PAPER 89-0204] p 277 A89-25179 Evaluation of an OH grid formulation for viscous cascade flows p 277 A89-25182 [AIAA PAPER 89-0207] Efficient application techniques of the EAGLE grid code to complex missile configurations [AIAA PAPER 89-0361] AIAA PAPER 89-0361] p 353 A89-25305 Numerical solutions on a Pathfinder and other configurations using unstructured grids and a finite element solver

[AIAA PAPER 89-0362] p 282 A89-25306 Application of direct solvers to unstructured meshes for the Euler and Navier-Stokes equations using upwind schemes

[AIAA PAPER 89-0364] p 283 A89-25308 Adaptive H-refinement on 3-D unstructured grids for transient problems

[AIAA PAPER 89-0365] p 283 A89-25309 The design and application of upwind schemes on unstructured meshes

[AIAA PAPER 89-0366] p 354 A89-25310 Conflicting stepsize requirements for stable PNS computations

[AIAA PAPER 89-0445] p 284 A89-25363 A multigrid and upwind viscous flow solver on 3-D

embedded and overlapped grids p 285 A89-25379 [AIAA PAPER 89-0464] Viscous-inviscid interaction and local grid refinement via truncation error injection [AIAA PAPER 89-0468] p 285 A89-25383 Two-dimensional Euler computations on a triangular mesh using an upwind, finite-volume scheme [AIAA PAPER 89-0470] p 354 A89-25385 An investigation of cell centered and cell vertex multigrid chemes for the Navier-Stokes equations p 345 A89-25440 [AIAA PAPER 89-0548] A three-dimensional upwind finite element point implicit unstructured grid Euler solver [AIAA PAPER 89-0658] p 289 A89-25521 Navier-Stokes simulation of transonic wing flow fields using a zonal grid approach p 290 A89-25862 Diagonal implicit multigrid calculation of inlet flowfields p 294 A89-27716 Transonic store separation using a three-dimensional chimera grid scheme AIAA PAPER 89-0637 p 296 A89-28442 COMPUTER AIDED DESIGN Efficient application techniques of the EAGLE grid code to complex missile configurations [AIAA PAPER 89-0361] p 353 A89-25305 Computational design aspects of a NASP ozzle/afterbody experiment p 284 A89-25364 [AIAA PAPER 89-0446] A model of pressure distributions on impeller blades for determining performance characteristics [AIAA PAPER 89-0840] p AIAA PAPER 89-0840] p 346 A89-25609 Applications of an AI design shell ENGINEOUS to p 355 A89-27618 advanced engineering products Analytical wing weight prediction/estimation using computer based design techniques p 316 N89-17589 Design synthesis for canard-delta combat aircraft, volumes 1 and 2 p 316 N89-17590 COMPUTER AIDED MANUFACTURING Building aircraft assembly tools from a 3-D database [SAE PAPER 881428] p 269 A89-28204 COMPUTER AIDED MAPPING Computer-generated map display for the pilot/vehicle interface [SAE PAPER 881440] p 319 A89-28214 COMPUTER GRAPHICS Streamlines and streamribbons in aerodynamics [AIAA PAPER 89-0140] p 276 A89-25123 Photo-based three dimensional graphics models for multi-sensor simulation --- terrain data bases for flight p 348 A89-27787 simulator COMPUTER PROGRAMS NNEPEQ - Chemical equilibrium version of the Navy/NASA Engine Program [ASME PAPER 88-GT-314] p 322 A89-24989 Evaluation of three turbulence models for the prediction of steady and unsteady airloads [AIAA PAPER 89-0609] p 288 A89-25485 Development of direct-inverse 3-D methods for applied transonic aerodynamic wing design and analysis [NASA-CR-184788] p 300 N89-16761 Accuracy of various wall-correction methods for 3D ubsonic wind-tunnel testing p 338 N89-16863 An evaluation of automating Carrier Air Traffic Control subsonic wind-tunnel testing Center (CATCC) status boards utilizing voice recognition input [AD-A200626] p 309 N89-17588 Design synthesis for canard-delta combat aircraft, volumes 1 and 2 COMPUTERIZED SIMULATION p 316 N89-17590 Numerical and experimental study of the crash behavior of helicopters and fixed-wing aircraft p 309 A89-24919 CFD simulation of square cross-section, contoured nozzle flows - Comparison with data [AIAA PAPER 89-0045] p 273 A89-25039 Numerical simulation of hypersonic flow around a space plane at high angles of attack using implicit TVD Navier-Stokes code [AIAA PAPER 89-0273] p 279 A89-25230 Numerical simulation of vortical flows on flexible wings [AIAA PAPER 89-0537] p 286 A89-25431 Comparison of two different Navier-Stokes methods for the simulation of 3-D transonic flows with separation [AIAA PAPER 89-0559] p 287 A89-25448 Computational design of low aspect ratio wing-winglets for transonic wind-tunnel testing [AIAA PAPER 89-0644] p 311 A89-25509 Infrared technique to measure the skin temperature on an electrothermal de-icer - Comparison with numerical simulations [AIAA PAPER 89-0760] p 303 A89-25566 Elevator deflection effects on the icing process AIAA PAPER 89-0846] p 290 A89-25615 [AIAA PAPER 89-0846] Aircraft vertical profile implementation using directed-graph methods p 332 A89-25683

CONVECTIVE HEAT TRANSFER

Navier-Stokes calculations for DFV tunnel using Runge-Kutta time-steppi	LR F5-1 ng sche	wing in wind
Finite element simulation of 3D to	urbulent	free shear
A dynamic model for vapor-cycle	p 294 cooling	systems
[SAE PAPER 881001]	p 313	A89-27809
[AIAA PAPER 89-0642]	p 296	A89-28444
Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1985	accide	nt Gander,
[AIAA PAPER 89-0706] Analysis of 3D viscous flows in trar	p 305 Isonic c	A89-28448 ompressors
Wind tunnel predicted air vehicle pe	p 329 rforman	N89-16831 ce: A review
of lessons learned The vertical motion simulator	p 337 p 339	N89-16852 N89-18384
CONFERENCES Numerical simulation of the transo	nic DEV	LR-F5 wind
experiment; Proceedings of the Inte on Numerical Simulation of Compre-	rnationa ssible V	Workshop
Aerodynamics, Goettingen, Federal Re Sept. 30-Oct. 2, 1987	epublic p 290	of Germany, A89-25856
PLANS '88 - IEEE Position Locat Symposium, Orlando, FL, Nov. 29-De	ion and c. 2, 19	Navigation
International Instrumentation S	p 339	A89-26701
Albuquerque, NM, May 2-6, 1988, Pro	ceeding	IS ARG 27651
Aerospace power systems technologi	p 340 av: Pro	ceedings of
the Aerospace Technology Conferen Anaheim, CA, Oct. 3-6, 1988	ce and	Exposition,
Intake Aerodynamics, volume 1 I	p 324 conferei	A89-28254 100
[VKI-LS-1988-04-VOL-1] Intake Aerodynamics, volume 2 (p 298 conferei	N89-16738 hce
[VKI-LS-1988-04-VOL-2] Transonic Compressors, volume 1 -	p 299 confe	N89-16748 Frence
[VKI-LS-1988-03-VOL-1] Transonic Compessors, volume 2	p 328 - confei	N89-16825 ence
[VKI-LS-1988-03-VOL-2] Turbine Engine Hot Section Technol	p 329 logy, 19	N89-16833
[NASA-CP-2493] CONFORMAL MAPPING	p 351	N89-17298
Prediction of 3D multi-stage turbing	e flow f	ield using a
[AIAA PAPER 89-0203] CONTAINERLESS MELTS	p 277	A89-25178
High-temperature containerless experimentation in the microgravity e a KC-135 aircraft	aircraf	t furnace tent aboard
[AIAA PAPER 89-0402] CONTAMINATION	p 345	A89-25337
A solution to water vapor in the I Facility	National	Transonic
[AIAA PAPER 89-0152] CONTROL SURFACES	p 334	A89-25135
Vortex generator jets - A means for control of boundary layer separation	passive	and active
[AIAA PAPER 89-0564] Dynamics of longitudinal motion of	p 287 an aero	A89-25453 oplane after
drop of loads CONTROL SYSTEMS DESIGN	p 333	A89-28396
An analysis of lateral-directional ha eigenstructure of high performance ai	ndling q rcraft	ualities and
[AIAA PAPER 89-0017]	p 331	A89-25013
nonlinear aircraft maneuver	piing s p 332	A89-25692
An H(infinity) method for the	design	of linear
time-invariant multivariable samp	pled-dat	A control
An alternative method to solve a v	ariation	al inequality
applied to an air tranic control example	p 354	A89-26196
for hydraulically actuated mechanisms	p 335	A89-27655
Considerations of control authorit STOVL propulsion system sizing	y requi	rements in
The advantage of a thrust rating co RB199 engine	p 327	used on the N89-16800
Controls and guidance: Aeronautics	p 334	N89-18401
CONTROL THEORY Modal control in systems with aftered	effect	
Controls and guidance: Aeronautics	p 354	A89-26038
CONVECTIVE HEAT TRANSFER	p 334	N89-18401
Single and multiple jet impingement	nt heat	transfer on

[AIAA PAPER 89-0174]

p 344 A89-25150

CONVERGENCE

p 321 N89-16819

novel infrared thermography heat transfer Α measurement technique [AIAA PAPER 89-0601] p 345 A89-25478

CONVERGENCE Convergence acceleration through the use of time

- inclining --- for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 An acceleration method for solving the Euler equations
- on an unstructured mesh by applying multigrid on an auxiliary structured mesh

[AIAA PAPER 89-0116] p 275 A89-25103 CONVERGENT NOZZLES

Subcritical swirling flows in convergent, annular p 323 A89-27694 nozzles CONVERGENT-DIVERGENT NOZZLES

Comparison of 3D computation and experiment for non-axisymmetric nozzles [AIAA PAPER 89-0007] p 325 A89-28403

COOLANTS

Coolant passage heat transfer with rotation p 351 N89-17314

COOLING SYSTEMS Improved reliability and maintainability for fighter aircraft Environmental Control Systems

[SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems --for aircraft

p 313 A89-27809 [SAE PAPER 881001] Topics of aircraft thermal management p 314 A89-28255 [SAE PAPER 881381]

COPPER ALLOYS Thermal conductivity and microstructure stability of heat treated AMZIRC copper-based alloys

p 341 A89-26361 CORNER FLOW

Computation for supersonic and turbulent separated flow over a compression corner p 292 A89-25931 CORRECTION

Wind tunnel-sidewall-boundary-layer effects in transonic airfoil testing-some correctable, but some not p 338 N89-16864

COST ANALYSIS

Analytical wing weight prediction/estimation using computer based design techniques p 316 N89-17589 COST ESTIMATES

Aircraft airframe cost estimating relationships: All mission types

p 269 N89-16719 [AD-A200262] Aircraft airframe cost estimating relationships: Fighters [AD-A200263] p 270 N89-16720

Aircraft airframe cost estimating relationships: Bombers and transports

[AD-A2002641 p 270 N89-16721 Aircraft airframe cost estimating relationships: Attack aircraft

p 270 N89-16722 AD-A2002651 COUNTER ROTATION

- A numerical study of the contrarotating vortex pair associated with a jet in a crossflow
- [AIAA PAPER 89-0448] p 284 A89-25366 Laser velocimeter measurements of the flowfield generated by an advanced counterrotating propeller

[AIAA PAPER 89-0434] p 293 A89-26373 COWLINGS p 315 N89-16746

Transonic cowl design CRACK INITIATION

High temperature constitutive and crack initiation modeling of coated single crystal superalloys p 342 N89-17334

CRACK PROPAGATION

Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine p 350 N89-17257 discs CRACKS

On a distributed parameter model for detecting cracks p 354 A89-25870 in a rotor

CRASH LANDING Effects of aircraft size on cabin floor dynamic pulses p 305 A89-28191 [SAE PAPER 881379]

CRASHES Kinematics of U.S. Army helicopter crashes - 1979-85 p 306 A89-28486

CRASHWORTHINESS

Numerical and experimental st	udy of the cra	ash behavior
of helicopters and fixed-wing air	craft n 309	A89-24919
Results of the AIA/ATA/FA	A Dynamic S	Seat Testing
Program	n 304	489.28187
Discussion of transport pass	enger seat p	erformance
characteristics	p 305	A89-28190

	EII 001010		p 000 .	
CREW PRO	CEDURES (INFLIGHT)		
Flight	mission	scenario	generatio	on with
knowledge	e-based syst	em	p 355 /	A89-27614

A-10

CRITICAL FLOW

Derivation of an integral equation for large disturbing transonic flow and its numerical method of undercritica p 293 A89-25944 flow CROSS FLOW

Stability of 3D wing boundary layer on a SST configuration

- [AIAĂ PAPER 89-0036] p 272 A89-25031 A numerical study of the contrarotating vortex pair associated with a jet in a crossflow
- p 284 A89-25366 [AIAA PAPER 89-0448] Numerical study of single impinging jets through a
- crossflow [AIAA PAPER 89-0449] p 284 A89-25367 CRUISING FLIGHT
- Performance potential of air turbo-ramjet employing supersonic through-flow fan

[AIAA PAPER 89-0010] p 322 A89-25006 CRYOGENIC WIND TUNNELS

Sidewall boundary-layer removal effects on wall adaptation in the Langley 0.3-meter transonic cryogenic tunnel

- [AIAA PAPER 89-0148] p 334 A89-25131 A solution to water vapor in the National Transonic Facility
- [AIAA PAPER 89-0152] p 334 A89-25135 Preliminary test results of NDA cryogenic wind tunnel and its system

[SAE PAPER 881449] p 336 A89-28219 NASA SC(2)-0714 airfoil data corrected for sidewall boundary-layer effects in the Langley 0.3-meter transonic

cryogenic tunnel p 301 N89-17568 [NASA-TP-2890] CRYSTAL DEFECTS

High temperature constitutive and crack initiation modeling of coated single crystal superalloys

- p 342 N89-17334 CRYSTALLOGRAPHY
- Constitutive modelling of single crystal and directionally p 342 N89-17325 solidified superalloys CYLINDERS

An experimental investigation of the aerodynamic characteristics of slanted base ogive cylinders using magnetic suspension technology [NASA-CR-184624] p 300 N89-16758

D

- DAMAGE
- Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine p 350 N89-17257 Mechanism of single shear fastened joints

p 352 N89-17700 DAMAGE ASSESSMENT

- p 269 A89-26674 Condor for high altitudes Damage tolerance behavior of fiber reinforced omposite airframes p 316 N89-17278 DATA ACQUISITION
- Automatic acquisition of domain and procedural p 318 A89-27624 knowledge National full-scale aerodynamic complex integrated systems test data system p 335 A89-27653

Software control of a high speed, modular signal conditioner and PCM encoder system p 318 A89-27670

DATA BASES

Photo-based three dimensional graphics models for multi-sensor simulation --- terrain data bases for flight simulator p 348 A89-27787 Building aircraft assembly tools from a 3-D database

[SAE PAPER 881428] p 269 A89-28204 Coolant passage heat transfer with rotation p 351 N89-17314

DATA COMPRESSION COMPASS (Trademark): A generalized ground-based

p 321 N89-16819 monitorina system DATA CORRELATION

Correlations of high density fuel effects [AIAA PAPER 89-0216] p 340 A89-25190 DATA LINKS

Cockpit display of hazardous weather information [AIAA PAPER 89-0808] p 335 A89-2 p 335 A89-25591 DATA PROCESSING

CF-18/F404 transient performance trending

p 328 N89-16814 DATA RECORDERS

Research pressed to improve flight information contribution to aircraft accident investigations p 318 A89-27247

DATA RECORDING COMPASS (Trademark): A generalized ground-based p 321 N89-16819 monitoring system

system for commercial avionics [SAE PAPER 881415] p 318 A89-28199 DATA TRANSMISSION Weather data dissemination to aircraft [AIAA PAPER 89-0809] p 304 A89-25592 DEBRIS Gas path condition monitoring using electrostatic p 321 N89-16817 techniques DEFECTS

COMPASS (Trademark): A generalized ground-based

Aircraft automation with an electronic library system

high capacity data storage and high resolution display

DATA SMOOTHING

monitoring system

DATA STORAGE

Material defects in a PM-nickel-base superalloy p 341 A89-25919

CF-18/F404 transient performance trending p 328 N89-16814

Review of existing NDT technologies and their p 349 N89-17255 canabilities DEFLECTION

Automatic generation of component modes for p 343 A89-24995 rotordynamic substructures DEGRADATION

An experimental investigation of multi-element airfoil ice accretion and resulting performance degradation p 297 A89-28453 [AIAA 89-0752]

DEICERS Electro-impulse de-icing systems - Issues and concerns

for certification [AIAA 89-0761] p 314 A89-28456

DEICING Infrared technique to measure the skin temperature on

an electrothermal de-icer - Comparison with numerical simulations

[AIAA PAPER 89-0760] p 303 A89-25566 DELAMINATING

Bolted scarf joints in carbon composite materials. Comparison between assemblies with an interference fit and those with play p 343 N89-17702 DELTA WINGS

Flow-field characteristics and normal-force correlations for delta wings from Mach 2.4 to 4.6 p 272 A89-25022

[AIAA PAPER 89-0026] Evaluation of leading- and trailing-edge flaps on flat and cambered delta wings at supersonic speeds

p 272 A89-25023 [AIAA PAPER 89-0027] Stability of 3D wing boundary layer on a SST configuration

[AIAA PAPER 89-0036] p 272 A89-25031 Unsteady Navier-Stokes computations past oscillating

delta wing at high incidence [AIAA PAPER 89-0081] p 273 A89-25071 An experimental investigation of delta wing vortex flow

with and without external jet blowing [AIAA PAPER 89-00841 p 273 A89-25074

Effects of leading-edge shape and vortex burst on the flowfield of a 70-degree-sweep delta-wing

p 274 A89-25076 [AIAA PAPER 89-0086] Visualization measurements of vortex flows p 276 A89-25166 [AIAA PAPER 89-0191]

A flow visualization and aerodynamic force data evaluation of spanwise blowing on full and half span delta wings [AIAA PAPER 89-0192]

p 276 A89-25167 The effects of a contoured apex on vortex breakdown

p 276 A89-25168 [AIAA PAPER 89-0193] The separated flow field on a slender wing undergoing transient pitching motions

p 276 A89-25169 [AIAA PAPER 89-0194] Low speed wind tunnel investigation of the flow about

delta wing, oscillating in pitch to very high angle of attack [AIAA PAPER 89-0295] p 281 A89-25252

Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow [AIAA PAPER 89-0341]

Applications of an efficient algorithm to transonic

Numerical solution of flow fields around Delta wings

Design synthesis for canard-delta combat aircraft,

Axial velocity density ratio influence on exit flow angle

Notes on a theoretical parachute opening force analysis

Air traffic control automation concepts to optimize flight

conservative full-potential flow past 3-D wings

using Euler equations method [NAL-TM-FM-8701]

in transonic/supersonic cascades

applied to a general trajectory

management system utilization

DESCENT TRAJECTORIES

volumes 1 and 2 DENSITY DISTRIBUTION

DEPLOYMENT

[AD-A201050]

p 282 A89-25288

p 291 A89-25930

p 299 N89-16757

p 316 N89-17590

p 329 N89-16830

p 302 N89-17582

p 307 A89-26733

SUBJECT INDEX

Design of automation tools for m	anagement of descent
INASA-TM-101078]	p 306 N89-17584
DESIGN ANALYSIS	moley configurations
directed towards the F-18 aircraft	inplex configurations
[AIAA PAPER 89-0121] Computational design of low asp	p 310 A89-25106 ect ratio wind-windlets
for transonic wind-tunnel testing	
[AIAA PAPER 89-0644] Mechanization, design and m	p 311 A89-25509 ethodological lessons
learned from a dynamic cockpit mo	ock-up evaluation
[SAE PAPER 881438] Supportability design requirement	ts for army aircraft and
equipment	0.256 490-29217
The design and development of	f transonic multistage
COMPRESSORS	p 329 N89-16834
Gas path modelling, diagnosi	s and sensor fault
detection Review of existing NDT tec	p 321 N89-16811 Innologies and their
capabilities	p 349 N89-17255
Measurements of gas turbine of	ombustor and engine
augmentor tube sooting characteris	stics
DIFFERENTIAL EQUATIONS	p 520 1403-10021
Active control of aeroelastic functional differential equations	systems governed by p 332 A89-25871
DIFFUSERS	p 002 700-20071
Modeling of subsonic flow through diffuser	a compact offset inlet
[AIAA PAPER 89-0639]	p 288 A89-25505
NASA Lewis Icing Research Tunne	linuser section of the
[AIAA 89-0755]	p 336 A89-28455
COMPASS (Trademark): A gene	ralized ground-based
monitoring system	p 321 N89-16819
Military engine condition monitor	ing systems: The UK
experience DIGITAL SIMULATION	p 320 N89-16797
Determination of the numerical in	ntegration step during
the analog-digital modeling of dyna	p 354 A89-27405
DIGITAL SYSTEMS	concept used on the
The advantage of a thrust rating RB199 engine	concept used on the p 327 N89-16800
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor	concept used on the p 327 N89-16800 in a digital avionic
DigitAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783]	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIECET CHERENT	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 81408]	concept used on the p 327 N89-16600 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES)	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl caabalities	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE FAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDIVIE divelop systems	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-25590
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tect capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371]	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-25590 p 318 A89-28184
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISKS (SHAPES) Review of existing NDT tecl capabilities DISKS (SHAPES) TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-25590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 minal Doppler Weather p 346 A89-25590 p 318 A89-25190 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881415] Use of color displays in the A320	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 minal Doppler Weather p 346 A89-25590 p 318 A89-28194 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881415] Use of color displays in the A320 [SAE PAPER 881416] Computer-concrated man display	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 minal Doppler Weather p 346 A89-25590 p 318 A89-25184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881415] Use of color displays in the A320 [SAE PAPER 881416] Computer-generated map display interface	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 minal Doppler Weather p 346 A89-25590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881415] Use of color displays in the A320 [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881440] DISSOCIATION	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 minal Doppler Weather p 346 A89-25590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881415] Use of color displays in the A320 [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881440] DISSOCIATION NNEFEQ - Chemical equilibri	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 minal Doppler Weather p 346 A89-25590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TOWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881475] Use of color displays in the A320 [SAE PAPER 881440] DISSOCIATION NNEPEQ - Chemical equilibri Nay/NASA Engine Program [ASME PAPER 88-GT-314]	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-28590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881415] Use of color displays in the A320 [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881440] DISSOCIATION NNEPEQ - Chemical equilibri Nav/NASA Engine Program [ASME PAPER 88-GT-314] DISTRIBUTED PARAMETER SYSTE	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-28590 p 318 A89-28184 onic library system igh resolution display p 318 A89-28199 (cockpit p 319 A89-28214 um version of the p 322 A89-24989 MS
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tect capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881415] Use of color displays in the A320 [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881440] DISSOCIATION NNEPEQ - Chemical equilibri Navy/NASA Engine Program [ASME PAPER 88-GT-314] DISTRIBUTED PARAMETER SYSTE On a distributed parameter mode in a rotor	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-25590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881415] Use of color displays in the A320 [SAE PAPER 881415] Use of color displays in the A320 [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881440] DISSOCIATION NIEPEQ - Chemical equilibri Navy/NASA Engine Program [ASME PAPER 88-GT-314] DISTRIBUTED PARAMETER SYSTE On a distributed parameter mode in a rotor DOPPLER NAVIGATION A Kalman filter for an inteorated Dc	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-25590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISKS (SHAPES) Review of existing NDT tecl capabilities DISKE (SHAPES) Review of existing NDT tecl capabilities Compatively experiences Terr Radar [ALA PAPER 88-0807] Avionics display systems [SAE PAPER 881415] Computer-generated map display interface [SAE PAPER 88-07-014] DISTRIBUTED PARAMETER SYSTE On a distributed parameter mode in a rotor DOPPLER NAVIGATION A Kalman filter for an integrated DC system	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-25590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881416] DISSOCIATION NNEPEQ - Chemical equilibri Navy/NASA Engine Program [ASME PAPER 88-GT-314] DISTRIBUTED PARAMETER SYSTE On a distributed parameter mode in a rotor DOPPLER NAJGATION A Kalman filter for an integrated DC system DOPPLER RADAR On design and projected use of	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-25590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881415] Use of color displays in the A320 [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881416] DISSOCIATION NNEPEQ - Chemical equilibri Navy/NASA Engine Program [ASME PAPER 88-114] DISTRIBUTED PARAMETER SYSTE On a distributed parameter mode in a rotor DOPPLER NAVIGATION A Kalman filter for an integrated DC system DOPPLER RADAR On design and projected use of low-level windshear alert system	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 ninal Doppler Weather p 346 A89-25590 p 318 A89-25590 p 318 A89-25890 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 89-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881371] Juse of color displays in the A320 [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881416] DISSOCIATION NNEPEQ - Chemical equilibri Navy/NASA Engine Program [ASME PAPER 88-GT-314] DISTRIBUTED PARAMETER SYSTE On a distributed parameter mode in a rotor DOPPLER NAVIGATION A Kalman filter for an integrated Do system DOPPLER RADAR On design and projected use of low-level windshear aller system [AIAA PAPER 89-0704]	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 minal Doppler Weather p 346 A89-25590 p 318 A89-28184 onic library system
DIGITAL SYSTEMS The advantage of a thrust rating RB199 engine Impact of device level faults processor [NASA-CR-184783] DIODES Laser communication test system [AD-A199612] DIRECT CURRENT A highly reliable DC power subsystems [SAE PAPER 881408] DISKS (SHAPES) Review of existing NDT tecl capabilities DISPLAY DEVICES TDWR display experiences Terr Radar [AIAA PAPER 88-0807] Avionics display systems [SAE PAPER 881371] Aircraft automation with an electr high capacity data storage and h system for commercial avionics [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881416] Computer-generated map display interface [SAE PAPER 881440] DISSOCIATION NNEPEQ - Chemical equilibri Navy/NASA Engine Program [AME PAPER 88-GT-314] DISTRIBUTED PARAMETER SYSTE On a distributed parameter mode in a rotor DOPPLER NAVIGATION A Kalman filter for an integrated Dc system [AIAA PAPER 89-0704] TDWR display experiences Terr Radar	concept used on the p 327 N89-16800 in a digital avionic p 356 N89-18046 p 349 N89-17215 source for avionic p 324 A89-28257 hnologies and their p 349 N89-17255 minal Doppler Weather p 346 A89-25590 p 318 A89-28184 conic library system

Drag measurements on a modified prolate spheroid using a magnetic suspension and balance system [AIAA PAPER 89-0648] p 335 A89-25512 Estimation of drag arising from asymmetry in thrust or airframe configuration [ESDU-88006] p 297 N89-16730 The accurate measurement of drag in the 8 ft x 8 ft nnel p 337 N89-16855 tunnel EJECTORS Accurate drag estimation using a single component drag p 337 N89-16856 model technique Precision improvement of transport aircraft drag performance p 300 N89-16858 measurements Balance accuracy and repeatability as a limiting parameter in aircraft development force measurements in conventional and cryogenic wind tunnels p 338 N89-16873 tires DRAG REDUCTION Feasibility study on the design of a laminar flow nacelle [AIAA PAPER 89-0640] p 311 A89-25506 DROP SIZE Airblast atomization at conditions of low air velocity p 344 A89-25191 [AIAA PAPER 89-0217] Use of the median volume droplet diameter in the characterization of cloud droplet spectra [AIAA PAPER 89-0756] p 352 A89-25562 DROP TESTS Numerical and experimental study of the crash behavior of helicopters and fixed-wing aircraft ELECTRIC CHARGE p 309 A89-24919 DROPS (LIQUIDS) Droplet impaction on a supersonic wedge -Consideration of similitude [AIAA PAPER 89-0763] p 304 A89-25567 DUCTED FAN ENGINES A study of turbomachine flow velocities [AIAA PAPER 89-0839] p 3 p 346 A89-25608 DUCTED FLOW Comparison of LDV measurements and Navier-Stokes solutions in a two-dimensional 180-degree turn-around [AIAA PAPER 89-0275] p 279 A89-25232 An LDV investigation of a multiple normal shock wave/turbulent boundary layer interaction p 282 A89-25300 [AIAA PAPER 89-0355] CFD application to subsonic inlet airframe integration --- computational fluid dynamics (CFD) p 299 N89-16753 DUMP COMBUSTORS Relation between diffusor losses and the inlet flow conditions of turbojet combustors p 322 A89-24916 An experimental and computational investigation of isothermal swirling flow in an axisymmetric dump combustor [AIAA PAPER 89-0620] p 323 A89-25491 DYNAMIC CHARACTERISTICS Development of a panel method for modeling configurations with unsteady component motions, phase p 315 N89-16775 [AD-A200255] Identification of dynamic characteristics for fault isolation purposes in a gas turbine using closed-loop measurements p 328 N89-16813 DYNAMIC MODELS A dynamic model for vapor-cycle cooling systems --systems for aircraft [SAE PAPER 881001] p 313 A89-27809 DYNAMIC RESPONSE Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 ELECTRIC PULSES Nonlinear dynamic responses of composite rotor blades [AD-A200145] p 315 N89-16774 DYNAMIC STABILITY The design and development of a dynamic plunge-pitch-roll model mount p 334 A89-25042 AIAA PAPER 89-00481 DYNAMIC STRUCTURAL ANALYSIS automated flutter A computational procedure for analysis p 348 A89-28070

DORNIER AIRCRAFT

[NASA-TM-101050]

DRAG COEFFICIENTS

DRAG MEASUREMENT

aircraft DOWNWASH

[ISAS-629]

DRAG

Finite element analysis of composite rudder for DO 228

A numerical simulation of flows about two-dimensional

Drag measurements on a modified prolate spheroid using a magnetic suspension and balance syste [AIAA PAPER 89-0648] p 335 A

Flight measured downwash of the QSRA

bodies of parachute-like configuration

p 347 A89-26284

p 316 N89-17593

p 302 N89-17580

p 335 A89-25512

ELECTROMAGNETIC INTERFERENCE

DYNAMIC TESTS

Results of the AIA/ATA/FAA Dynamic Seat Testing Program [SAE PAPER 881375] p 304 A89-28187

Effects of aircraft size on cabin floor dynamic pulses [SAE PAPER 881379] p 305 A89-28191

DYNAMICAL SYSTEMS Determination of the numerical integration step during the analog-digital modeling of dynamic systems

p 354 A89-27405 Ε

EDUCATION

Aircraft design education at North Carolina State University

[AIAA PAPER 89-0649] p 357 A89-25513 FIGENVECTORS

An analysis of lateral-directional handling qualities and eigenstructure of high performance aircraft [AIAA PAPER 89-0017] p 33 p 331 A89-25013

Improved methods of characterizing ejector pumping

[AIAA PAPER 89-0008] p 322 A89-25004 ELASTIC DAMPING

Fore-and-aft stiffness and damping characteristics of 30 x 11.5-14.5, Type VIII, bias-ply and radial-belted aircraft

[SAE PAPER 881357] p 313 A89-28176

ELASTIC DEFORMATION Bolted scarf joints in carbon composite materials. Comparison between assemblies with an interference fit and those with play p 343 N89-17702

ELASTOMERS

Properties of aircraft tire materials [SAE PAPER 881358] p 313 A89-28177

ELECTRIC BATTERIES Overview on the evolution of aircraft battery systems

used in Air Force aircraft [SAE PAPER 881411] p 324 A89-28260

Electric charge acquired by airplanes penetrating nunderstorms p 304 A89-26231 thunderstorms

ELECTRIC EQUIPMENT Electrical equipment of aircraft --- Russian book

p 346 A89-26171 ELECTRIC GENERATORS

A highly reliable DC power source for avionic subsystems

[SAE PAPER 881408] p 324 A89-28257 Experimental cascaded doubly fed variable speed

constant frequency generator system [SAE PAPER 881409] p 324 A89-28258 Parallel operation of VSCF electrical power generators

[SAE PAPER 881410] p 324 A89-28259 High reliability aircraft generator system p 325 A89-28263 [SAE PAPER 881414]

Emergency power combined with auxiliary power unit in aircraft

[SAE PAPER 881500] p 325 A89-28266

T-100 Multipurpose Small Power Unit - Technology for the next generation auxiliary power units

p 349 A89-28267 [SAE PAPER 881501] ELECTRIC NETWORKS

Electrical equipment of aircraft --- Russian book

p 346 A89-26171 ELECTRIC POWER SUPPLIES

- Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988
- [SAE SP-758] p 324 A89-28254 ELECTRIC POWER TRANSMISSION
- Parallel operation of VSCF electrical power generators SAE PAPER 881410] p 324 A89-28259 [SAE PAPER 881410] Unbalanced and nonlinear loads in aircraft electrical
- [SAE PAPER 881413] p 325 A89-28262 ELECTRIC PROPULSION

The all electric airplane revisited [SAE PAPER 881407] p 314 A89-28256

Electro-impulse de-icing systems - Issues and concerns for certification

AIAA 89-07611 p 314 A89-28456 ELECTRODES

Field enhancement of UHF-VHF aircraft antennas [AD-A2001801 p 349 N89-17069 ELECTROMAGNETIC INTERFERENCE

Electromagnetic emissions from a modular low voltage EIDI system --- Electro-Impulse Deicing p 303 A89-25564 [AIAA PAPER 89-0758]

A-11

ELECTROMAGNETIC PULSES

ELECTROMAGNETIC PULSES

Electromagnetic emissions from a modular low voltage EIDI system --- Electro-Impulse Deicing n 303 A89-25564 [AIAA PAPER 89-0758]

ENGINE FAILURE

ENGINE INLETS

p 349 N89-17256

ENGINE MONITORING

ELECTROMECHANICAL DEVICES		
Performance testing of an electric	ally actu	ated aircraft
braking system		
[SAE PAPER 881399]	p 313	A89-28194
ELECTRONIC AIRCRAFT		
The all electric airplane revisited		
[SAE PAPER 881407]	p 314	A89-28256
ELECTRONIC FILTERS		
A signal filter with zero phase lag	p 336	A89-27674
ELECTRONIC WARFARE		

Temperature compensation using GaAs MMIC devices p 347 A89-26548 ELECTROSTATIC CHARGE

Gas path condition monitoring using electrostatic

p 321 N89-16817 techniques

Integrating causal reasoning a	t differe	nt levels of
abstraction in problem-solving s	system fi	unctioning as
pilot assistant in commercial air tran	nsport er	nergencies
	p 355	A89-27609
Emergency power combined with	h auxiliai	ry power unit
	n 225	489-28266
[SAE PAPER 001500]	p 323	103-20200
ENDURANCE		
Amber for long endurance	p 269	A89-26673
ENERGY BUDGETS		
Thermal-energy management	for a	ir breathing
hyper-velocity vehicles		
[AIAA PAPER 89-0183]	p 310	A89-25158
ENGINE AIRFRAME INTEGRATION	•	
A numerical study of hypersoni	c propul	sion/airframe
integration problem		
	n 979	489.25026
[AIAA PAPER 09-0030]	P 212	
Intake Aerogynamics, Volume 2 -		

p 299 N89-16748 [VKI-LS-1988-04-VOL-2] CFD application to subsonic inlet airframe integration --- computational fluid dynamics (CFD) p 299 N89-16753

CFD application to supersonic/hypersonic inlet airframe integration --- computational fluid dynamics (CFD) p 299 N89-16754

F100-PW-220 engine monitoring system

ENGINE CONTROL

p 320 N89-16795 Military engine monitoring status at GE Aircraft Engines p 320 N89-16798 Cincinnati, Ohio Commercial engine monitoring status at GE Aircraft p 320 N89-16799 Engines, Cincinnati, Ohio The advantage of a thrust rating concept used on the p 327 N89-16800 **BB199** engine Fault management in aircraft power plant controls p 327 N89-16809 ENGINE DESIGN Turbulent mixing in supersonic combustion systems [AIAA PAPER 89-02601 p 323 A89-25218 Applications of an AI design shell ENGINEOUS to advanced engineering products p 355 A89-27618 Modular analysis of scramjet flowfields p 325 A89-28337 Combustor air flow prediction capability comparing p 349 A89-28345 several turbulence models Intake Aerodynamics, volume conferen p 298 [VKI-LS-1988-04-VOL-1] N89-16738 p 314 N89-16741 Inlet-engine compatibility Intake swirl and simplified methods for dynamic pressure p 299 N89-16742 distortion assessment Jaguar/Tornado intake design p 299 N89-16743 N89-16746 p 315 Transonic cowl design p 299 Intake drag N89-16747 Intake Aerodynamics, volume 2 --- conference p 299 N89-16748 [VKI-LS-1988-04-VOL-2] Transport aircraft intake design p 315 N89-16749 Recent UK trials in engine health monitoring: Feedback N89-16790 p 326 and feedforward Military engine monitoring status at GE Aircraft Engines. p 320 N89 16798 Cincinnati, Ohio Commercial engine monitoring status at GE Aircraft p 320 N89-16799 Engines, Cincinnati, Ohio The advantage of a thrust rating concept used on the p 327 N89-16800 RB199 engine Transonic Compessors, volume 2 -- conference p 329 N89-16833 [VKI-LS-1988-03-VOL-2] The design and development of transonic multistage p 329 N89-16834 compresso Design of critical compressor stages p 330 N89-16835 p 330 Supersonic compressors N89-16836 Supersonic throughflow fans p 330 N89-16837 Design methodology for advanced High Pressure (HP) p 330 N89-16840 compressor first stage Relationships of nondestructive evaluation needs and

component design

man and the second seco	System-theoretical method for dynamic on-condition
Pattern-based fault diagnosis using neural networks	monitoring of gas turbines p 321 N89-16812
p 354 A89-27602	Identification of dynamic characteristics for fault isolation
Hierarchical representation and machine learning from	purposes in a gas turbine using closed-loop measurements n.328 N89-16813
abnormal conditions n 355 A89-27622	Gas path condition monitoring using electrostatic
MIS a machine learning system for engine fault	techniques p 321 N89-16817
diagnosis p 355 A89-27623	COMPASS (Trademark): A generalized ground-based
Active suppression of aerodynamic instabilities in	ENGINE PARTS
turbomachines p 295 A89-28341	Applications of an Al design shell ENGINEOUS to
Recent UK trials in engine health monitoring: Feedback	advanced engineering products p 355 A89-27618
E100 BW 220 optime monitoring system	Composite mechanics for engine structures
p 320 N89-16795	F100_PW-220 engine monitoring system
Military engine condition monitoring systems: The UK	p 320 N89-16795
experience p 320 N89-16797	Relationships of nondestructive evaluation needs and
Military engine monitoring status at GE Aircraft Engines,	component design p 349 N89-17256
Cincinnati, Ohio p 320 N89-16798	short term developments in non-destructive evaluation
NGINE INLETS Relation between diffusor losses and the inlet flow	State-of-the-art in non-destructive evaluation of turbine
conditions of turboiet combustors p 322 A89-24916	engine parts p 350 N89-17261
Estimates of oxides of nitrogen formed in an inlet air	ENGINE STARTERS
stream for high Mach number flight conditions	pheumatic link secondary power systems for military
[AIAA PAPER 89-0197] p 277 A89-25172	[SAE PAPER 881499] p 325 A89-28265
TAIAA PAPER 89-07591 p 311 A89-25565	ENGINE TESTS
Intake Aerodynamics, volume 1 conference	NNEPEQ - Chemical equilibrium version of the
[VKI-LS-1988-04-VOL-1] p 298 N89-16738	Navy/NASA Engine Program
Introduction to intake aerodynamics	Eacility requirements for hypersonic propulsion system
Tactical fighter inlets n 298 N89-16740	testing
Inlet-engine compatibility p 314 N89-16741	[AIAA PAPER 89-0184] p 335 A89-25159
Intake swirl and simplified methods for dynamic pressure	An experimental and computational investigation of
distortion assessment p 299 N89-16742	isothermal swining now in an axisymmetric dump
Jaguar/Tornado intake design p 299 N89-16743	[AIAA PAPER 89-0620] p 323 A89-25491
Transonic cowl design p 315 N89-16746	Low frequency pressure oscillations in a model ramjet
Intake drag p 299 N89-16747	combustor - The nature of frequency selection
Intake Aerodynamics, volume 2 conference	[AIAA PAPER 89-0623] p 323 A89-25493
[VKI-LS-1988-04-VOL-2] p 299 N89-16748	monitoring
Wind tunnel air intake test techniques	[SAE PAPER 881444] p 356 A89-28215
p 299 N89-16751	Wind tunnel air intake test techniques
CFD application to subsonic inlet airframe integration	p 299 N89-16751 Recent LIK tricls is oncine boalth monitoring: Feedback
computational fluid dynamics (CFD)	and feedforward D 326 N89-16790
CED application to supersonic/bypersonic inlet airframe	System considerations for integrated machinery health
integration computational fluid dynamics (CFD)	monitoring p 327 N89-16804
p 299 N89-16754	Accuracy requirements for high-speed test with engine
NGINE MONITORING INSTRUMENTS	simulation on transport aircraft models in the NLR-HST
meniable information from engine performance	p 336 1169-10670
	Evel additive system for test cells
[SAE PAPER 881444] p 356 A89-28215	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management evetoms in the UK arread forces n 326 N89-16783	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring:	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AlAA 96 0782] p 337 A89-28457
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS)	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AlA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems
[SAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring : Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft p 313 A89-27809
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: p 326 N89-16784 Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16786 CF-18 engine monitoring p 319 N89-16787 B-B CITS engine monitoring p 319 N89-16787	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 88099] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: P 326 N89-16784 Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 CF-18 engine performance monitoring p 326 N89-16786 CF-18 engine performance monitoring p 326 N89-16786 B-1B CITS engine monitoring p 319 N89-16788 Engine life consumption monitoring program for RB199 interacted fild monitoring program for RB199	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16784 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16788 Engine life consumption monitoring system p 326 N89-16787 B-20 N89-16788 p 320 N89-16788	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft ENVIRONMENTAL CONTROL Sate 28608 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 ENVERNATIC COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring; Policy, plans and experience p 326 N89-16783 On board life monitoring system Tornado (OLMOS) p 319 N89-16784 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-18 CITS engine monitoring program for RB199 integrated in the on-board life monitoring system p 320 N89-16788 Engine life consumption monitoring system p 320 N89-16789 Recent UK trials in engine health monitoring: Feedback p 320 N89-16789	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft [SAE PAPER 880999] p 312 A89-27608 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27825
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16786 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16788 Engine life consumption monitoring rogram for RB199 integrated in the on-board life monitoring system p 320 N89-16789 Recent UK trials in engine health monitoring: Feedback and feedforward p 326 N89-16790	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Error and the individual composition of the second composition of the
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: P 326 N89-16784 Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring pogram for RB199 integrated in the on-board life monitoring system p 320 N89-16789 Recent UK trials in engine health monitoring: Feedback and feedforward p 320 N89-16790 The CFM 56-5 on the A-320 at Air France p 320 N89-16790	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Inertial energy distribution error control for optimal wind chock consectation
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16786 Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring: Feedback and feedforward p 326 N89-16790 The CFM 56-5 on the A-320 at Air France p 320 N89-16793 E100-PW-220 engine monitoring system	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration [A89-016] p 331 A89-25012
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16788 Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring: Feedback and feedforward p 326 N89-16790 The CFM 56-5 on the A-320 at Air France p 320 N89-16793 F100-PW-220 engine monitoring ystem p 320 N89-16793	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27825 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration p 331 A89-25012 A Kalman filter for an integrated Doppler/GPS navigation [Alama filter for an integrated Doppler/GPS navigation
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16788 Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring: Feedback and feedforward p 326 N89-16789 Recent UK trials in engine health monitoring: Feedback and feedforward p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring system	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/spoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27825 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration p 331 A89-25012 AtalAAPER 88-0016] p 331 A89-25012 Atalman filter for an integrated Doppler/GPS navigation system p 308 A89-26740
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16786 Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring; Feedback and feedforward p 326 N89-16789 Recent UK trials in engine health monitoring; Feedback and feedforward p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16795 Service life calculator for the M53 turbofan engine p 326 N89-16795	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIROMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIROMENTAL CONTROL Improved reliability and maintainability for fighter aircraft [SAE PAPER 880999] p 312 A89-27608 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration p 331 A89-25012 A Kalman filter for an integrated Doppler/GPS navigation system p 306 A89-26740
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: P 326 N89-16784 Policy, plans and experience p 326 N89-16784 On board life monitoring system p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring program for RB199 integrated in the on-board life monitoring system p 320 N89-16790 Recent UK trials in engine health monitoring: Feedback and feedforward p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16795 service	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft [SAE PAPER 880999] p 312 A89-27608 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 EROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration p 331 A89-25012 A Kaiman filter for an integrated Doppler/GPS ravigation system p 306 A89-26740 B-1B CITS engine monitoring p 319 N89-16788 A critical assessment of wind tunnel results for the NACA
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: P 326 N89-16784 Policy, plans and experience p 326 N89-16784 On board life monitoring system p 319 N89-16786 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-18 CITS engine monitoring program for RB199 integrated in the on-board life monitoring system p 320 N89-16787 Recent UK trials in engine health monitoring. Feedback and feedforward p 326 N89-16790 The CFM 56-5 on the A-320 at Air France p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16796 p 320 N89-16796 Military engine condition monitoring system p 320 N89-16796 Military engine monitoring system p 320 N89-16796 Military engine monitor	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft [SAE PAPER 880999] p 312 A89-27608 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration [AIAA PAPER 89-0016] p 331 A89-25012 A Kalman filter for an integrated Doppler/GPS navigation system B -1B CITS engine monitoring p 319 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-168647
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: P 326 N89-16784 Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16786 Information management systems for on-board monitoring systems p 319 N89-16786 CF18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p orgram for RB199 integrated in the on-board life monitoring system p 320 N89-16787 B-cent UK trials in engine health monitoring: Feedback and feedforward p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16795 Service life calculator for the M53 turbofan engine p 320 N89-16796 Military engine condition monitoring systems: The UK p 320 N89-16796 Military engine monitoring status at GE Aircraft Engines, Cincinnati, Ohio p 320 N	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIROMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27825 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration p 331 A89-25012 A Kalman filter for an integrated Doppler/GPS navigation system p 306 A89-26740 B-18 CITS engine monitoring p 319 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16788
monitoring Stems of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16783 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16788 Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring: Feedback and feedforward p 326 N89-16789 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16795 Service life calculator for the M53 turbofan engine p 326 N89-16796 Military engine condition monitoring systems: The UK experience p 320 N89-16796 Military engine monitoring status at GE Aircraft Engines, Cincinnati, Ohio p 320 N89-16798	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 [AD-A200801] p 342 N89-17681 [ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27825 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration [AIAA PAPER 89-016] p 331 A89-25012 A Kalman filter for an integrated Doppler//GPS navigation system p 306 A89-26740 B-1B CITS engine monitoring p 319 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16847 EULER EQUATIONS OF MOTION A comparative study of iterative aligorithms for the Euler equations of gasdynamics
Information in the interval of	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIROMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A69-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 EROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration [AIAA PAPER 89-0016] p 331 A89-25012 A Kaman filter for an integrated Dopleir/GPS navigation system p 308 A89-26740 B-18 CITS engine monitoring p 319 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16847 EULER EQUATIONS OF MOTION A comparative study of iterative algorithms for the Euler equations of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration p 331 A89-25012 A Kalman filter for an integrated Doppler/GPS navigation system p 308 A89-26740 B-1B CITS engine monitoring p 319 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16847 EULER EQUATIONS OF MOTION A comparative study of iterative algorithms for the Euler equations of gasdynamics g 343 A89-25101 Unsteady Euler airfoil solutions using unstructured Differential ene
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27608 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration [AIAA PAPER 89-0016] p 331 A89-25012 A Kalman filter for an integrated Doppler/GPS navigation system p 306 A89-26740 B-1B CITS engine monitoring p 319 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16787 A comparative study of iterative algorithms for the Euler equations of gasdynamics p 343 A89-25101 Unsteady Euler airfoil solutions using unstructured dynamic meshes p 343 </td
ISAE PAPER 881444] p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: P 326 N89-16784 On board life monitoring system p 319 N89-16784 On board life monitoring systems p 319 N89-16786 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 320 N89-16787 B-1B CITS engine monitoring program for RB199 integrated in the on-board life monitoring system p 320 Integrated in the on-board life monitoring system p 320 N89-16790 The CFM 56-5 on the A-320 at Air France p 320 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring systems: The UK experience p 320 N89-16796 Military engine condition monitoring systems: The UK experience p 320 N89-16797 Military engine monitoring status at GE Aircraft Engines, Cincinnati, Ohio p 320 N89-16798	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 [ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0782] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration p 308 A89-26740 B-1B CITS engine monitoring p 311 A89-2611 A89-26172 A Kalman filter for an integrated Doppler/GPS navigation system p 300 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16788 A critical assessment of wind tunnel results for the Euler equations of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101 Unsteady Euler airfoil solutions using unstructured dynamic me
Information monitoring p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16786 Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring; Feedback and feedforward p 326 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16793 F100-PW-220 engine monitoring systems p 320 N89-16793 F100-PW-220 engine monitoring systems p 320 N89-16793 F100-PW-220 engine monitoring systems: The UK experience p 320 N89-16795 Service life calculator for the M53 turbofan engine p 320 N89-16795 Military engine condition monitoring systems: The UK experience p 320 N89-16796 Military engine monitoring status at GE Aircraft Engines, Cincinnati, Ohio p 320 N89-16798 Commercial engine monitoring status at GE Aircraft Engines, Cincinnati, Ohio p 320 N89-16799 The advantage of a thrust rating concept used on the R8199 engine p 321 N89-16801 Gas path analysis and engine performance monitoring p 321 N89-16801 Gas path analysis and engine performance monitoring p 321 N89-16801	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIROMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27825 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration [AIAA PAPER 89-016] p 331 A89-26740 B-18 CITS engine monitoring p 319 N89-16740 B-180-16847 B-18 CITS engine monitoring p 300 N89-16847 EULER EQUATIONS OF MOTION A comparative study of iterative algorithms for the Euler equations of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101 Unsteady Euler airfoil solutions using unstructured dynamic meshes [AIAA PAPER 89-0115] p 275
Information monitoring p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-1B CITS engine monitoring p 319 N89-16788 Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring; Feedback and feedforward p 326 N89-16793 F100-PW-220 engine monitoring system p 320 N89-16795 Service life calculator for the M53 turbofan engine p 326 N89-16796 Military engine condition monitoring systems: The UK experience p 320 N89-16797 Military engine monitoring status at GE Aircraft Engines, Cincinnati, Ohio p 320 N89-16798 The advantage of a thrust rating concept used on the RB199 engine p 327 N89-16800 Trend monitoring of a turboprop engine at low and mean power p 321 N89-16801 Gas path analysis and engine performance monitoring in a Chincok helicopter p 327 N89-16800 System p 327 N89-16800	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 [AD-A200801] p 342 N89-17681 [ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27825 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration [AIAA PAPER 89-0016] p 331 A89-26740 B-1B CITS engine monitoring p 300 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16847 EULER EQUATIONS OF MOTION A comparative study of iterative algorithms for the Euler equations of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101 Unsteady Euler airfoil solutions using unstructured dynamic meshes [AIAA PAPER 89
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIROMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880999] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 EROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration [AIAA PAPER 89-0016] p 331 A89-26740 B-1B CITS engine monitoring p 310 N89-16788 A critical assessment of wind tunnel results for the NACA A comparative study of iterative algorithms for the Euler equations of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101 Unsteady Euler airfoil solutions using unstructured dynamic meshes [AIAA PAPER 89-0115] p 275 A89-25102
Information in the interval of	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880099] p 312 A89-27808 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/apoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration p 331 A89-25012 A Kalman filter for an integrated Doppler/GPS navigation system p 308 A89-26740 B-1B CITS engine monitoring p 319 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16788 A comparative study of iterative algorithms for the Euler equations of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101 Unsteady Euler airfoil solutions using unstructured dynamic meshes [AIAA
Information p 356 A89-28215 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 On board life monitoring system Tornado (OLMOS) p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 CF-18 engine performance monitoring p 326 N89-16787 B-18 CITS engine monitoring p 319 N89-16786 Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring system p 320 N89-16780 Recent UK trials in engine health monitoring. F 100-PW-220 engine monitoring system p 320 N89-16790 The CFM 56-5 on the A-320 at Air France p 320 N89-16793 F 100-PW-220 engine monitoring system p 320 N89-16793 Service life calculator for the M53 turbofan engine p 320 N89-16796 Military engine condition monitoring systems: The UK experience p 320 N89-16797 Military engine monitoring status at GE Aircraft Engines, Cincinnati, Ohio p 320 N89-16797 The advantage of a thrust rating concept used on the RB199 engine p 321 N89-16799 The advantage of a thrust rating concept used on the RB199 engine p 321 N89-18600 Trend monitoring of a turboprop engine at low and mean power p 321 N89-18600 Trend monitoring of a turboprop engine at low and mean power p 327 N89-18600 Maintenance aid system for wide body aircraft monitoring p 327 N89-18600 Maintenance aid system for wide body aircraft p 327 N89-18602	Fuel-additive system for test cells [AD-A200801] p 342 N89-17681 ENVIRONMENT SIMULATION The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment [AIAA 89-0762] p 337 A89-28457 ENVIRONMENTAL CONTROL Improved reliability and maintainability for fighter aircraft Environmental Control Systems [SAE PAPER 880099] p 312 A89-27608 A dynamic model for vapor-cycle cooling systems for aircraft [SAE PAPER 881001] p 313 A89-27809 EPOXY MATRIX COMPOSITES Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925 ERROR ANALYSIS Inertial energy distribution error control for optimal wind shear penetration [AIAA PAPER 89-0016] p 331 A89-25012 A Kalman filter for an integrated Doppler/GPS navigation system p 306 A89-26740 B-1B CITS engine monitoring p 319 N89-16788 A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16787 Quationis of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101 Unsteady Euler airfoil solutions using unstructured dynamic meshes [AIAA PAPER 89-0115] p 275

SUBJECT INDEX

Transonic Euler solutions on mutually interfering finned bodies

[AIAA PAPER 89-0264] p 278 A89-25222 Analysis of three-dimensional aerospace configurations

- using the Euler equations [AIAA PAPER 89-0268] p 279 A89-25226 Three-dimensional hybrid finite volume solutions to the
- Euler equations for supersonic/hypersonic aircraft [AIAA PAPER 89-0281] p 280 A89-25238 Application of direct solvers to unstructured meshes for the Euler and Navier-Stokes equations using upwind
- [AIAA PAPER 89-0364] p 283 A89-25308
- Two-dimensional Euler computations on a triangular mesh using an upwind, finite-volume scheme [AIAA PAPER 89-0470] p 354 A89-25385
- A cell-vertex multigrid Euler scheme for use with multiblock grids [AIAA PAPER 89-0472] p 285 A89-25387
- [AIAA PAPER 89-0472] p 285 A89-25387 Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic flows
- [AIAA PAPER 89-0562] p 287 A89-25451 An Euler analysis of leading-edge vortex flows on a
- forebody-strake at supersonic speeds [AIAA PAPER 89-0343] p 293 A89-26371
- Euler flow solutions for transonic shock wave-boundary layer interaction p 295 A89-28074 Unsteady Euler cascade analysis
- [AIAA PAPER 89-0322] p 295 A89-28406 Numerical analysis of flow through oscillating cascade sections
- [AIAA PAPER 89-0437] p 296 A89-28413 Numerical solution of flow fields around Delta wings using Euler equations method
- [NAL-TM-FM-8701] p 299 N89-16757 Full-potential integral solutions for steady and unsteady transonic airfoils with and without embedded Euler domains p 301 N89-17566

EXHAUST FLOW SIMULATION

- Comparison of 3D computation and experiment for non-axisymmetric nozzles [AIAA PAPER 89-0007] p 325 A89-28403
- EXHAUST GASES The effect of exhaust plume/afterbody interaction on
- Installed scramjet performance [AIAA PAPER 89-0032] p 272 A89-25028
- The effect of exhaust plume/afterbody interaction on installed Scramjet performance [NASA-TM-101033] p 330 N89-17600
- [NASA-TM-101033] p 330 N89-17600 EXHAUST NOZZLES
- Measurements of gas turbine combustor and engine augmentor tube sooting characteristics
- [AD-A199768] p 328 N89-16821 EXPERT SYSTEMS
- Pattern-based fault diagnosis using neural networks
- p 354 A89-27602 Integrating causal reasoning at different levels of abstraction --- in problem-solving system functioning as
- pilot assistant in commercial air transport emergencies p 355 A89-27609 The development of an automated flight test
- management system for flight test planning and p 312 A89-27613 monitoring generation Flight mission scenario with knowledge-based system p 355 A89-27614 Automatic acquisition of domain and procedura p 318 A89-27624 knowledge
- Applying evidential reasoning to avionics troubleshooting p 355 A89-27629
- Controls and guidance: Aeronautics p 334 N89-18401
- EXTERNAL STORE SEPARATION Transonic store separation using a three-dimensional
 - chimera grid scheme [AIAA PAPER 89-0637] p 296 A89-28442
 - F

F-111 AIRCRAFT

- Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925
- F-14 AIRCRAFT
- IFM applications to cavity flowfield predictions [AIAA PAPER 89-0477] p 285 A89-25390 F-14 flow field simulation [AIAA PAPER 89-0642] p 296 A89-28444 F-15 AIRCRAFT Departure resistance and spin characteristics of the F-15 S/MTD [AIAA PAPER 89-0012] p 331 A89-25008 Anile Fibrer Aircraft Simulation
- Agile Fighter Aircraft Simulation

 [AIAA PAPER 89-0015]
 p 331
 A89-25011

- Laboratory and flight evaluation of the Integrated Inertial Sensor Assembly (IISA) p 307 A89-26708 F-16 AIRCRAFT
- Unsteady transonic algorithm improvements for realistic aircraft applications p 312 A89-27738 F-18 AIRCRAFT
- A patched-grid algorithm for complex configurations directed towards the F-18 aircraft
- [AIAA PAPER 89-0121] p 310 A89-25106 Navier-Stokes solutions about the F/A-18 forebody-LEX configuration and Leading Edge Extension
- configuration --- Leading Edge Extension [AIAA PAPER 89-0338] p 281 A89-25285 Numerical simulation of high-incidence flow over the 18 functions forshort.
- F-18 fuselage forebody [AIAA PAPER 89-0339] p 282 A89-25286 FABRICATION
- The effects of a compressor rebuild on gas turbine engine performance p 327 N89-16803 Joining of carbon fiber composite with fasteners
- p 343 N89-17701 FACTORIZATION Scramjet analysis with chemical reaction using
- three-dimensional approximate factorization [AIAA PAPER 89-0672] p 323 A89-25533
- [AIAA PAPER 89-06/2]
 p 323
 A89-25533

 Navier-Stokes simulation of wind-tunnel flow using
 LU-ADI factorization algorithm
 p 291
 A89-25864
- FAILURE ANALYSIS Maintenance aid system for wide body aircraft
 - p 327 N89-16805 Fault management in aircraft power plant controls
- p 327 N89-16809
- An analysis method for bolted joints in primary composite aircraft structure p 317 N89-17691 FASTENERS
- Joining of carbon fiber composite with fasteners p 343 N89-17701
- FATIGUE (MATERIALS) On board life monitoring system Tornado (OLMOS)
- p 319 N89-16785 Information management systems for on-board monitoring systems p 319 N89-16786 FAULT TOLERANCE
- Ranging and Processing Satellite (RAPSAT)
- p 340 A89-26738 The Honeywell/DND helicopter integrated navigation system (HINS) p 308 A89-26741
- FEEDBACK CONTROL Inertial energy distribution error control for optimal wind shear penetration
- [AIAA PAPER 89-0016] p 331 A89-25012 Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law
- (AIAA PAPER 89-0018) p 331 A89-25014 Control of nearly singular decoupling systems and nonlinear aircraft maneuver p 332 A89-25692 An H(infinity) method for the design of linear time-invariant multivariable sampled-data control
- systems p 354 A89-26187 Feedback control of vibrations in an extendible cantilever sweptback wing p 332 A89-26193
- FEEDERS MPC-75 feeder civil aircraft
- [AD-4200907] p 317 N89-17594 FIBER COMPOSITES
- Damage tolerance behavior of fiber reinforced composite airframes p 316 N89-17278 FIBER OPTICS
- International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings p 348 A89-27651
- p 348 A89-27651 Fiber optic torquemeter design and development p 348 A89-27661
- p 348 A89-2766" FIELD EFFECT TRANSISTORS
- Temperature compensation using GaAs MMIC devices p 347 A89-26548

FIGHTER AIRCRAFT

- Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014
- [AIAA PAPER 89-0018] p 331 A89-25014 TranAir and Euler computations of a generic fighter including comparisons with experimental data ----
- full-potential equations for transonic flow [AIAA PAPER 89-0263] p 310 A89-25221
- Improved reliability and maintainability for fighter aircraft Environmental Control Systems
- [SAE PAPER 880999] p 312 A89-27808 Conceptual design of a STOVL fighter/attack aircraft [SAE PAPER 881431] p 313 A89-28206 Computer-generated map display for the pilot/vehicle
- interface [SAE PAPER 881440] p 319 A89-28214 LDV surveys over a fighter model at moderate to high
- angles of attack [SAE PAPER 881448] p 295 A89-28218

FIRE PREVENTION

- [AD-A200263] p 270 N89-16720 Tactical fighter inlets p 298 N89-16740 Inlet-engine compatibility p 314 N89-16741 Particular flight mechanics specifications related to wind tunnel test results p 339 N89-16879 Vibration and aeroelastic tailoring of advanced composite plate-like lifting surfaces p 351 N89-17263 Design synthesis for canard-delta combat aircraft, volumes 1 and 2 p 316 N89-17590 FINITE DIFFERENCE THEORY A numerical method for unsteady transonic flow about p 291 A89-25929 tapered wings Combustor air flow prediction capability comparing everal turbulence models p 349 A89-28345 FINITE ELEMENT METHOD Fast laminar near wake flow calculation by an implicit method solving the Navier-Stokes equations p 270 A89-24923 Passage-averaged Navier-Stokes equations with finite element applications [AIAA PAPER 89-0208] p 344 A89-25183 Numerical solutions on a Pathfinder and other configurations using unstructured grids and a finite element [AIAA PAPER 89-0362] p 282 A89-25306 An adaptive implicit/explicit finite element scheme for compressible viscous high speed flow [AIAA PAPER 89-0363] p 344 A89-25307 Adaptive H-refinement on 3-D unstructured grids for transient problems [AIAA PAPER 89-0365] p 283 A89-25309 An efficient, explicit finite-rate algorithm to compute flows in chemical nonequilibrium [AIAA PAPER 89-0522] p 285 A89-25418 Progress on a Taylor weak statement finite element algorithm for high-speed aerodynamic flows [AIAA PAPER 89-0654] p 289 A89-25517 A three-dimensional upwind finite element point implicit unstructured grid Euler solver [AIAA PAPER 89-0658] p 289 A89-25521 Finite element analysis of composite rudder for DO 228 ircraft p 347 A89-26284 aircraft Finite element simulation of 3D turbulent free shear p 294 A89-26946 Analysis of structures with rotating, flexible substructures flows applied to rotorcraft aeroelasticity p 312 A89-27695 A computational procedure for automated flutter
- analysis p 348 A89-28070 The design, construction and test of a postbuckled, carbon fibre reinforced plastic wing box
- p 315 N89-16773 Turbine Engine Hot Section Technology, 1987
- [NASA-CP-2493] p 351 N89-17298 Structural response of an advanced combustor liner:
- Test and analysis p 351 N89-17329 High temperature constitutive and crack initiation modeling of coated single crystal superalloys
- p 342 N89-17334
 - Efficient finite-volume parabolized Navier-Stokes solutions for three-dimensional, hypersonic, chemically reacting flowfields
 - [AIAA PAPER 89-0103] p 274 A89-25090 Supersonic inlet calculations using an upwind finite-volume method on adaptive unstructured grids
 - [AIAA PAPER 89-0113] p 274 A89-25100 Analysis of three-dimensional aerospace configurations using the Euler equations
 - [AIAA PAPER 89-0268] p 279 A89-25226 Three-dimensional hybrid finite volume solutions to the
 - Euler equations for supersonic/hypersonic aircraft [AIAA PAPER 89-0281] p 280 A89-25238 The design and application of upwind schemes on
 - unstructured meshes [AIAA PAPER 89-0366] p 354 A89-25310 Two-dimensional Euler computations on a triangular
 - mesh using an upwind, finite-volume scheme [AIAA PAPER 89-0470] p 354 A89-25385
 - A cell-vertex multigrid Euler scheme for use with multiblock grids [AIAA PAPER 89-0472] p 285 A89-25387
 - [AIAA PAPER 89-0472] p 285 A89-25387 An investigation of cell centered and cell vertex multigrid schemes for the Navier-Stokes equations
 - [AIAA PAPER 89-0548] p 345 A89-25440 An improved upwind finite volume relaxation method for
- high speed viscous flows [AIAA PAPER 89-0549] p 286 A89-25441 FINNED BODIES
- Transonic Euler solutions on mutually interfering finned bodies
- [AIAA PAPER 89-0264] p 278 A89-25222 FIRE PREVENTION

Problems of ensuring civil-aircraft fire safety p 304 A89-27249
status

FITTINGS

Materials for interiors - A brief review of their current

Typical joints in a wing structure p 317 N89-17693 FLAPS (CONTROL SURFACES)

p 342 A89-28433

Integrating causal reasoning at different levels of	The vertical motion simulator p 339 N89-18384
pilot assistant in commercial air transport emergencies	Photo-based three dimensional graphics models for
p 355 A89-27609	multi-sensor simulation terrain data bases for flight
Impact of severe weather on aviation - A pilot	Simulator p 348 A69-27787 The vertical motion simulator p 339 N89-18384
Viewpoint [AIAA 89-0798] p 353 A89-28461	FLIGHT TESTS
Effect of heavy rain on aviation engines	Laboratory and flight evaluation of the Integrated Inertial
[AIAA 89-0799] p 326 A89-28462 Diloted-simulation evaluation of escape quidance for	Correction for deflections of the vertical at the runup
microburst wind shear encounters	site p 307 A89-26725
[NASA-TP-2886] p 321 N89-16820	The development of an automated flight test management system for flight test planning and
Air traffic control automation concepts to optimize flight	monitoring p 312 A89-27613
management system utilization p 307 A89-26733	International Instrumentation Symposium, 34th,
Aircraft automation with an electronic library system	p 348 A89-27651
system for commercial avionics	Software control of a high speed, modular signal
[SAE PAPER 881415] p 318 A89-28199	conditioner and PCM encoder system n 318 A89-27670
[SAE PAPER 881416] p 319 A89-28200	Real-time comparison of X-29A flight data and simulation
Real-time simulation for survivable penetration	data p 332 A89-27736
[SAE PAPER 881515] p 333 A89-28236	[SAE PAPER 881418] p 324 A89-28202
Dynamic response of aircraft autopilot systems to	The current status of the flight test of the ASKA
atmospheric disturbances p 333 A89-27737	[SAE PAPER 881433] p 314 A69-26208 Determination of longitudinal aerodynamic derivatives
Particular flight mechanics specifications related to wind tunnel test results p 339 N89-16879	using flight data from an icing research aircraft
FLIGHT OPERATIONS	[AIAA 89-0754] p 333 A89-28454
Do pilots let aircraft operations schedules influence	I he development of a capability for aerodynamic testing of large-scale wind sections in a simulated natural rain
[AIAA PAPER 89-0743] p 303 A89-25558	environment
FLIGHT OPTIMIZATION	[AIAA 89-0762] p 337 A89-28457
Air traffic control automation concepts to optimize flight	[NASA-CR-177507] p 301 N89-17577
Overview of optimal trajectories for flight in a	Tip aerodynamics and acoustics test: A report and data
windshear	SUFVEY [NASA_DD_1170] n 302 N89-17579
[AIAA 89-0812] p 306 A89-28464 FLIGHT PATHS	Flight measured downwash of the QSRA
Precision trajectory reconstruction	[NASA-TM-101050] p 316 N89-17593
p 307 A89-26726	FLIGHT VEHICLES Modal control in systems with aftereffect
problem of flight path generation in a military hostile	p 354 A89-26038
environment p 355 A89-27611	FLOORS Effects of aircraft size on cabin floor dynamic pulses
drop of loads p 333 A89-28396	[SAE PAPER 881379] p 305 A89-28191
FLIGHT PLANS	FLOW CHARACTERISTICS
The effects of enroute turbulence reports on air carrier	flows
[AIAA PAPER 89-0741] p 303 A89-25557	[AIAA PAPER 89-0207] p 277 A89-25182
The effects of inclement weather on airline operations	Intake-airframe integration p 315 N89-16744
[AIAA PAPER 89-0797] p 304 A89-25585 Flight mission scenario generation with	FLOW DEFLECTION
knowledge-based system p 355 A89-27614	Evolution of perturbations near a surface in supersonic
FLIGHT RECORDERS	flow p 294 A89-27384
contribution to aircraft accident investigations	A free-trailing vane flow direction indicator employing
p 318 A89-27247	a linear output Hall effect transducer
Analysis of windshear from alline flight data p 332 A89-27734	p 336 A89-27675
FLIGHT SAFETY	The effect of Mach number on the stability of a plane
Selection of the critical icing/flight case for an	supersonic wave
[AIAA PAPER 89-0757] p 303 A89-25563	[AIAA PAPER 89-0285] p 280 A89-25242
National lightning detection - A real-time service to	at large Revnolds numbers p 293 A89-26163
aerospace (AIAA PAPER 89-07871 p.352 A89-25578	Effects of a downstream disturbance on the structure
Weather data dissemination to aircraft	of a turbulent plane mixing layer p 348 A89-27692
[AIAA PAPER 89-0809] p 304 A89-25592	FLOW DISTRIBUTION Flow-field characteristics and normal-force correlations
of responsibilities p 357 A89-26665	for delta wings from Mach 2.4 to 4.6
Problems of ensuring civil-aircraft fire safety	[AIAA PAPER 89-0026] p 272 A89-2502
p 304 A89-27249 Sensor consideration in the design of a windshear	Effects of leading-edge snape and vortex burst on the flowfield of a 70-degree-sweep delta-wing
detection and guidance system	[AIAA PAPER 89-0086] p 274 A89-25070
[SAE PAPER 881417] p 319 A89-28201	Streamlines and streamribbons in aerodynamics
ne integration of European hight-salety systems p 308 A89-28292	[AIAA PAPER 89-0140] p 276 A69-2512 Production of 2D multi-stage turbing flow field using a
Ways to solve current flight-safety problems	multiple-grid Euler solver
p 305 A89-28294 Suptom considerations for integrated machinery health	[AIAA PAPER 89-0203] p 277 A89-25176
monitoring p 327 N89-16804	An experimental investigation of the effects of a base
FLIGHT SIMULATION	and transonic speeds
Agile Fighter Aircraft Simulation [AIAA PAPER 89-0015] D 331 A89-25011	[AIAA PAPER 89-0210] p 277 A89-2518
Determination of the numerical integration step during	Analysis of three-dimensional aerospace configuration using the Fuler equations
the analog-digital modeling of dynamic systems	[AIAA PAPER 89-0268] p 279 A89-2522
p 354 A89-27405 Real-time comparison of X-29A flight data and simulation	Effect of nose bluntness on flow field over slender bodie
data p 332 A89-27736	in hypersonic flows
Simulation evaluation of transition and hover flying qualities of the E-7A STOV/ pircreft	Supersonic sudden-expansion flow with fluid injection
[SAE PAPER 881430] p 333 A89-28205	An experimental and computational study
	All experimental and competational study
Piloted-simulation evaluation of escape guidance for	[AIA PAPER 89-0389] p 284 A89-25326
Piloted-simulation evaluation of escape guidance for microburst wind shear encounters [NASA-TP-2866] n 321 NR9-16820	[AIAA PAPER 89-0389] p 284 A89-25320 IFM applications to cavity flowfield predictions [AIAA PAPER 89-0477] p 285 A89-25390
Piloted-simulation evaluation of escape guidance for microburst wind shear encounters [NASA-TP-2886] p 321 N89-16820	[AIAA PAPER 89-0389] p 284 A89-2532 IFM applications to cavity flowfield predictions [AIAA PAPER 89-0477] p 285 A89-2539

Unsteady, separated flow behind an oscillating,	view
two-dimensional flap [AIAA PAPER 89-0288] p 280 A89-25245	[AIA
FLAT PLATES	[AIA]
Free vibration and panel flutter of quadrilateral laminated	Pi
Some implications of warping restraint on the behavior	[NA
of composite anisotropic beams p 312 A89-27747	FLIGH
Analysis of structures with rotating, flexible substructures	Ai man
applied to rotorcraft aeroelasticity p 312 A89-27695	Ai
FLEXIBLE WINGS Numerical simulation of vortical flows on flexible winds	high syste
[AIAA PAPER 89-0537] p 286 A89-25431	[SA
Some implications of warping restraint on the behavior of composite anisotropic beams p 312 A89-27747	U: [SAI
FLIGHT CONDITIONS	R
Weather accident prevention using the tools that we	(SA
[AIAA PAPER 89-0707] p 302 A89-25547	D
Severe weather - Impact on aviation and FAA programs	atmo
[AIAA PAPER 89-0794] p 352 A89-25583	tunn
Impact of severe weather on aviation - An NWS	FLIGH
perspective [AIAA PAPER 89-0795] p 304 A89-25584	enro
The effects of inclement weather on airline operations	[AIA]
[AIAA PAPER 89-0797] p 304 A89-25585 Weather data dissemination to aircraft	FLIGH
[AIAA PAPER 89-0809] p 304 A89-25592	man
Flow measurement on the fuselage of a Boeing 737 airolane	O
[AIAA PAPER 89-0209] p 295 A89-28404	[AIA]
Impact of severe weather on aviation - A pilot	FLIGH
[AIAA 89-0798] p 353 A89-28461	PI
Effect of heavy rain on aviation engines	A
FLIGHT CONTROL	envi
Agile Fighter Aircraft Simulation	D
[AIAA PAPEH 89-0015] p 331 A89-25011 Inertial energy distribution error control for optimal wind	drop FLIGH
shear penetration	TI
[AIAA PAPEH 89-0016] p 331 A89-25012 An analysis of lateral-directional handling gualities and	fligh [AlA
eigenstructure of high performance aircraft	T
[AIAA PAPER 89-0017] p 331 A89-25013 Laboratory and flight evaluation of the Integrated Inertial	(AIA FI
Sensor Assembly (IISA) p 307 A89-26708	kno
Advanced flight control for the Fokker 100	FLIGH
[SAE PAPER 881373] p 333 A89-28185 Modal control of an oblique wing aircraft	con
[NASA-TP-2898] p 333 N89-16845	
Controls and guidance: Aeronautics	~
FLIGHT HAZARDS	FLIGH
On design and projected use of Doppler radar and	unp
IOW-IEVEL WINDSNEAR AIERT SYSTEMS IN AIRCRATT TERMINAL Operations	[AI/
[AIAA PAPER 89-0704] p 302 A89-25545	aero
Weather accident prevention using the tools that we have	[AIA]
[AIAA PAPER 89-0707] p 302 A89-25547	۷۷ AIA]
A numerical investigation of the influence of surface	Ţ
[AIAA PAPER 89-0737] p 346 A89-25554	or re P
Enroute convective turbulence deviation considerations	-
on short segments [AIAA PAPER 89-0738] n 302 A89-25555	S dete
Enroute turbulence avoidance procedures	[SA
[AIAA PAPER 89-0739] p 303 A89-25556	т
Do pilots let aircraft operations schedules influence enroute turbulence avoidance procedures?	v
[AIAA PAPER 89-0743] p 303 A89-25558	e
TDWR display experiences Terminal Doppler Weather	moi
[AIAA PAPER 89-0807] p 346 A89-25590	FLIG
Cockpit display of hazardous weather information	۸ (Al)
[AIAA PAPER 89-0808] p 335 A89-25591 The effect of a ground-based inversion layer on an	
impacting microburst	the
[AIAA PAPER 89-0810] p 352 A89-25593	F
An unsteady vortex-ring model for microburst simulation	dat S
[AIAA PAPER 89-0811] p 353 A89-25594	qua
Numerical simulation of microburst downdrafts -	[SA
technology	mic
[AIAA PAPER 89-0821] p 353 A89-25599	[N#
• • •	
A-14	

Evaluation of three turbulence models for the prediction of steady and unsteady airloads [AIAA PAPER 89-0609] p 288 A89-25485 Laser velocimeter measurements of the flowfield generated by an advanced counterrotating propeller [AIAA PAPER 89-0434] p 293 A89-26373 Miniaturized compact water-cooled pitot-pressure probe for flow-field surveys in hypersonic wind tunnels p 348 A89-27659 Diagonal implicit multigrid calculation of inlet flowfields p 294 A89-27716 Modular analysis of scramjet flowfields p 325 A89-28337 Comparison of 3D computation and experiment for non-axisymmetric nozzles [AIAA PAPER 89-0007] p 325 A89-28403 Flow measurement on the fuselage of a Boeing 737 airolane [AIAA PAPER 89-0209] p 295 A89-28404 Transonic store separation using a three-dimensional chimera grid scheme [AIAA PAPER 89-0637] p 296 A89-28442 F-14 flow field simulation [AIAA PAPER 89-0642] p 296 A89-28444 Investigation of the flow in the diffuser section of the NASA Lewis Icing Research Tunnel [AIAA 89-0755] p 336 A89-28455 Vortex dynamics for rotorcraft interactional aerodynamics [AD-A200128] p 297 N89-16726 Numerical solution of flow fields around Delta wings using Euler equations method [NAL-TM-FM-8701] p 299 N89-16757 Reynolds number effects in transonic flow [AGARD-AG-303] p 300 N89-16760 Shock losses in transonic and supersonic compressor cascades p 329 N89-16829 Accuracy of various wall-correction methods for 3D subsonic wind-tunnel testing p 338 N89-16863 Accuracy problems in wind tunnels during transport p 338 N89-16877 aircraft development Measurement of airfoil heat transfer coefficients on a turbine stage p 351 N89-17311 An experimental investigation of the perpendicular vortex-airfoil interaction at transonic speeds p 301 N89-17569 A numerical simulation of flows about two-dimensional bodies of parachute-like configuration [ISAS-629] p 302 N89-17580 FLOW EQUATIONS Numerical simulation of vortical flows on flexible wings [AIAA PAPER 89-0537] p 286 A89-25431 Direct solution of unsteady transonic flow equations in frequency domain MAA PAPER 89-0641] p 288 A89-25507 Derivation of an integral equation for large disturbing [AIAA PAPER 89-0641] transonic flow and its numerical method of undercritical p 293 A89-25944 flow FLOW GEOMETRY Measurements of a supersonic turbulent boundary layer with mass addition [AIAA PAPER 89-0135] p 344 A89-25119 Comparison of LDV measurements and Navier-Stokes solutions in a two-dimensional 180-degree turn-around duct [AIAA PAPER 89-0275] p 279 A89-25232 Computation of turbulent incompressible wing-body junction flow [AIAA PAPER 89-0279] p 310 A89-25236 Navier-Stokes solutions for vortical flows over a tangent-ogive cylinder [AIAA PAPER 89-0337] p 281 A89-25284 Navier-Stokes computations of separated vortical flows past prolate spheroid at incidence [AIAA PAPER 89-0553] p 286 A89-25443 Simple turbulence models for supersonic and hypersonic flows - Bodies at incidence and compression corners [AIAA PAPER 89-0669] p 289 A89-25530 p 289 A89-25530 FLOW MEASUREMENT Laser holographic interferometric measurements of the flow in a scramjet inlet at Mach 4 [AIAA PAPER 89-0043] p 273 A89-25037

 [Alice Particle Besture 3]
 p. 273
 A89-25037

 Flow quality measurements for the Langley 8-foot transonic pressure tunnel LFC experiment
 [Alice Particle 3]
 p. 276
 A89-25133

 [Alice Particle 3]
 p. 276
 A89-25133
 [Alice 3]
 p. 276
 A89-25133

Flow measurements of an airfoil with single-slotted flap [AIAA PAPER 89-0533] p 286 A89-25427

Boundary layer measurements on an airfoil at low Reynolds numbers in an accelerating flow from a nonzero base velocity [AIAA PAPER 89-0569] p 288 A89-25458

Turbulence measurements in a radial upwash p 294 A89-27706

Flow measurement on the fuselage of a Boeing 737 [AIAA PAPER 89-0209] p 295 A89-28404 FLOW RESISTANCE The influence of freestream vorticity on particle lift, drag, and heat transfer [AIAA PAPER 89-0555] p 345 A89-25445 FLOW STABILITY The effect of Mach number on the stability of a plane supersonic wave [AIAA PAPER 89-0285] p 280 A89-25242 Numerical simulation of the growth of instabilities in supersonic free shear layers [AIAA PAPER 89-0376] p 283 A89-25319 FLOW THEORY Evolution of particle-laden jet flows - A theoretical and perimental study p 348 A89-27693 FLOW VELOCITY Relation between diffusor losses and the inlet flow conditions of turbojet combustors p 322 A89-24916 Airblast atomization at conditions of low air velocity [AIAA PAPER 89-0217] p 344 A89-25191 Effects of energy release on high-speed flows in an axisymmetric compustor [AIAA PAPER 89-0385] p 283 A89-25326 A study of turbomachine flow velocities [AIAA PAPER 89-0839] p 34 p 346 A89-25608 Preliminary results in the development of a method to correct propeller inflow for improved unsteady force calculations [AIAA PAPER 89-0436] p 293 A89-26374

Low-speed vortical flow over a 5-degree cone with tip geometry variations [SAE PAPER 881422] p 295 A89-28203

LDV surveys over a fighter model at moderate to high angles of attack [SAE PAPER 881448] p 295 A89-28218

Boundaries of linear characteristics of cambered and twisted wings at subcritical Mach numbers [ESDU-88030] p 298 N89-16735

Axial velocity density ratio influence on exit flow angle in transonic/supersonic cascades p 329 N89-16830 FLOW VISUALIZATION

Aerodynamic visualization for impulsively started airfolis p 270 A89-24925 Flow visualization studies of the Mach number effects on the dynamic stall of an oscillating airfol [AIAA PAPER 89-0023] p 271 A89-25019

 [AIAA PAPER 89-0023]
 p 271
 A89-25019

 Microtuft flow visualization at Mach 10 and 14 in the
 NSWC hypervelocity wind tunnel No. 9

 [AIAA PAPER 89-0041]
 p 334
 A89-25035

 [AlaA PAPER 69-0041]
 p 334
 A89-25035

 Visualization measurements of vortex flows
 [AlaA PAPER 89-0191]
 p 276
 A89-25166

A flow visualization and aerodynamic force data evaluation of spanwise blowing on full and half span delta wings

[AIĂA PAPER 89-0192] p 276 A89-25167 Combined tangential-normal injection into a supersonic flow

[AIAA PAPER 89-0622] p 288 A89-25492 Flow visualization investigation of dynamic stall on a pitching airfoil

[AIAA PAPER 89-0842] p 290 A89-25611 The effects of aspect ratio on the stall of a finite wing [AIAA PAPER 89-0570] p 296 A89-28434 FLUID DYNAMICS

Evaluation of three turbulence models for the prediction of steady and unsteady airloads [AIAA PAPER 89-0609] p 288 A89-25485

[AIAA PAPER 89-0609] p 288 A89-25485 FLUID FLOW

Coolant passage heat transfer with rotation p 351 N89-17314 FLUID INJECTION

Combined tangential-normal injection into a supersonic flow

[AIAA PAPER 89-0622] p 288 A89-25492 FLUID PRESSURE

Shock capturing using a pressure-correction method [AIAA PAPER 89-0561] p 345 A89-25450 FLUTTER

Oscillating aerodynamics and flutter of an aerodynamically detuned cascade in an incompressible flow

[AIAA PAPER 89-0289] p 280 A89-25246 Active control of aeroelastic systems governed by functional differential equations p 332 A89-25871 FLUTTER ANALYSIS

A state-space model of unsteady aerodynamics in a compressible flow for flutter analyses

[AIAA PAPER 89-0022] p 271 A89-25018 Direct solution of unsteady transonic flow equations in frequency domain

[AIAA PAPER 89-0641] p 288 A89-25507 Vibration and flutter analysis of composite wing panels p 346 A89-26273

FUEL COMBUSTION

Free vibration and panel flutter of quadrilateral laminated plates p 347 A89-26274 Aeroelastic flutter of low aspect ratio cantilever omposite plate p 347 A89-26281 composite plate Unsteady transonic algorithm improvements for realistic aircraft applications p 312 A89-27738 Technique for the prediction characteristics in separated flow of airfoil flutter D 348 A89-27744 A computational procedure for automated flutter analysis p 348 A89-28070 FLUX VECTOR SPLITTING A comparative study of iterative algorithms for the Euler quations of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101 An implicit flux-vector splitting scheme for the computation of viscous hypersonic flow [AIAA PAPER 89-0274] p 279 A89-25231 Navier-Stokes computations of separated vortical flows past prolate spheroid at incidence [AIAA PAPER 89-0553] p 286 A89-25443 FLY BY WIRE CONTROL The all electric airplane revisited [SAE PAPER 881407] p 314 A89-28256 FOKKER AIRCRAFT Advanced flight control for the Fokker 100 [SAE PAPER 881373] p 333 p 333 A89-28185 FORCE DISTRIBUTION Lift and longitudinal forces on propeller/nacelle/wing/flap systems [ESDU-88031] p 298 N89-16736 ESDU-88031 j Expriments on the DFVLR-F4 wing body configuration a several European windtunnels p 337 N89-16848 in several European windtunnels FOREBODIES A numerical study of hypersonic propulsion/airframe integration problem [AIAA PAPER 89-0030] p 272 A89-25026 Navier-Stokes solutions about the F/A-18 forebody-LEX configuration --- Leading Edge Extension [AIAA PAPER 89-0338] p 2 p 281 A89-25285 Numerical simulation of high-incidence flow over the F-18 fuselage forebody [AIAA PAPER 89-0339] p 282 A89-25286 An Euler analysis of leading-edge vortex flows on a forebody-strake at supersonic speeds [AIAA PAPER 89-0343] p 293 A89-26371 Wing rock generated by forebody vortices p 312 A89-27735 FORWARD SCATTERING Performance of the forward scattering spectrometer probe in NASA's loing Research Tunnel AIAA PAPER 89-0769] p 346 A89-25570 FRACTURE MECHANICS ACTURE MECHANICS Review of existing NDT technologies and their apabilities p 349 N89-17255 capabilities Relationships of nondestructive evaluation needs and component design p 349 N89-17256 Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine scs p 350 N89-17257 Turbine Engine Hot Section Technology, 1987 [NASA-CP-2493] p 351 N89-17298 FREE FLOW Adaptive computations of multispecies mixing between cramjet nozzle flows and hypersonic freestream AIAA PAPER 89-0009 p 322 A89-25005 [AIAA PAPER 89-0009] Direct numerical simulation of compressible free shear [AIAA PAPER 89-0374] p 283 A89-25317 Numerical simulation of the growth of instabilities in supersonic free shear layers [AIAA PAPER 89-0376] p 283 A89-25319 Boundary layer measurements on an airfoil at low Reynolds numbers in an accelerating flow from a nonzero base velocity [AIAA PAPER 89-0569] p 288 A89-25458 FREE JETS The turbulent free jet issuing from a sharp-edged elliptical slot [AIAA PAPER 89-0664] p 345 A89-25526 FREE VIBRATION Free vibration and panel flutter of guadrilateral laminated plates p 347 A89-26274 FRICTION MEASUREMENT A summary of recent aircraft/ground vehicle friction measurement tests [SAE PAPER 881403] p 336 A89-28196 FUEL COMBUSTION Correlations of high density fuel effects [AIAA PAPER 89-0216] p 3 p 340 A89-25190 3-D combustor performance validation with high density fuels [AIAA PAPER 89-0219] p 340 A89-25193 Experimental and analytical study on exit radial temperature profile of experimental 2D combustor [AIAA PAPER 89-0493] p 340 A89-25403

FUEL CONSUMPTION

An investigation of the physical and chemical factors affecting the perfomance of fuels in the JFTOT --- Jet rmal Oxidation Tester Fuel Th

p 341 A89-28242 [SAE PAPER 881533] FUEL CONSUMPTION

implementation using Aircraft vertical profile p 332 A89-25683 directed-graph methods FUEL INJECTION

- Supersonic sudden-expansion flow with fluid injection -An experimental and computational study
- p 284 A89-25328 [AIAA PAPER 89-0389] A model for 3-D sonic/supersonic transverse fuel injection into a supersonic air stream

p 345 A89-25376 [AIAA PAPER 89-0460] FUEL SPRAYS

- Airblast atomization at conditions of low air velocity p 344 A89-25191 [AIAA PAPER 89-0217] Evolution of particle-laden jet flows - A theoretical and p 348 A89-27693 experimental study
- FUEL TESTS
- An investigation of the physical and chemical factors affecting the perfomance of fuels in the JFTOT --- Jet Fuel Thermal Oxidation Tester
- p 341 A89-28242 [SAE PAPER 881533] Development of a laboratory method for studying water coalescence of aviation fuel
- p 341 A89-28243 [SAE PAPER 881534] Ball-on-cylinder testing for aviation fuel lubricity p 341 A89-28244
- [SAE PAPER 881537] FUEL-AIR BATIO Combined tangential-normal injection into a supersonic
- flow p 288 A89-25492
- [AIAA PAPER 89-0622] Measurements of gas turbine combustor and engine augmentor tube sooting characteristics
- p 328 N89-16821 [AD-A199768] FULL SCALE TESTS
- National full-scale aerodynamic complex integrated p 335 A89-27653 systems test data system The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment
- p 337 A89-28457 [AIAA 89-0762] FURNACES
- High-temperature containerless aircraft furnace experimentation in the microgravity environment aboard a KC-135 aircraft
- p 345 A89-25337 AIAA PAPER 89-0402] FUSELAGES
- Three-dimensional compressible boundary layer calculations to fourth order accuracy on wings and fuselages
- [AIAA PAPER 89-0130] p 275 A89-25115 A transonic computational method for an aft-mounted nacelle/pylon configuration with propeller power effect (AIAA PAPER 89-0560) p 311 A89-25449
- [AIAA PAPER 89-0560] Transport airplane fuselage section longitudinal impact test p 305 A89-28189
- [SAE PAPER 881377] Flow measurement on the fuselage of a Boeing 737 airplane
- p 295 A89-28404 [AIAA PAPER 89-0209] p 317 N89-17693 Typical joints in a wing structure

G

GALLIUM ARSENIDES

- Temperature compensation using GaAs MMIC devices p 347 A89-26548
- GAS ATOMIZATION
- Airblast atomization at conditions of low air velocity [AA PAPER 89-0217] p 344 A89-25191 [AIAA PAPER 89-0217] A new technique for the production of gas atomized p 340 A89-25902
- GAS COOLING

A-16

- A dynamic model for vapor-cycle cooling systems --for aircraft p 313 A89-27809 [SAE PAPER 881001]
- GAS DYNAMICS
- A comparative study of iterative algorithms for the Euler equations of gasdynamics
- p 343 A89-25101 [AIAA PAPER 89-0114] and sensor fault Gas path modelling, diagnosis p 321 N89-16811 detection
- GAS FLOW Airblast atomization at conditions of low air velocity AIAA PAPER 89-0217] p 344 A89-25191 [AIAA PAPER 89-0217] Gas path modelling, diagnosis and sensor fault p 321 N89-16811 detection
- GAS INJECTION Influence of vane/blade spacing and injection on stage p 325 A89-28342 heat-flux distributions GAS PATH ANALYSIS
- Gas path analysis and engine performance monitorin p 327 N89-16802 in a Chinook helicopter

- Gas path modelling, diagnosis and sensor fault p 321 N89-16811 detection Gas path condition monitoring using electrostatic p 321 N89-16817
- techniques GAS PRESSURE
- A new technique for the production of gas atomized p 340 A89-25902 nowder GAS TURBINE ENGINES
- Prediction of 3D multi-stage turbine flow field using a multiple-grid Euler solver p 277 A89-25178
- [AIAA PAPER 89-0203] 3-D combustor performance validation with high density fuels p 340 A89-25193
- [AIAA PAPER 89-0219] Influence of clearance leakage on turbine heat transfer at and near blade tips - Summary of recent results p 344 A89-25275 [AIAA PAPER 89-0327]
- Experimental and analytical study on exit radial temperature profile of experimental 2D combustor p 340 A89-25403 [AIAA PAPER 89-0493]
- Pneumatic link secondary power systems for military aircraft
- p 325 A89-28265 [SAE PAPER 881499] T-100 Multipurpose Small Power Unit - Technology for the next generation auxiliary power units
- p 349 A89-28267 (SAE PAPER 881501) Composite mechanics for engine structures p 341 A89-28344
- Combustor air flow prediction capability comparing p 349 A89-28345 several turbulence models
- Effect of heavy rain on aviation engines p 326 A89-28462 [AIAA 89-0799] The effects of a compressor rebuild on gas turbine
- N89-16803 p 327 engine performance System-theoretical method for dynamic on-condition p 321 N89-16812 monitoring of gas turbines
- Identification of dynamic characteristics for fault isolation purposes in a gas turbine using closed-loop p 328 N89-16813 measurements
- Gas path condition monitoring using electrostatic p 321 N89-16817 techniques Measurements of gas turbine combustor and engine
- augmentor tube sooting characteristics p 328 N89-16821 [AD-A199768]
- Relationships of nondestructive evaluation needs and p 349 N89-17256 component design Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine
- p 350 N89-17257 discs State-of-the-art in non-destructive evaluation of turbine p 350 N89-17261 engine parts
- Turbine Engine Hot Section Technology, 1987 (ASA-CP-2493) p 351 N89-17298 [NASA-CP-2493]
- Aerothermal modeling program. Phase 2, element B: low interaction experiment p 351 N89-17304 Flow interaction experiment Measurement of airfoil heat transfer coefficients on a
- p 351 N89-17311 turbine stage Coolant passage heat transfer with rotation
- p 351 N89-17314 Three-dimensional inelastic analysis methods for hot
- p 351 N89-17316 section components Constitutive modelling of single crystal and directionally
- p 342 N89-17325 solidified superallovs Structural response of an advanced combustor liner: p 351 N89-17329 Test and analysis Thermal barrier coating life
- prediction model p 351 N89-17333 development High temperature constitutive and crack initiation

modeling of coated single crystal superalloys p 342 N89-17334

- Creep fatigue life prediction for engine hot section materials (ISOTROPIC) fifth year progress review p 352 N89-17336
- GAS TURBINES
- Computations of 3D viscous flows in rotating turbomachinery blades p 281 A89-25273
- [AIAA PAPER 89-0323] Measurement and modelling of turbulent spot growth on a gas turbine blade
- p 281 A89-25276 [AIAA PAPER 89-0328] GENERAL AVIATION AIRCRAFT
- MPC-75 feeder civil aircraft p 317 N89-17594 [AD-A200907] GEOSYNCHRONOUS ORBITS The emergence of satellite communication for commercial aircraft
- p 308 A89-28183 [SAE PAPER 881370] GLAZES
- Modeling of surface roughness effects on glaze ice accretion p 305 A89-28451 AIAA 89-07341
- GLOBAL POSITIONING SYSTEM
- EURONAV A state of the art military GPS receiver p 340 A89-26711
- A Kalman filter for an integrated Doppler/GPS navigation p 308 A89-26740 system

- The Honeywell/DND helicopter integrated navigation p 308 A89-26741 system (HINS) GPS antennas for civil aviation n 308 A89-28296 GPS antenna problems for military aircraft A89-28297 p 309
- An antenna for the GPS installation at DFVLR p 309 A89-28298 A GPS receiver antenna with integrated down-mixer

p 309 A89-28299 GRAIN SIZE

A new technique for the production of gas atomized p 340 A89-25902

GRAVITATIONAL EFFECTS VERDICT - A plan for gravity compensation of inertial p 307 A89-26724

- navigation systems GRID GENERATION (MATHEMATICS) Zonal modelling of flows through multiple inlets and
- p 271 A89-25003 [AIAA PAPER 89-0005]
- Prediction of 3D multi-stage turbine flow field using a
- multiple-grid Euler solver p 277 A89-25178 [AIAA PAPER 89-0203] Numerical solutions on a Pathfinder and other
- configurations using unstructured grids and a finite element solver p 282 A89-25306 [AIAA PAPER 89-0362]
- The design and application of upwind schemes on unstructured meshes
- p 354 A89-25310 [AIAA PAPER 89-0366] Conflicting stepsize requirements for stable PNS
- computations p 284 A89-25363 [AIAA PAPER 89-0445]
- A self-adaptive computational method applied to transonic turbulent projectile aerodynamics p 290 A89-25606
- [AIAA PAPER 89-0837] Numerical simulation of viscous transonic flow over the p 291 A89-25863 DFVLR F5 wing
- GROUND EFFECT (AERODYNAMICS)
- Characteristics of the ground vortex formed by a jet moving over a fixed ground plane p 288 A89-25514
- [AIAA PAPER 89-0650] V/STOL aircraft and the problem iet-induced of p 317 N89-18380 suckdown

GROUND STATIONS

HALL EFFECT

HEAT FLUX

HEAT PIPES

heat-flux distributions

HEAT RESISTANT ALLOYS

attrited prealloy powder

solidified superalloys

[AIAA PAPER 89-0029]

[AIAA PAPER 89-0327]

[AIAA PAPER 89-0555]

and heat transfer

HEAT TRANSFER

aircraft

Test and analysis

- Cockpit display of ground-based weather data during thunderstorm research flights p 269 A89-28463 TAIAA 89-08061 GROUND TESTS
- A summary of recent aircraft/ground vehicle friction measurement tests
- n 336 A89-28196 [SAE PAPER 881403] Prop-fan structural results from PTA tests [SAE PAPER 881418] p 324
- p 324 A89-28202 **GUIDANCE SENSORS**
- Laboratory and flight evaluation of the Integrated Inertial p 307 A89-26708 Sensor Assembly (IISA)

Н

A free-trailing vane flow direction indicator employing

Influence of vane/blade spacing and injection on stage

Structural response of an advanced combustor liner:

Superplasticity of HIPped PM superalloys made from

Constitutive modelling of single crystal and directionally

High temperature constitutive and crack initiation

Heat transfer and pressure comparisons between

Influence of clearance leakage on turbine heat transfer

The influence of freestream vorticity on particle lift, drag,

at and near blade tips - Summary of recent results

computation and wind tunnel for a research hypersonic

Material defects in a PM-nickel-base superalloy

modeling of coated single crystal superalloys

p 307 A89-26726

p 336 A89-27675

p 325 A89-28342

p 351 N89-17329

p 314 A89-28255

p 341 A89-25915

p 341 A89-25919

p 342 N89-17325

p 342 N89-17334

p 272 A89-25025

p 344 A89-25275

p 345 A89-25445

Precision trajectory reconstruction

a linear output Hall effect transducer

Topics of aircraft thermal management [SAE PAPER 881381] p 3

- A numerical investigation of the influence of surface roughness on heat transfer in ice accretion [AIAA PAPER 89-0737] p 346 A89-25554
- [AIAA PAPER 89-0737] Experimental research of flow separation, heat transfer and ablation on flat plate-wedges in supersonic, turbulent
- p 292 A89-25938 flow Turbine Engine Hot Section Technology, 1987 [NASA-CP-2493] p 351 N8 p 351 N89-17298
- Measurement of airfoil heat transfer coefficients on a turbine stage p 351 N89-17311 Coolant passage heat transfer with rotation

p 351 N89-17314

- HEAT TRANSFER COEFFICIENTS
- Measurement of airfoil heat transfer coefficients on a turbine stage p 351 N89-17311 Coolant passage heat transfer with rotation
- p 351 N89-17314
- HEAT TREATMENT
- Thermal conductivity and microstructure stability of heat treated AMZIRC copper-based alloys p 341 A89-26361

HELICOPTER DESIGN

- Oscillatory flow field simulation in a blow-down wind tunnel and the passive shock wave/boundary layer control concept
- [AIAA PAPER 89-0214] p 278 A89-25188 Kinematics of U.S. Army helicopter crashes - 1979-85 p 306 A89-28486
- Application of a Comprehensive Analytical Model of Rotor Aerodynamics and Dynamics (CAMRAD) to the McDonnell Douglas AH-64A helicopter
- [NASA-CR-177455] p 301 N89-17578 HELICOPTER ENGINES
- System-theoretical method for dynamic on-condition monitoring of gas turbines p 321 N89-16812 HELICOPTER PERFORMANCE
- Kinematics of U.S. Army helicopter crashes 1979-85
- p 306 A89-28486 HELICOPTER WAKES
- The free-wake prediction of rotor hover performance using a vortex embedding method
- [AIAA PAPER 89-0638] p 296 A89-28443 Development of a panel method for modeling configurations with unsteady component motions, phase
- [AD-A200255] p 315 N89-16775 HELICOPTERS
- Source localization technique for impulsive multiple sources --- microphone arrays for helicopter rotor noise p 356 A89-27741 measurement
- Nonlinear dynamic responses of composite rotor blades [AD-A200145] p 315 N89-16774
- Wake model for helicopter rotors in high speed flight [NASA-CR-177507] p 301 N89-17577 Tip aerodynamics and acoustics test: A report and data
- survey [NASA-RP-1179] p 302 N89-17579 Helicopter tail rotor blade-vortex interaction noise
- [NASA-CR-183178] p 356 N89-18167 HEURISTIC METHODS
- An application of heuristic search techniques to the problem of flight path generation in a military hostile environment p 355 A89-27611 HIGH ALTITUDE
- Design and experimental results for a high-altitude, long-endurance airfoit p 312 A89-27740 HIGH ALTITUDE BALLOONS
- Recent results in the NASA research balloon program [AIAA PAPER 89-0233] p 269 A89-25199 HIGH SPEED
- Wake model for helicopter rotors in high speed flight NASA-CR-177507] p 301 N89-17577 [NASA-CR-177507] HIGH TEMPERATURE AIR
- Thermal analysis of engine inlet anti-icing systems [AIAA PAPER 89-0759] p 311 A89-25 p 311 A89-25565
- HIGH TEMPERATURE ENVIRONMENTS Thermal barrier coating life prediction model
- development p 351 N89-17333 High temperature constitutive and crack initiation modeling of coated single crystal superalloys
- p 342 N89-17334 HIGH TEMPERATURE TESTS
- Engineering ceramics Applications and testing equirements p 347 A89-27632 requirements HOLOGRAPHIC INTERFEROMETRY
- Laser holographic interferometric measurements of the flow in a scramjet inlet at Mach 4 [AIAA PAPER 89-0043] p 273 A89-25037
- HOT ISOSTATIC PRESSING Superplasticity of HIPped PM superalloys made from
- attrited prealloy powder p 341 A89-25915

- HOT-FILM ANEMOMETERS
 - The design and use of a temperature-compensated hot-film anemometer system for boundary-layer flow transition detection on supersonic aircraft
- p 318 A89-27668 HOVERING
- Simulation evaluation of transition and hover flying qualities of the E-7A STOVL aircraft
- [SAE PAPER 881430] p 333 A89-28205 V/STOL aircraft and the problem of jet-induced uckdown p 317 N89-18380 HOVERING STABILITY
- The free-wake prediction of rotor hover performance sing a vortex embedding method
- [AIAA PAPER 89-0638] p 296 A89-28443 HUMAN REACTIONS
- Impact of severe weather on aviation A pilot viewpoint [AIAA 89-0798] p 353 A89-28461
- HYDRAULIC EQUIPMENT A microprocessor-based proportional-integral controller
- for hydraulically actuated mechanisms p 335 A89-27655
- The comparative analysis and development of an 8000 psi rotary vane actuator
- SAE PAPER 881435] p 349 A89-28210 HYDROGEN FUELS
- A model for 3-D sonic/supersonic transverse fuel injection into a supersonic air stream [AIAA PAPER 89-0460] p 345 A89-25376
- HYPERSONIC AIRCRAFT Heat transfer and pressure comparisons between
- computation and wind tunnel for a research hypersonic aircraft
- [AIAA PAPER 89-0029] p 272 A89-25025 Three-dimensional hybrid finite volume solutions to the Euler equations for supersonic/hypersonic aircraft [AIAA PAPER 89-0281] p 280 A89
- p 280 A89-25238 HYPERSONIC FLIGHT
- Estimates of oxides of nitrogen formed in an inlet air stream for high Mach number flight conditions [AIAA PAPER 89-0197] p 277 A89-25172
- [AIAA PAPER 89-0197] A model for 3-D sonic/supersonic transverse fuel injection into a supersonic air stream
- [AIAA PAPER 89-0460] p 345 A89-25376 Aerodynamic prediction rationale for analyses of hypersonic configurations
- [AIAA PAPER 89-0525] p 285 A89-25420 Miniature PCM compatible wideband spectral analyzer
- for hypersonic flight research p 318 A89-27664 Modular analysis of scramjet flowfields p 325 A89-28337
- Derivation of primary air-data parameters for hypersonic flight
- [ESDU-880251 p 298 N89-16732 Report of the Defense Science Board task force on the
- National Aerospace Plane (NASP) [AD-A201124] p 317 N89-17595
- HYPERSONIC FLOW Adaptive computations of multispecies mixing between
- scramjet nozzle flows and hypersonic freestream [AIAA PAPER 89-0009] p 322 A89-25005

Prediction of supersonic/hypersonic viscous flows over RVs and decoys [AIAA PAPER 89-0028]

- p 272 A89-25024 Efficient finite-volume parabolized Navier-Stokes solutions for three-dimensional, hypersonic, chemically reacting flowfields
- [AIAA PAPER 89-0103] p 274 A89-25090 A set of strongly coupled, upwind algorithms for
- computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Three-dimensional flow simulation about the AFE vehicle
- in the transitional regime --- Aeroassist Flight Experiment [AIAA PAPER 89-0245] p 278 A89-25207
- Large-angle-of-attack viscous hypersonic flows over complex lifting configurations
- [AIAA PAPER 89-0269] p 279 A89-25227 Effect of nose bluntness on flow field over slender bodies
- in hypersonic flows [AIAA PAPER 89-0270] p 279 A89-25228 Numerical simulation of hypersonic flow around a space plane at high angles of attack using implicit TVD
- Navier-Stokes code [AIAA PAPER 89-0273] p 279 A89-25230
- An implicit flux-vector splitting scheme for the mputation of viscous hypersonic flow [AIAA PAPER 89-0274] p 279 A89-25231
- Nonequilibrium effects for hypersonic transitional flows using continuum approach
- [AIAA PAPER 89-0461] p 284 A89-25377 An efficient, explicit finite-rate algorithm to compute flows in chemical nonequilibrium [AIAA PAPER 89-0522]
 - p 285 A89-25418

HYPERVELOCITY FLOW

- Effect of dynamic changes in body configuration on shock structure
- [AIAA PAPER 89-0526] p 285 A89-25421 An improved upwind finite volume relaxation method for
- high speed viscous flows [AIAA PAPER 89-0549] p 286 A89-25441 A three-dimensional upwind finite element point implicit
- A three canonication operations and three canonications point implicit unstructured grid Euler solver
 p 289
 A89-25521

 Simple turbulence models for supersonic and hypersonic
- [AIAA PAPER 89-0669] p 289 A69-2530 On the solution of nonequilibrium hypersonic inviscid steady flows [AIAA PAPER 89-0671]
- p 289 A89-25532 Nonequilibrium viscous hypersonic flows over ablating Teflon surfaces
- [AIAA PAPER 89-0314] p 293 A89-26368
- Supersonic, transverse jet from a rotating ogive cylinder a hypersonic flow p 294 A89-27728 in a hypersonic flow Viscous shock-layer solutions for the low-density
- hypersonic flow past long slender bodies [AIAA PAPER 88-0460] HYPERSONIC HEAT TRANSFER p 295 A89-28251
- Pressure and heat transfer investigation of a modified
- NASP baseline configuration at M = 6 --- National Aero-Space Plane
- [AIAA PAPER 89-0246] p 339 A89-25208 HYPERSONIC INLETS Hypersonic scramjet inlet flow investigations, M1 =
- 16-26 [AIAA PAPER 89-0003] p 270 A89-25002
- CFD application to supersonic/hypersonic inlet airframe integration --- computational fluid dynamics (CFD)
- p 299 N89-16754 HYPERSONIC NOZZLES
- Adaptive computations of multispecies mixing between scramjet nozzle flows and hypersonic freestream [AIAA PAPER 89-0009] p 322 A8 p 322 A89-25005
- HYPERSONIC REENTRY Prediction of supersonic/hypersonic viscous flows over RVs and decoys

Hypersonic scramjet inlet flow investigations, M1 =

Numerical solutions to three-dimensional shock

Combined propulsion for hypersonic and space ehicles p 322 A89-24917

A numerical study of hypersonic propulsion/airframe

The effect of exhaust plume/afterbody interaction on

Facility requirements for hypersonic propulsion system

Three-dimensional flow simulation about the AFE vehicle

in the transitional regime --- Aeroassist Flight Experiment

Aerodynamic prediction rationale for analyses of

Report of the Defense Science Board task force on the

Fast laminar near wake flow calculation by an implicit method solving the Navier-Stokes equations

Infrared thermography in blowdown and intermittent

Miniaturized compact water-cooled pitot-pressure probe

Thermal-energy management for air breathing hyper-velocity vehicles

An adaptive implicit/explicit finite element scheme for

for flow-field surveys in hypersonic wind tunnels

wave/vortex interaction at hypersonic speeds

p 270 A89-25002

p 289 A89-25534

p 272 A89-25026

p 272 A89-25028

p 310 A89-25158

p 335 A89-25159

p 278 A89-25207

p 284 A89-25364

p 285 A89-25420

p 317 N89-17595

p 270 A89-24923

p 334 A89-25036

p 348 A89-27659

p 310 A89-25158

p 344 A89-25307

A-17

aspects of a NASP

for air breathing

[AIAA PAPER 89-0028] p 272 A89-25024 HYPERSONIC SHOCK

16-26

vehicles

[AIAA PAPER 89-0003]

AIAA PAPER 89-0674]

HYPERSONIC VEHICLES

integration problem

[AIĂA PAPER 89-0030]

[AIAA PAPER 89-0032]

[AIAA PAPER 89-0183]

testing [AIAA PAPER 89-0184]

[AIAA PAPER 89-0245]

[AIAA PAPER 89-0446]

[AIAA PAPER 89-0525]

AD-A201124]

HYPERSONIC WAKES

hypersonic facilities

[AIAA PAPER 89-0042]

HYPERVELOCITY FLOW

[AIAA PAPER 89-0183]

[AIAA PAPER 89-0363]

compressible viscous high speed flow

hypersonic configurations

HYPERSONIC WIND TUNNELS

Computational design

nozzle/afterbody experiment

National Aerospace Plane (NASP)

installed scramjet performance

Thermal-energy management hyper-velocity vehicles

HYPERSONIC SPEED

HYPERVELOCITY WIND TUNNELS

HYPERVELOCITY WIND TUNNELS Microtuft flow visualization at Mach 10 and 14 in the

NSWC hypervelocity wind tunnel No. 9 p 334 A89-25035 TAIAA PAPER 89-00411

ICE FORMATION

- Problems in understanding aircraft icing dynamics p 302 A89-25553 AIAA PAPER 89-07351
- A numerical investigation of the influence of surface roughness on heat transfer in ice accretion p 346 A89-25554 AIAA PAPER 89-07371
- Effect of simulated glaze ice on a rectangular wing AIAA PAPER 89-0750] p 303 A89-25560 [AIAA PAPER 89-0750] Prop-fan airfoil icing characteristics
- AIAA PAPER 89-0753] p 303 A89-25561 Use of the median volume droplet diameter in the [AIAA PAPER 89-0753] characterization of cloud droplet spectra
- [AIAA PAPER 89-0756] p 352 A89-25562 Selection of the critical icing/flight case for an unprotected airfoil
- p 303 A89-25563 [AIAA PAPER 89-0757] Performance of the forward scattering spectrometer
- probe in NASA's Icing Research Tunnel p 346 A89-25570 [AIAA PAPER 89-0769] Distributed ice accretion sensor for smart aircraft
- structures [AIAA PAPER 89-0772] n 311 A89-25571
- Elevator deflection effects on the icing process p 290 A89-25615 [AIAA PAPER 89-0846]
- Investigation of surface water behavior during glaze ice p 304 A89-27739 accretion An overview of the current NASA program on aircraft
- icing research [SAE PAPER 881386] p 305 A89-28192
- Modeling of surface roughness effects on glaze ice accretion p 305 A89-28451
- [AIAA 89-0734] An experimental investigation of multi-element airfoil ice accretion and resulting performance degradation
- p 297 A89-28453 (AIAA 89-0752) Determination of longitudinal aerodynamic derivatives using flight data from an icing research aircraft
- p 333 A89-28454 [AIAA 89-0754] Investigation of the flow in the diffuser section of the NASA Lewis Icing Research Tunnel
- p 336 A89-28455 [AIAA 89-0755] Development of a new subsonic icing wind tunnel p 337 A89-28458 TAIAA 89-07731
- ICE PREVENTION
- Thermal analysis of engine inlet anti-icing systems p 311 A89-25565 [AIAA PAPER 89-0759] Developments in expulsive separation ice protection blankets

[AIAA PAPER 89-0774]	p 311	A89-25572
MAGING TECHNIQUES		

- Long term possibilities for nondestructive evaluation for p 350 N89-17259 US Navy aircraft IMPACT
- Impact of device level faults in a digital avionic processor n 356 N89-18046

[NASA-CH-104/00]	p	
MPACT DAMAGE		

- Measurement of dynamic reactions in passenger seat leas
- p 305 A89-28188 [SAE PAPER 881376] Damage tolerance behavior of composite airframes fiber reinforced p 316 N89-17278
- IMPACT TESTS Measurement of dynamic reactions in passenger seat leas
- p 305 A89-28188 [SAE PAPER 881376] Transport airplane fuselage section longitudinal impact

test

A-18

- p 305 A89-28189 [SAE PAPER 881377] IMPACT TOLERANCES Damage tolerance behavior of fiber reinforced p 316 N89-17278 composite airframes IMPINGEMENT Droplet impaction on a supersonic wedge Consideration of similitude p 304 A89-25567 [AIAA PAPER 89-0763] IN-FLIGHT MONITORING An overview of US Navy engine monitoring system p 326 N89-16782 programs and user experience
- Engine usage condition and maintenance management p 326 N89-16783 systems in the UK armed forces On board life monitoring system Tornado (OLMOS) p 319 N89-16785
- Information management systems for on-board p 319 N89-16786 monitoring systems CF-18 engine performance monitoring p 326 N89-16787
- p 319 N89-16788 B-1B CITS engine monitoring

- Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring system p 320 N89-16789
- Recent UK trials in engine health monitoring: Feedback p 326 N89-16790 and feedforward
- The CFM 56-5 on the A-320 at Air France p 320 N89-16793
- F100-PW-220 engine monitoring system p 320 N89-16795
- Service life calculator for the M53 turbofan engine p 326 N89-16796
- Military engine condition monitoring systems: The UK p 320 N89-16797 experience
- Military engine monitoring status at GE Aircraft Engines, p 320 N89-16798 Cincinnati, Ohio Gas path analysis and engine performance monitoring
- p 327 N89-16802 in a Chinook helicopter System considerations for integrated machinery health p 327 N89-16804 monitoring
- Maintenance aid system for wide body aircraft p 327 N89-16805
- Identification of dynamic characteristics for fault isolation purposes in a gas turbine using closed-loop measurements p 328 N89-16813 Gas path condition monitoring using electrostatic
- p 321 N89-16817 techniques COMPASS (Trademark): A generalized ground-based p 321 N89-16819 monitoring system
- Incidence angle rules in supersonic cascades p 328 N89-16827
- INCOMPRESSIBLE FLOW Computation of turbulent incompressible wing-body junction flow
- p 310 A89-25236 [AIAA PAPER 89-0279] flutter of an aerodynamics and Oscillating aerodynamically detuned cascade in an incompressible
- flow p 280 A89-25246 [AIAA PAPER 89-0289] Navier-Stokes solutions for vortical flows over a
- tangent-ogive cylinder [AIAA PAPER 89-0337] p 281 A89-25284
- Aerodynamic performance of wings of arbitrary planform in inviscid, incompressible, irrotational flow p 297 N89-16728 [AD-A200436]
- INEQUALITIES
- An alternative method to solve a variational inequality applied to an air traffic control example p 354 A89-26196

INERTIAL NAVIGATION

- Laboratory and flight evaluation of the Integrated Inertial p 307 A89-26708 Sensor Assembly (IISA) VERDICT - A plan for gravity compensation of inertial p 307 A89-26724 navigation systems Correction for deflections of the vertical at the runup
- p 307 A89-26725 eite Precision trajectory reconstruction p 307 A89-26726
- Causal probability model for transoceanic track separations with applications to automatic dependent surveillance p 308 A89-26735 Development of new redundant flight safety system
- using inertial sensors p 306 N89-17585 [ISAS-634]
- Advanced Fighter Technology Integration/Sandia Inertial Terrain-Aided Navigation (AFTI/SITAN) p 309 N89-17587 [DE89-004000]
- INFORMATION DISSEMINATION Cockpit display of hazardous weather information
- p 335 A89-25591 TAIAA PAPER 89-08081 INFORMATION SYSTEMS
- Information management systems for on-board nonitoring systems p 319 N89-16786 INFRARED DETECTORS
- Infrared technique to measure the skin temperature on an electrothermal de-icer - Comparison with numerical
- simulations p 303 A89-25566 [AIAA PAPER 89-0760]
- INFRARED RADIOMETERS Infrared thermography in blowdown and intermittent hypersonic facilities
- AIAA PAPER 89-00421 p 334 A89-25036 INFRARED SIGNATURES A novel infrared thermography heat transfer
- measurement technique p 345 A89-25478 TAIAA PAPER 89-06011
- INLET AIRFRAME CONFIGURATIONS Intake Aerodynamics, volume 1 --- conference
- p 298 N89-16738 (VKI-I S-1988-04-VOL-11 p 298 N89-16740 Tactical fighter inlets p 314 N89-16741 Inlet-engine compatibility Intake swirl and simplified methods for dynamic pressure p 299 N89-16742 distortion assessment p 315 N89-16744 Intake-airframe integration Intakes for high angle of attack p 315 N89-16745

- Intake Aerodynamics, volume 2 --- conference p 299 N89-16748 [VKI-LS-1988-04-VOL-2] CFD application to subsonic inlet airframe integration --- computational fluid dynamics (CFD)
- p 299 N89-16753 CFD application to supersonic/hypersonic inlet airframe integration --- computational fluid dynamics (CFD)
- p 299 N89-16754 INLET FLOW
- Hypersonic scramjet inlet flow investigations, M1 = 16-26
- p 270 A89-25002 [AIAA PAPER 89-0003] Zonal modelling of flows through multiple inlets and nozzles
- p 271 A89-25003 [AIAA PAPER 89-0005] Laser holographic interferometric measurements of the
- flow in a scramiet inlet at Mach 4 [AIAA PAPER 89-0043] p 273 A89-25037
- Supersonic inlet calculations using an upwind finite-volume method on adaptive unstructured grids
- [AIAA PAPER 89-013] p 274 A89-25100 Estimates of oxides of nitrogen formed in an inlet air stream for high Mach number flight conditions
- p 277 A89-25172 [AIAA PAPER 89-0197] p 277 A89-25172 Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic
- flows [AIAA PAPER 89-0562] p 287 A89-25451 Modeling of subsonic flow through a compact offset inlet
- diffuser p 288 A89-25505 [AIAA PAPER 89-0639] Preliminary results in the development of a method to correct propeller inflow for improved unsteady force
- calculations p 293 A89-26374 [AIAA PAPER 89-0436]
- Diagonal implicit multigrid calculation of inlet flowfields p 294 A89-27716 Intake swirl and simplified methods for dynamic pressure
- p 299 N89-16742 distortion assessment p 315 N89-16744 Intake-airframe integration
- Incidence angle rules in supersonic cascades p 328 N89-16827
- Measurement of airfoil heat transfer coefficients on a p 351 N89-17311 turbine stage
- INSPECTION
 - Relationships of nondestructive evaluation needs and p 349 N89-17256
 - component design Importance of sensitivity and reliability of NDI techniques
 - on damage tolerance based life prediction of turbine
 - p 350 N89-17257
 - Long term possibilities for nondestructive evaluation for
- p 350 N89-17259 US Navy aircraft Need for common AGARD approach and actions p 350 N89-17260

INSTALLING

- Installed thrust as a predictor of engine health for jet p 327 N89-16806 enaines The effect of exhaust plume/afterbody interaction on
- installed Scramjet performance p 330 N89-17600 [NASA-TM-101033]

Aircraft accident/incident summary report, Travis Air

Utilization of wind tunnel instrumentation with software

Integral equation solution of the full potential equation

Temperature compensation using GaAs MMIC devices

An interactive boundary-layer procedure for oscillating

Infrared thermography in blowdown and intermittent

Influence of wing geometry on leading-edge vortices and

vortex-induced aerodynamics at supersonic speeds

p 306 N89-16768

p 348 A89-27651

p 335 A89-27654

p 287 A89-25452

p 347 A89-26548

p 271 A89-25016

p 334 A89-25036

p 273 A89-25072

p 273 A89-25073

p 274 A89-25075

shock wave/vortex

34th

Symposium,

- INSTRUMENT FLIGHT RULES
- The realization of microwave landing system benefits p 307 A89-26734 INSTRUMENT LANDING SYSTEMS

Instrumentation

Albuquerque, NM, May 2-6, 1988, Proceedings

Force Base, California, 8 April 1987

[PB88-910414]

International

INTEGRAL EQUATIONS

for transonic flows

[AIAA PAPER 89-0563]

[AIAA PAPER 89-0020]

[AIAA PAPER 89-0042]

[AIAA PAPER 89-0082]

[AIAA PAPER 89-0083]

[AIAA PAPER 89-0085]

hypersonic facilities

interaction

INTERACTIONAL AERODYNAMICS

airfoils including transition effects

An experimental study of

Vortex/boundary layer interactions

INTEGRATED CIRCUITS

INSTRUMENTS

verifications

An interactive three-dimensional boundary-layer method for transonic flow over swept wings [AIAA PAPER 89-0112] p 274 A89-25099

Grid refinement studies of turbine rotor-stator interaction

[AIAA PAPER 89-0325] p 281 A89-25274 Mach number dependence of flow separation induced normal shock-wave/turbulent boundary-layer bv interaction at a curved wall

[AIAA PAPER 89-0353] p 282 A89-25298 An LDV investigation of a multiple normal shock wave/turbulent boundary layer interaction

[AIAA PAPER 89-0355] p 282 A89-25300 An exploratory study of corner bleed on a fin generated three-dimensional shock wave turbulent boundary layer interaction

[AIAA PAPER 89-0356] p 282 A89-25301 A numerical study of the contrarotating vortex pair associated with a jet in a crossflow

- [AIAA PAPER 89-0448] p 284 A89-25366 Numerical study of single impinging jets through a
- crossflow [AIAA PAPER 89-0449] p 284 A89-25367 Viscous-inviscid interaction and local grid refinement via
- truncation error injection [AIAA PAPER 89-0468] p 285 A89-25383
- Propeller/wing interaction [AIAA PAPER 89-0535] p 311 A89-25429
- Numerical solutions to three-dimensional shock wave/vortex interaction at hypersonic speeds
- [AIAA PAPER 89-0674] p 289 A89-25534 Measurement of transient vortex-surface interaction obenomena
- [AIAA PAPER 89-0833] p 289 A89-25603 Supersonic, transverse jet from a rotating ogive cylinder
- in a hypersonic flow p 294 A89-27728 Effect of sidewall boundary layer on a wing in a wind tunnel p 294 A89-27742
- Influence of vane/blade spacing and injection on stage p 325 A89-28342 heat-flux distributions Experimental and numerical investigation of an obligue
- shock wave/turbulent boundary layer interaction with continuous suction [AIAA PAPER 89-0357] p 296 A89-28407
- Vortex dynamics for rotorcraft interactional aerodynamics
- [AD-A200128] p 297 N89-16726 INTERFACES
- An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition input
- [AD-A200626] p 309 N89-17588 INTERFERENCE FIT
- Bolted scarf joints in carbon composite materials. Comparison between assemblies with an interference fit and those with play INTERNATIONAL COOPERATION p 343 N89-17702

The integration of European flight-safety systems p 308 A89-28292

- INVENTORY CONTROLS
- Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study p 270 N89-17564
- AD-A200665] INVISCID FLOW
- Convergence acceleration through the use of time inclining --- for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085
- Viscous-inviscid interaction and local grid refinement via truncation error injection
- [AIAA PAPER 89-0468] p 285 A89-25383 A three-dimensional upwind finite element point implicit
- unstructured grid Euler solver [AIAA PAPER 89-0658] p 289 A89-25521 On the solution of nonequilibrium hypersonic inviscid steady flows
- [AIAA PAPER 89-0671] p 289 A89-25532 Unsteady separation wave in a supersonic boundary
- yer p 293 A89-26011 Aerodynamic performance of wings of arbitrary planform laver in inviscid, incompressible, irrotational flow
- p 297 N89-16728 [AD-A200436] ISOTHERMAL PROCESSES
- An experimental and computational investigation of isothermal swirling flow in an axisymmetric dump combustor
- [AIAA PAPER 89-0620] p 323 A89-25491 ISOTROPY
- Creep fatigue life prediction for engine hot section materials (ISOTROPIC) fifth year progress review p 352 N89-17336
- ITERATIVE SOLUTION
- A comparative study of iterative algorithms for the Euler equations of gasdynamics
- [AIAA PAPER 89-0114] p 343 A89-25101

Applications of AF3 efficient iteration scheme to transonic nonconservative full-potential flow past airfoils p 292 A89-25940

An alternative method to solve a variational inequality applied to an air traffic control example p 354 A89-26196

Applications of an Al design shell ENGINEOUS to advanced engineering products p 355 A89-27618

J

- Jaquar/Tornado intake design p 299 N89-16743 JET ENGINE FUELS
 - Correlations of high density fuel effects [AIAA PAPER 89-0216] p 3

JAGUAR AIRCRAFT

- p 340 A89-25190 An investigation of the physical and chemical factors affecting the perfomance of fuels in the JFTOT --- Jet Fuel Thermal Oxidation Tester
- [SAE PAPER 881533] p 341 A89-28242 Ball-on-cylinder testing for aviation fuel lubricity [SAE PAPER 881537]
- p 341 A89-28244 Experimental verification of properties for a jet-A fuel the thermodynamic
- [NASA-TM-101475] p 342 N89-17017 Fuel-additive system for test cells
- [AD-A200801] p 342 N89-17681 JET ENGINES
- Thermal analysis of engine inlet anti-icing systems [AIAA PAPER 89-0759] p 311 A89-25565 Pattern-based fault diagnosis using neural networks
- p 354 A89-27602 Hierarchical representation and machine learning from faulty jet engine behavioral examples to detect real time p 355 A89-27622 abnormal conditions
- Gas path modelling, diagnosis and sensor fault p 321 N89-16811 detection Review of existing NDT technologies and their capabilities p 349 N89-17255
- JET EXHAUST V/STOL aircraft and the problem of jet-induced uckdown p 317 N89-18380 suckdown
- JET ELOW A numerical study of the contrarotating vortex pair
- sociated with a jet in a crossflow [AIAA PAPER 89-0448] p 284 A89-25366
- Vortex generator jets A means for passive and active control of boundary layer separation
- [AIAA PAPER 89-0564] p 287 A89-25453 Aerothermal modeling program. Phase 2, element B: p 351 N89-17304 Flow interaction experiment
- JET IMPINGEMENT
- Single and multiple jet impingement heat transfer on rotating disks
- [AIAA PAPER 89-0174] p 344 A89-25150 Numerical study of single impinging jets through a crossflow
- [AIAA PAPER 89-0449] p 284 A89-25367 Shock capturing using a pressure-correction method
- [AIAA PAPER 89-0561] p 345 A89-25450 Characteristics of the ground vortex formed by a jet moving over a fixed ground plane [AIAA PAPER 89-0650]
- p 288 A89-25514 JET MIXING FLOW
- Experimental and analytical study on exit radial temperature profile of experimental 2D combustor [AIAA PAPER 89-0493] p 340 A89-25403
- JET PUMPS A model of pressure distributions on impeller blades for
- determining performance characteristics [AIAA PAPER 89-0840] p 346 A89-25609
- JET VANES Variable geometry in supersonic compressors
- p 330 N89-16838 JOINTS (JUNCTIONS)
 - Typical joints in a wing structure p 317 N89-17693 Mechanism of single shear fastened joints
 - p 352 N89-17700 Joining of carbon fiber composite with fasteners
 - p 343 N89-17701



- KALMAN FILTERS
 - Evaluation of a Kalman filter for SAR motion compensation p 347 A89-26721 A Kalman filter for an integrated Doppler/GPS navigation system p 308 A89-26740 The Honeywell/DND helicopter integrated navigation
- system (HINS) p 308 A89-26741 KELVIN-HELMHOLTZ INSTABILITY
- The effects of walls on a compressible mixing layer [AIAA PAPER 89-0372] p 283 A89-25315 p 283 A89-25315

KNOWLEDGE BASES (ARTIFICIAL INTELLIGENCE) Automatic acquisition of domain and procedural knowledge p 318 A89-27624

LATERAL CONTROL

- Applying evidential reasoning to avionics troubleshooting p 355 A89-27629 KNOWLEDGE REPRESENTATION
 - Hierarchical representation and machine learning from faulty jet engine behavioral examples to detect real time p 355 A89-27622 abnormal conditions

L

L-1011 AIRCRAFT

Analysis of windshear from airline flight data p 332 A89-27734

- LAMINAR BOUNDARY LAYER Stability and transition of two-dimensional laminar boundary layers in compressible flow over an adiabatic
- p 270 A89-24922 wall On the structure of two- and three-dimensional
- separation AAA PAPER 89-02871 p 280 A89-25244 LAMINAR FLOW
- Fast laminar near wake flow calculation by an implicit method solving the Navier-Stokes equations
- p 270 A89-24923 A numerical study of hypersonic propulsion/airframe integration problem
- Three-dimensional compressible boundary laver [AIĂA PAPER 89-0030]
- calculations to fourth order accuracy on wings and fuselages [AIAA PAPER 89-0130] p 275 A89-25115
- Upwind Navier-Stokes solutions for leading-edge vortex
- [AIAA PAPER 89-0265] p 278 A89-25223 Control of laminar separation over airfoils by acoustic excitation
- [AIAA PAPER 89-0565] p 288 A89-25454 LAMINAR FLOW AIRFOILS
- Flow quality measurements for the Langley 8-foot transonic pressure tunnel LFC experiment
- [AIAA PAPER 89-0150] AA PAPER 89-0150] p 276 A89-25133 Evaluation of an analysis method for low-speed airfoils by comparison with wind tunnel results
- [AIAA PAPER 89-0266] NAA PAPER 89-0266] p 278 A89-25224 Optimization of natural laminar flow airfoils for high section lift-to-drag ratios in the lower Reynolds number range
- [AIAA PAPER 89-0539] p 296 A89-28428 LAMINAR WAKES
- Study of the vortical wake patterns of an oscillating airfoil [AIAA PAPER 89-0554] p 287 A89-25444

Free vibration and panel flutter of quadrilateral laminated

Vibration and aeroelastic tailoring of advanced composite plate-like lifting surfaces p 351 N89-17263 Test specimens for bearing and by-pass stress

Aircraft landing gear design: Principles and practices

Long term possibilities for nondestructive evaluation for

Comparison of LDV measurements and Navier-Stokes

An LDV investigation of a multiple normal shock

Laser velocimeter measurements of the flowfield

LDV surveys over a fighter model at moderate to high

Laser holographic interferometric measurements of the

An analysis of lateral-directional handling qualities and

generated by an advanced counterrotating propeller

vave/turbulent boundary layer interaction

solutions in a two-dimensional 180-degree turn-around

interaction in carbon fibre reinforced plastic laminates

Mechanism of single shear fastened joints

p 347 A89-26274

p 342 N89-17696

p 352 N89-17700

p 312 A89-26950

p 350 N89-17259

p 279 A89-25232

p 282 A89-25300

p 293 A89-26373

p 295 A89-28218

p 273 A89-25037

p 349 N89-17215

p 331 A89-25013

A-19

LAMINATES

LANDING GEAR

LASER APPLICATIONS

[AIAA PAPER 89-0275]

[AIAA PAPER 89-0355]

[AIAA PAPER 89-0434]

(SAE PAPER 881448)

LASER INTERFEROMETRY

[AIAA PAPER 89-0043]

[AIAA PAPER 89-0017]

flow in a scramiet inlet at Mach 4

Laser communication test system

eigenstructure of high performance aircraft

angles of attack

[AD-A199612]

LATERAL CONTROL

LASER DOPPLER VELOCIMETERS

US Navy aircraft

Book

duct

LASERS

plates

LATERAL STABILITY

LATERAL STABILITY

Lateral oscillations of sting-mounted models at high aloha

[AIAA PAPER 89-0047]	p 310	A89-2504
LEADING EDGE FLAPS		

Evaluation of leading- and trailing-edge flaps on flat and cambered delta wings at supersonic speeds p 272 A89-25023

[AIAA PAPER 89-0027] LEADING EDGE SLATS

Flow measurements of an airfoil with single-slotted flan p 286 A89-25427

[AIAA PAPER 89-0533] LEADING EDGES

Flow-field characteristics and normal-force correlations for delta wings from Mach 2.4 to 4.6 p 272 A89-25022

[AIAA PAPER 89-0026] p 272 A89-25022 An experimental investigation of delta wing vortex flow with and without external jet blowing

p 273 A89-25074 [AIAA PAPER 89-0084] Influence of wing geometry on leading-edge vortices and vortex-induced aerodynamics at supersonic speeds

p 274 A89-25075 [AIAA PAPER 89-0085] p 274 A89-25075 Effects of leading-edge shape and vortex burst on the flowfield of a 70-degree-sweep delta-wing

p 274 A89-25076 [AIAA PAPER 89-0086] Upwind Navier-Stokes solutions for leading-edge vortex

flows AIAA PAPER 89-0265] p 278 A89-25223 Navier-Stokes solutions about the F/A-18 forebody-LEX [AIAA PAPER 89-0265]

configuration --- Leading Edge Extension p 281 A89-25285 [AIAA PAPER 89-0338] Numerical study of the effect of tangential leading edge

blowing on delta wing vortical flow AIAA PAPER 89-03411 p 282 A89-25288

Elevator deflection effects on the icing process p 290 A89-25615 [AIAA PAPER 89-0846] An Euler analysis of leading-edge vortex flows on a forebody-strake at supersonic speeds

[AIAA PAPER 89-0343] p 293 A89-26371 Theoretical investigation for the effects of sweep, leading-edge geometry, and spanwise pressure gradients

on transition and wave drag transonic, and supersonic speed with experimental correlations SAE PAPER 881484] p 295 A89-28229

LEAKAGE Influence of clearance leakage on turbine heat transfer

at and near blade tips - Summary of recent results [AIAA PAPER 89-0327] p 344 A89p 344 A89-25275 LEARNING MACHINES

Hierarchical representation and machine learning from faulty jet engine behavioral examples to detect real time p 355 A89-27622 abnormal conditions MLS, a machine learning system for engine fault

p 355 A89-27623 diagnosis LIABILITIES Some considerations on the liability of air traffic control

p 357 A89-26666 noncioe LIFE (DURABILITY)

Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring system p 320 N89-16789

Installed thrust as a predictor of engine health for jet p 327 N89-16806 engines

Relationships of nondestructive evaluation needs and p 349 N89-17256 component design

Thermal barrier coating life prediction model p 351 N89-17333 development

High temperature constitutive and crack initiation modeling of coated single crystal superalloys

p 342 N89-17334 Creep fatigue life prediction for engine hot section materials (ISOTROPIC) fifth year progress review p 352 N89-17336

LIFE CYCLE COSTS

Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study p 270 N89-17564 [AD-A200665]

LIFT Effects of leading-edge shape and vortex burst on the

- flowfield of a 70-degree-sweep delta-wing [AIAA PAPER 89-0086] p 27 p 274 A89-25076
- Application of continuous vorticity panels in three-dimensional lifting flows with partial separation [AIAA PAPER 89-0117] p 275 A89-25104

High-lift aerodynamics for transport aircraft by interactive experimental and theoretical tool development p 278 A89-25225 [AIAA PAPER 89-0267]

Rolling moment derivative Lxi, for plain ailerons at subsonic speeds p 297 N89-16731 [ESDU-88013]

and longitudinal forces on Lift propeller/nacelle/wing/flap systems

p 298 N89-16736 [ESDU-88031] Comparison of the results of tests on A300 aircraft in the RAE 5 metre and the ONERA F1 wind tunnels

p 300 N89-16849

LIFT DEVICES

Vibration and aeroelastic tailoring of advanced composite plate-like lifting surfaces p 351 N89-17263 LIFT DRAG RATIO

Optimization of natural laminar flow airfoils for high section lift-to-drag ratios in the lower Reynolds number

range (AIAA PAPER 89-0539) n 296 A89-28428 LIFTING BODIES

Large-angle-of-attack viscous hypersonic flows over complex lifting configurations p 279 A89-25227

[AIAA PAPER 89-0269] Spanload optimization for strength designed lifting surfaces

[AIAA PAPER 88-2512] p 314 A89-28252 LIGHT MODULATION

Phase-only filters with improved signal to noise ratio p 356 A89-28382 LIGHTNING

National lightning detection - A real-time service to aerospace

p 352 A89-25578 (AIAA PAPER 89-07871 Lightning initiation on aircraft in thunderstorms p 353 A89-26214

Lightning triggered by the presence of aerospace p 353 A89-26215 vehicles LINEAR SYSTEMS

Modal control in systems with aftereffect

p 354 A89-26038 method for the design of linear multivariable sampled-data control An H(infinity) method for the time-invariant p 354 A89-26187 systems

LINES OF FORCE Merging of aircraft vortex trails - Similarities to magnetic

p 356 A89-26630 field merging LININGS

Three-dimensional inelastic analysis methods for hot p 351 N89-17316 section components Structural response of an advanced combustor liner: p 351 N89-17329 Test and analysis LIQUID COOLING

Miniaturized compact water-cooled pitot-pressure probe for flow-field surveys in hypersonic wind tunnels p 348 A89-27659

LITHIUM ALLOYS

Superplastic formed aluminum-lithium aircraft structure p 316 N89-17591 140.42002451 LOAD DISTRIBUTION (FORCES)

Comparison of the results of tests on A300 aircraft in the RAE 5 metre and the ONERA F1 wind tunnels p 300 N89-16849

LOGISTICS

Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study p 270 N89-17564

[AD-A200665] LONGITUDINAL CONTROL

Dynamics of longitudinal motion of an aeroplane after p 333 A89-28396 drop of loads LONGITUDINAL STABILITY

Longitudinal stability analysis for deformable aircraft p 332 A89-25934 Transport airplane fuselage section longitudinal impact

test p 305 A89-28189 [SAE PAPER 881377] LOSSES

Loss development in transonic compressor cascades p 328 N89-16826 Shock losses in transonic and supersonic compressor p 329 N89-16829 cascades

LOW ASPECT RATIO Computational design of low aspect ratio wing-winglets

for transonic wind-tunnel testing p 311 A89-25509 AIAA PAPER 89-06441

LOW DENSITY FLOW

Supersonic low-density flow over airfoils

[AIAA PAPER 89-0530] p 286 A89-25424 Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies

p 295 A89-28251 AIAA PAPER 88-04601 LOW REYNOLDS NUMBER

Low Reynolds number numerical solutions of chaotic p 275 A89-25108 [AIAA PAPER 89-0123]

Evaluation of an analysis method for low-speed airfoils by comparison with wind tunnel results

[AIAA PAPER 89-0266] p 278 A89-25224 Tip vortex/airfoil interaction for a canard//wing

configuration at low Reynolds numbers p 286 A89-25430 [AIAA PAPER 89-0536]

An experimental evaluation of a low-Reynolds number high-lift airfoil with vanishingly small pitching moment p 286 A89-25432 [AIAA PAPER 89-0538] Boundary layer measurements on an airfoil at low

Reynolds numbers in an accelerating flow from a nonzero base velocity p 288 A89-25458 [AIAA PAPER 89-0569]

Design and experimental results for a high-altitude, ng-endurance airfoil p 312 A89-27740 long-endurance airfoil Optimization of natural laminar flow airfoils for high

SUBJECT INDEX

section lift-to-drag ratios in the lower Reynolds number AIAA PAPER 89-05391 n 296 A89-28428

LOW SPEED Low speed aerodynamics of canard configurations p 294 A89-26689

LOW SPEED WIND TUNNELS Evaluation of an analysis method for low-speed airfoils

by comparison with wind tunnel results p 278 A89-25224 [AIAA PAPER 89-0266] p 278 A89-25224 Low speed wind tunnel investigation of the flow about

delta wing, oscillating in pitch to very high angle of attack [AIAA PAPER 89-0295] p 281 A89-25252

LOW VOLTAGE

Electromagnetic emissions from a modular low voltage EIDI system --- Electro-Impulse Deicing [AIAA PAPER 89-0758] p 303 A89-25564

Μ

MACH NUMBER

MACHINE TOOLS

field merging

MAGNETIC SUSPENSION

[AIAA PAPER 89-0648]

[NASA-CR-184624]

MAINTENANCE

[PB88-910414]

monitoring systems

engine performance

MAN MACHINE SYSTEMS

[SAE PAPER 881472]

[NASA-TM-101078]

[AD-A2006261

traffic

input

magnetic suspension technology

Force Base, California, 8 April 1987

systems in the UK armed forces

CF-18 engine performance monitoring

Reconfigurable cockpit development

F100-PW-220 engine monitoring system

CF-18/F404 transient performance trending

Policy, plans and experience

Flow visualization studies of the Mach number effects on the dynamic stall of an oscillating airfoil

p 271 A89-25019 [AIAA PAPER 89-0023] Thermodynamics and wave processes in high Mach number propulsive ducts

p 278 A89-25219 IAIAA PAPER 89-02611 The effect of Mach number on the stability of a plane

supersonic wave

AA PAPER 89-02851 p 280 A89-25242 Mach number dependence of flow separation induced

normal shock-wave/turbulent boundary-layer hv interaction at a curved wall

[AIAA PAPER 89-0353] p 282 A89-25298 Shock capturing using a pressure-correction method

p 345 A89-25450 [AIAA PAPER 89-0561] Derivation of primary air-data parameters for hypersonic flight

[ESDU-88025] p 298 N89-16732

Boundaries of linear characteristics of cambered and twisted wings at subcritical Mach numbers p 298 N89-16735 ESDU-880301 Loss development in transonic compressor cascades

Building aircraft assembly tools from a 3-D database [SAE PAPER 881428] p 269 A89-28204

Merging of aircraft vortex trails - Similarities to magnetic

Drag measurements on a modified prolate spheroid

An experimental investigation of the aerodynamic

Aircraft accident/incident summary report, Travis Air

Engine usage condition and maintenance management

Canadian forces aircraft condition/health monitoring:

Information management systems for on-board

The effects of a compressor rebuild on gas turbine

Design of automation tools for management of descent

An evaluation of automating Carrier Air Traffic Control

Center (CATCC) status boards utilizing voice recognition

On board life monitoring system Tornado (OLMOS)

characteristics of slanted base ogive cylinders using

using a magnetic suspension and balance system

MAGNETIC FIELD CONFIGURATIONS

p 328 N89-16826

p 269 A89-28204

p 356 A89-26630

p 335 A89-25512

p 300 N89-16758

p 306 N89-16768

p 326 N89-16783

p 326 N89-16784

p 319 N89-16785

p 319 N89-16786

p 326 N89-16787

p 320 N89-16795

p 327 N89-16803

p 328 N89-16814

p 319 A89-28224

p 306 N89-17584

p 309 N89-17588

MANAGEMENT METHODS

Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study

[AD-A200665] p 270 N89-17564 MANAGEMENT SYSTEMS

The development of an automated flight test management system for flight test planning and p 312 A89-27613 monitoring

MASS TRANSFER

Measurements of a supersonic turbulent boundary layer with mass addition

[AIAA PAPER 89-0135] p 344 A89-25119 MATCHED FILTERS

Phase-only filters with improved signal to noise ratio p 356 A89-28382

MATERIALS TESTS

Local buckling and crippling of thin-walled composite structures under axial compression p 341 A89-27733 MATHEMATICAL MODELS

Modification of compressible turbulent boundary layer structures by streamlined devices

- [AIAA PAPER 89-0212] p 277 A89-25186 Vortex dynamics for rotorcraft interactional
- aerodynamics [AD-A200128] p 297 N89-16726 Development of a panel method for modeling

configurations with unsteady component motions, phase

- [AD-A200255] p 315 N89-16775 System-theoretical method for dynamic on-condition p 321 N89-16812 monitoring of gas turbines
- Accuracy of various wall-correction methods for 3D subsonic wind-tunnel testing p 338 N89-16863 Some difficulties in the wind tunnel prediction of modern

civil aircraft buffeting. Proposed remedies

- p 301 N89-16869 Requirements and capabilities in unsteady windtunnel p 339 N89-16878 p 339 testing
- Application of a Comprehensive Analytical Model of Rotor Aerodynamics and Dynamics (CAMRAD) to the

McDonnell Douglas AH-64A helicopter p 301 N89-17578 [NASA-CR-177455] A numerical simulation of flows about two-dimensional

bodies of parachute-like configuration p 302 N89-17580 **JISAS-6291**

MEASURING INSTRUMENTS

Accurate drag estimation using a single component drag p 337 N89-16856 model technique MECHANICAL ENGINEERING

The design and development of transonic multistage p 329 N89-16834 compressors

MECHANICAL SHOCK Electro-impulse de-icing systems - Issues and concerns for certification

[AIAA 89-0761] p 314 A89-28456 METAL FATIGUE

Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs p 350 N89-17257 Constitutive modelling of single crystal and directionally

p 342 N89-17325

solidified superalloys METAL PLATES

Mechanism of single shear fastened joints p 352 N89-17700

METAL POWDER

A new technique for the production of gas atomized p 340 A89-25902 powder Superplasticity of HIPped PM superalloys made from p 341 A89-25915 attrited prealloy powder

METEOROLOGICAL RADAR

Enroute turbulence avoidance procedures [AIAA PAPER 89-0739] p 303 A89-25556 The effects of enroute turbulence reports on air carrier

flight operations [AIAA PAPER 89-0741] p 303 A89-25557 TDWR display experiences --- Terminal Doppler Weather

Radar [AIAA PAPER 89-0807] D 346 A89-25590 METEOROLOGICAL RESEARCH AIRCRAFT

- Cockpit display of ground-based weather data during thunderstorm research flights
- [AIAA 89-08061 p 269 A89-28463 MÉTEOROLOGICAL SERVICES Weather accident prevention using the tools that we have
- [AIAA PAPER 89-0707] p 302 A89-25547
- Weather data dissemination to aircraft [AIAA PAPER 89-0809] p 3 p 304 A89-25592 MICROBURSTS (METEOROLOGY)
- Weather accident prevention using the tools that we have
- [AIAA PAPER 89-0707] p 302 A89-25547
- TDWR display experiences --- Terminal Doppler Weather Radar p 346 A89-25590

[AIAA PAPER 89-0807]

Cockpit display of hazardous weather information [AIAA PAPER 89-0808] p 335 A89-25591

- The effect of a ground-based inversion layer on an impacting microburst [AIAA PAPER 89-0810] p 352 A89-25593
- unsteady vortex-ring model for microburst An simulation
- [AIAA PAPER 89-0811] p 353 A89-25594 Numerical simulation of microburst downdrafts Application to on-board and look ahead sensor echnology
- AIAA PAPER 89-08211 p 353 A89-25599 Piloted-simulation evaluation of escape guidance for
- microburst wind shear encounters [NASA-TP-2886] p 321 N89-16820 MICROGRAVITY APPLICATIONS
- High-temperature containerless aircraft furnace experimentation in the microgravity environment aboard
- a KC-135 aircraft AIAA PAPER 89-04021 p 345 A89-25337
- MICROPHONES Source localization technique for impulsive multiple sources --- microphone arrays for helicopter rotor noise
- measurement p 356 A89-27741 An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition input
- [AD-A200626] p 309 N89-17588 MICROPROCESSORS
 - A microprocessor-based proportional-integral controller for hydraulically actuated mechanisms
 - p 335 A89-27655
- MICROSTRUCTURE Thermal conductivity and microstructure stability of heat treated AMZIRC copper-based alloys
- p 341 A89-26361 **MICROWAVE AMPLIFIERS**
- Temperature compensation using GaAs MMIC devices p 347 A89-26548
- MICROWAVE LANDING SYSTEMS
- The realization of microwave landing system benefits p 307 A89-26734 **MICROWAVE PHOTOGRAPHY**
- Investigation of surface water behavior during glaze ice p 304 A89-27739 accretion **MILITARY AIRCRAFT**
 - Mechanization, design and methodological lessons earned from a dynamic cockpit mock-up evaluation [SAE PAPER 881438] p 319 A89-28213 Supportability design requirements for army aircraft and equipment
- SAE PAPER 8814471 p 356 A89-28217 Real-time simulation for survivable penetration
- [SAE PAPER 881515] p 333 A89-28236 GPS antenna problems for military aircraft p 309 A89-28297
- **MILITARY HELICOPTERS**
- The Honeywell/DND helicopter integrated navigation system (HINS) p 308 A89-26741 Gas path analysis and engine performance monitoring
- in a Chinook helicopter p 327 N89-16802 **MILITARY OPERATIONS**
- An application of heuristic search techniques to the problem of flight path generation in a military hostile environment p 355 A89-27611 **MILITARY TECHNOLOGY**
- EURONAV A state of the art military GPS receiver p 340 A89-26711 An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782
- Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Canadian forces aircraft condition/health monitoring:
- Policy, plans and experience p 326 N89-16784 MINICOMPUTERS
- Military engine condition monitoring systems: The UK experience p 320 N89-16797 MISSILE CONFIGURATIONS
- Lateral oscillations of sting-mounted models at high alpha
- [AIAA PAPER 89-0047] p 310 A89-25041
- Efficient application techniques of the EAGLE grid code to complex missile configurations [AIAA PAPER 89-0361] p 353 A89-25305
- MIXING LAYERS (FLUIDS) The compressible mixing layer - Linear theory and direct
- simulation [AIAA PAPER 89-0371] p 283 A89-25314
- Combined tangential-normal injection into a supersonic flow
- [AIAA PAPER 89-0622] p 288 A89-25492 Effects of a downstream disturbance on the structure p 348 A89-27692 of a turbulent plane mixing layer

NAVIER-STOKES EQUATION

Improved methods of characteriz	ing ejec	tor pumping
performance		
[AIAA PAPER 89-0008]	p 322	A89-25004
Computational studies of a localiz	ed supe	ersonic shear
layer		
[AIAA PAPER 89-0125]	p 275	A89-25110
MODAL RESPONSE		
Modal control of an obligue wing a	aircraft	
[NASA-TP-2898]	p 333	N89-16845
MODELS		
Wake model for helicopter rotors	in high	speed flight
[NASA-CR-177507]	p 301	N89-17577
MOISTURE CONTENT		
A solution to water vapor in the	Nation	al Transonic
Facility		
[AIAA PAPER 89-0152]	p 334	A89-25135
Development of a laboratory metho	od for st	udving water
coalescence of aviation fuel		, ,
[SAE PAPER 881534]	p 341	A89-28243
MOMENT DISTRIBUTION	•	
Expriments on the DFVLR-F4 wind	a body i	configuration
in several European windtunnels	D 337	N89-16848
MOTION PICTURES	F	
Precision trajectory reconstruction		
	n 307	A89-26726
	p 00.	
laguar/Tornado intoko dopian	a 200	NO0 16740
Jaguar / Joinaud Intake design	h 588	1109-10/43
intake-airrrame integration	p 315	N89-16744

MIXING LENGTH ELOW THEORY

- NACELLES
 - A transonic computational method for an aft-mounted nacelle/pylon configuration with propeller power effect [AIAA PAPER 89-0560] p 311 A89-25449 Feasibility study on the design of a laminar flow

N

- nacelle [AIAA PAPER 89-0640] p 311 A89-25506 Iongitudinal Lift and forces on propeller/nacelle/wing/flap systems
- p 298 N89-16736 [ESDU-880311 NASA PROGRAMS
 - Recent results in the NASA research balloon program p 269 A89-25199 [AIAA PAPER 89-0233] Developments in expulsive separation ice protection blankets
 - [AIAA PAPER 89-0774] p 311 A89-25572 An overview of the current NASA program on aircraft icing research
- [SAE PAPER 881386] p 305 A89-28192 p 317 N89-18387 The national aero-space plane NASTRAN
- Vibration and flutter analysis of composite wing panels p 346 A89-26273
- NATIONAL AEROSPACE PLANE PROGRAM Pressure and heat transfer investigation of a modified
- NASP baseline configuration at M = 6 --- National Aero-Space Plane
- [AIAA PAPER 89-0246] p 339 A89-25208 Computational design aspects of a NASP nozzle/afterbody experiment
- [AIAA PAPER 89-0446] p 284 A89-25364 The national aero-space plane NAVIER-STOKES EQUATION p 317 N89-18387
- Fast laminar near wake flow calculation by an implicit method solving the Navier-Stokes equations
- p 270 A89-24923 A numerical study of hypersonic propulsion/airframe integration problem
- [AIAA PAPER 89-0030] p 272 A89-25026 Unsteady Navier-Stokes computations past oscillating
- delta wing at high incidence [AIAA PAPER 89-0081] p 273 A89-25071 Adaptive grid embedding Navier-Stokes technique for

Passage-averaged Navier-Stokes equations with finite

Upwind Navier-Stokes solutions for leading-edge vortex

Large-angle-of-attack viscous hypersonic flows over

Numerical simulation of hypersonic flow around a space

Comparison of LDV measurements and Navier-Stokes

solutions in a two-dimensional 180-degree turn-around

plane at high angles of attack using implicit TVD

p 277 A89-25179

p 344 A89-25183

p 278 A89-25223

p 279 A89-25227

p 279 A89-25230

p 279 A89-25232

A-21

cascade flows

flows

duct

[AIAA PAPER 89-0204]

element applications [AIAA PAPER 89-0208]

[AIAA PAPER 89-0265]

[AIAA PAPER 89-0269]

[AIAA PAPER 89-0273]

[AIAA PAPER 89-0275]

Navier-Stokes code

complex lifting configurations

NAVIGATION AIDS

Grid refinement studies of turbine rotor-stator interaction

p 281 A89-25274 [AIAA PAPER 89-0325] Navier-Stokes solutions for vortical flows over a tangent-ogive cylinder

A PAPER 89-0337] n 281 A89-25284 Navier-Stokes solutions about the F/A-18 forebody-LEX configuration --- Leading Edge Extension

p 281 A89-25285 [AIAA PAPER 89-0338] Application of direct solvers to unstructured meshes for the Euler and Navier-Stokes equations using upwind

schemes [AIAA PAPER 89-0364] p 283 A89-25308 Conflicting stepsize requirements for stable PNS computations

[AIAA PAPER 89-0445] p 284 A89-25363 An investigation of cell centered and cell vertex multigrid schemes for the Navier-Stokes equations

p 345 A89-25440 [AIAA PAPER 89-0548] An improved upwind finite volume relaxation method for high speed viscous flows

p 286 A89-25441 [AIAA PAPER 89-0549] Navier-Stokes computations of separated vortical flows past prolate spheroid at incidence

p 286 A89-25443 [AIAA PAPER 89-0553] Prediction of separated transonic wing flows with a

non-equilibrium algebraic model [AIAA PAPER 89-05581 p 287 A89-25447 Comparison of two different Navier-Stokes methods for

the simulation of 3-D transonic flows with separation A89-25448 [AIAA PAPER 89-0559] p 287 Evaluation of three turbulence models for the prediction

of steady and unsteady airloads p 288 A89-25485 [AIAA PAPER 89-06091

- Navier-Stokes simulation of transonic wing flow fields using a zonal grid approach p 290 A89-25862 Navier-Stokes simulation of wind-tunnel flow using
- LU-ADI factorization algorithm p 291 A89-25864 Three-dimensional viscous flow simulations using an p 291 A89-25865

implicit relaxation scheme Simulation of the DFVLR-F5 wing experiment using a block structured explicit Navier-Stokes method

p 291 A89-25866 Turbulence modeling in separated flow behind strong p 294 A89-27746 shocks

Numerical analysis of flow through oscillating cascade sections

[AIAA PAPER 89-0437] p 296 A89-28413 Accuracy problems in wind tunnels during transport rcraft development p 338 N89-16877 aircraft development A numerical simulation of flows about two-dimensional

bodies of parachute-like configuration p 302 N89-17580 [ISAS-629]

NAVIGATION AIDS The Honeywell/DND helicopter integrated navigation p 308 A89-26741 system (HINS)

Integrating causal reasoning at different levels of abstraction --- in problem-solving system functioning as pilot assistant in commercial air transport emergencies p 355 A89-27609

A GPS receiver antenna with integrated down-mixer p 309 A89-28299

Advanced Fighter Technology Integration/Sandia Inertial Terrain-Aided Navigation (AFTI/SITAN) p 309 N89-17587 [DE89-004000]

NAVSTAR SATELLITES EURONAV - A state of the art military GPS receiver p 340 A89-26711

NEAR WAKES

Fast laminar near wake flow calculation by an implicit method solving the Navier-Stokes equations p 270 A89-24923

An experimental investigation of the effects of a base cavity on the near-wake flowfield of a body at subsonic

and transonic speeds p 277 A89-25184 [AIAA PAPER 89-0210]

NEURAL NETS Pattern-based fault diagnosis using neural networks

p 354 A89-27602 NICKEL ALLOYS

Material defects in a PM-nickel-base superalloy p 341 A89-25919 Constitutive modelling of single crystal and directionally

p 342 N89-17325 solidified superalloys NITROGEN OXIDES

Estimates of oxides of nitrogen formed in an inlet air stream for high Mach number flight conditions p 277 A89-25172 [AIAA PAPER 89-0197]

NOISE GENERATORS Source localization technique for impulsive multiple

sources --- microphone arrays for helicopter rotor noise p 356 A89-27741 measurement NOISE REDUCTION

Helicopter tail rotor blade-vortex interaction noise p 356 N89-18167 (NASA-CR-1831781

NONDESTRUCTIVE TESTS

On a distributed parameter model for detecting cracks p 354 A89-25870 in a rotor Review of existing NDT technologies and their

p 349 N89-17255 capabilities Relationships of nondestructive evaluation needs and

p 349 N89-17256 component design Importance of sensitivity and reliability of NDI techniques

on damage tolerance based life prediction of turbine p 350 N89-17257 Short term developments in non-destructive evaluation

applicable to turbine engine parts p 350 N89-17258 Long term possibilities for nondestructive evaluation for US Navy aircraft p 350 N89-17259

Need for common AGARD approach and actions p 350 N89-17260

State-of-the-art in non-destructive evaluation of turbine p 350 N89-17261 engine parts

NONEQUILIBRIUM CONDITIONS

A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium p 277 A89-25174 [AIAA PAPER 89-0199]

NONEQUILIBRIUM FLOW An efficient, explicit finite-rate algorithm to compute flows in chemical nonequilibrium

[AIAA PAPER 89-0522] p 285 A89-25418 On the solution of nonequilibrium hypersonic inviscid

steady flows p 289 A89-25532 [AIAA PAPER 89-0671]

Nonequilibrium viscous hypersonic flows over ablating Teflon surfaces p 293 A89-26368 AIAA PAPER 89-03141

NONEQUILIBRIUM THERMODYNAMICS Nonequilibrium effects for hypersonic transitional flows

using continuum approach p 284 A89-25377 [AIAA PAPER 89-0461]

NONLINEAR SYSTEMS

Control of nearly singular decoupling systems and p 332 A89-25692 nonlinear aircraft maneuver Nonlinear dynamic responses of composite rotor blades

[AD-A200145] p 315 N89-16774 NORMAL SHOCK WAVES

Mach number dependence of flow separation induced normal shock-wave/turbulent boundary-layer interaction at a curved wall

p 282 A89-25298 [AIAA PAPER 89-0353] normal-shock/turbulent-boundary-layer Confined interaction followed by an adverse pressure gradient

[AIAA PAPER 89-0354] p 282 A89-25299 An LDV investigation of a multiple normal shock

wave/turbulent boundary layer interaction p 282 A89-25300 [AIAA PAPER 89-0355] NOSE CONES

Effect of nose bluntness on flow field over slender bodies in hypersonic flows

p 279 A89-25228 [AIAA PAPER 89-0270] Low-speed vortical flow over a 5-degree cone with tip geometry variations p 295 A89-28203

[SAE PAPER 881422] NOSE TIPS

Low-speed vortical flow over a 5-degree cone with tip geometry variations [SAE PAPER 881422] p 295 A89-28203

NOZZLE DESIGN

Computational design aspects nozzle/afterbody experiment [AIAA PAPER 89-0446] Results from NACC of a NASP p 284 A89-25364

Results from NASA Langley experimental studies of multiaxis thrust vectoring nozzles

p 324 A89-28228 [SAE PAPER 881481] New design of the nozzle section of a large subsonic wind tunnel

[F+W-TF-1926] p 339 N89-17601 **NOZZLE FLOW**

Zonal modelling of flows through multiple inlets and nozzles p 271 A89-25003

[AIAA PAPER 89-0005] Adaptive computations of multispecies mixing between scramjet nozzle flows and hypersonic freestream

p 322 A89-25005 [AIAA PAPER 89-0009] CFD simulation of square cross-section, contoured nozzle flows - Comparison with data

p 273 A89-25039 [AIAA PAPER 89-0045] Viscous swirling nozzle flow

[AIAA PAPER 89-0280] p 279 A89-25237 Subcritical swirling flows in convergent, annular

p 323 A89-27694 nozzles Comparison of 3D computation and experiment for non-axisymmetric nozzles

p 325 A89-28403 [AIAA PAPER 89-0007] NOZZLE GEOMETRY

CFD simulation of square cross-section, contoured nozzle flows - Comparison with data [AIAA PAPER 89-0045] p 273 A89-25039

Viscous swirling nozzle flow p 279 A89-25237 [AIAA PAPER 89-0280] New design of the nozzle section of a large subsonic wind tunnel p 339 N89-17601 [F+W-TF-1926] NUMERICAL ANALYSIS Numerical analysis of flow through oscillating cascade p 296 A89-28413 [AIAA PAPER 89-0437] Numerical solution of flow fields around Delta wings using Euler equations method p 299 N89-16757 [NAL-TM-FM-8701] Notes on a theoretical parachute opening force analysis applied to a general trajectory p 302 N89-17582 [AD-A201050] NUMERICAL CONTROL Secondary power - Benefits of digital control and vehicle management system integration p 325 A89-28264 SAE PAPER 8814981 NUMERICAL FLOW VISUALIZATION Streamlines and streamribbons in aerodynamics p 276 A89-25123 [AIAA PAPER 89-0140] Numerical simulation of high-incidence flow over the F-18 fuselage forebody p 282 A89-25286 TAIAA PAPER 89-03391 Direct numerical simulation of compressible free shear n 283 A89-25317 [AIAA PAPER 89-0374] Study of the vortical wake patterns of an oscillating airfoil [AIAA PAPER 89-0554] p 287 A89-25444 NUMERICAL INTEGRATION Determination of the numerical integration step during the analog-digital modeling of dynamic systems p 354 A89-27405 NUMERICAL STABILITY Conflicting stepsize requirements for stable PNS

computations p 284 A89-25363 [AIAA PAPER 89-0445]

OBLIQUE WINGS Scissor wing - An alternative to variable sweep p 310 A89-25009 [AIAA PAPER 89-0013]

0

Modal control of an oblique wing aircraft p 333 N89-16845 [NASA-TP-2898] OGIVES

Supersonic, transverse jet from a rotating ogive cylinder a hypersonic flow p 294 A89-27728 in a hypersonic flow

An experimental investigation of the aerodynamic characteristics of slanted base ogive cylinders using magnetic suspension technology

p 300 N89-16758 [NASA-CB-184624] ONBOARD DATA PROCESSING

Ranging and Processing Satellite (RAPSAT) p 340 A89-26738

OPACITY

Fuel-additive system for test cells p 342 N89-17681 [AD-A200801]

OPERATING TEMPERATURE Engineering ceramics - Applications and testing p 347 A89-27632 requirements

OPTICAL COMMUNICATION

Laser communication test system p 349 N89-17215 [AD-A199612]

OPTIMAL CONTROL

OPTIMIZATION

[AIAA PAPER 88-2512]

[AIAA PAPER 89-0539]

[AIAA PAPER 89-0289]

[AD-A200180]

OSCILLATING FLOW

eurfocoe

range

flow

Inertial energy distribution error control for optimal wind shear penetration

[AIAA PAPER 89-0016] n 331 A89-25012 Aircraft vertical profile implementation using

p 332 A89-25683 directed-graph methods

An H(infinity) method for the design of linear time-invariant multivariable sampled-data control

Spanload optimization for strength designed lifting

Optimization of natural laminar flow airfoils for high

section lift-to-drag ratios in the lower Reynolds number

Aeroelastic optimization of a helicopter rotor

Field enhancement of UHF-VHF aircraft antennas

Oscillating aerodynamics and flutter of an aerodynamically detuned cascade in an incompressible

p 354 A89-26196

p 314 A89-28252

p 296 A89-28428

p 316 N89-16778

p 349 N89-17069

p 280 A89-25246

p 354 A89-26187 systems

An alternative method to solve a variational inequality applied to an air traffic control example

0020201		
Experimental investigation cascade aerodynamics	n of transonic	oscillating
[AIAA PAPER 89-0321]	p 293	A89-26369
Exit angle rules in superson	ic cascades	
	p 329	N89-16828
OXIDATION RESISTANCE	•	
Engineering ceramics -	Applications	and testing
requirements	p 347	A89-27632
P		
PANEL METHOD (FLUID DYNA	AMICS)	
Application of continuo	us vorticity	panels in
three-dimensional lifting flows	with partial sep	Daration
[AIAA PAPER 89-0117]	p 2/5 of the multicler	A89-25104
A prediction of the stalling c	n 292 a	A89-25932
Development of a pane	al method fo	r modeling
configurations with unsteady	component mo	tions, phase
1		
[AD-A200255]	p 315	N89-16775
PARACHUTE DESCENT	situation along	+ha C 160
Study of the aerodynamic	situation along	I the C 160
IDAT_88_061	n 299	N89-16756
PARACHUTE FABRICS	p 200	100 10100
Notes on a theoretical parac	hute opening fo	orce analysis
applied to a general trajectory	, <u> </u>	
[AD-A201050]	p 302	N89-17582
PARACHUTES		the C 160
Study of the aerodynamic	situation along	Ine C 160
IDAT-88-061	n 299	N89-16756
A numerical simulation of fl	ows about two	dimensional
bodies of parachute-like confi	guration	
[ISAS-629]	p 302	N89-17580
Notes on a theoretical parac	hute opening fo	orce analysis
applied to a general trajectory	- 000	NO0 17500
[AD-A201050]	p 302	1089-17562
Test specimens for bea	ring and by-	oass stress
interaction in carbon fibre rein	forced plastic l	aminates
	p 342	N89-17696
PARAMETER IDENTIFICATION	4	
Hierarchical representation	and machine k	earning from
faulty jet engine behavioral ex	amples to dete	ect real time
abnormal conditions	p 355	A89-2/622
Evolution of particle-laden i	et flows - A the	eoretical and
experimental study	D 348	A89-27693
PARTICLE SIZE DISTRIBUTIO	N	
Performance of the forwa	rd scattering s	spectrometer
probe in NASA's Icing Resea	ch Tunnel	
[AIAA PAPER 89-0769]	р 346	A89-25570
PASSENGER AIRCRAFT		

Results of the AIA/ATA/FAA Dynamic Seat Testing Program [SAE PAPER 881375] p 304 A89-28187

Discussion of transport passenger seat performance characteristics

[SAE PAPER 881378]	p 305	A89-28190
PATTERN RECOGNITION		
Pattern-based fault diagnosis u	using neural	networks

p 354 A89-27602 PCM TELEMETRY

Software control of a high speed, modular signal conditioner and PCM encoder system

p 318 A89-27670 PERFORMANCE

- Reliable information from engine performance monitoring p 356 A89-28215 (SAF PAPER 881444)
- PERFORMANCE PREDICTION 3-D combustor performance validation with high density

fuels [AIAA PAPER 89-0219] p 340 A89-25193

Aerodynamic prediction rationale for analyses of hypersonic configurations [AIAA PAPER 89-0525] p 285 A89-25420 Real-time comparison of X-29A flight data and simulation

- data p 332 A89-27736 Trend monitoring of a turboprop engine at low and mean p 321 N89-16801
- Wind tunnel predicted air vehicle performance: A review of lessons learned p 337 N89-16852

PERFORMANCE TESTS Performance of the forward scattering spectrometer

- probe in NASA's Icing Research Tunnel p 346 A89-25570 [AIAA PAPER 89-0769]
- Comparative tests of aircraft radial and bias ply tires [SAE PAPER 881359] p 313 A89-28178 Performance testing of an electrically actuated aircraft
- braking system [SAE PAPER 881399] p 313 A89-28194

information from engine performance Reliable monitorin

p 356 A89-28215 [SAE PAPER 881444] An experimental investigation of multi-element airfoil ice accretion and resulting performance degradation

p 297 A89-28453 [AIAA 89-0752] PERTURBATION THEORY Modifications to transonic flow codes for unsteady

- perturbations around an experimental mean [AIAA PAPER 89-0447] p 284 A89-25365 Evolution of perturbations near a surface in supersonic p 294 A89-27384 flow
- PIEZOELECTRIC TRANSDUCERS Distributed ice accretion sensor for smart aircraft
- structures p 311 A89-25571 AIAA PAPER 89-07721 PILOT ERROR
- Causal probability model for transoceanic track separations with applications to automatic dependent p 308 A89-26735 surveillance
- PILOT PERFORMANCE Do pilots let aircraft operations schedules influence enroute turbulence avoidance procedures?
- p 303 A89-25558 [AIAA PAPER 89-0743] Problems of ensuring civil-aircraft fire safety p 304 A89-27249
- Computer-generated map display for the pilot/vehicle intorfa/
- [SAE PAPER 881440] p 319 A89-28214 Piloted-simulation evaluation of escape guidance for microburst wind shear encounters
- [NASA-TP-2886] p 321 N89-16820 **PILOT TRAINING**
- Enroute turbulence avoidance procedures p 303 A89-25556 [AIAA PAPER 89-0739] Photo-based three dimensional graphics models for multi-sensor simulation --- terrain data bases for flight p 348 A89-27787 simulator
- Aircraft accident/incident summary report, Travis Air Force Base, California, 8 April 1987 p 306 N89-16768 [PB88-910414]
- PISTON ENGINES Condor for high altitudes p 269 A89-26674
- PITCH (INCLINATION) The separated flow field on a slender wing undergoing
- transient pitching motions AIAA PAPER 89-0194] p 276 A89-25169
- PITCHING MOMENTS Extended pitch axis effects on flow about a pitching
- airfoil p 272 A89-25021
- [AIAA PAPER 89-0025] An experimental evaluation of a low-Reynolds number high-lift airfoil with vanishingly small pitching moment [AIAA PAPER 89-0538] p 286 A89-25432 PITOT TUBES
- Miniaturized compact water-cooled pitot-pressure probe for flow-field surveys in hypersonic wind tunnels
- p 348 A89-27659 PLANFORMS
- Aerodynamic performance of wings of arbitrary planform n inviscid, incompressible, irrotational flow
- [AD-A200436] p 297 N89-16728 PLANNING
- Canadian forces aircraft condition/health monitoring: p 326 N89-16784 Policy, plans and experience PLASMA SPRAYING
- prediction model Thermal barrier coating life development p 351 N89-17333 PLASTIC AIRCRAFT STRUCTURES
- Finite element analysis of composite rudder for DO 228 p 347 A89-26284 aircraft

PLATES (STRUCTURAL MEMBERS)

Vortical flows past normal plate and spoiler of time dependent height

- [AIAA PAPER 89-0291] p 280 A89-25248 PLUMES
- The effect of exhaust plume/afterbody interaction on installed Scramjet performance
- [NASA-TM-101033] p 330 N89-17600 Fuel-additive system for test cells
- p 342 N89-17681 [AD-A2008011 POLICIES
- Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 POROUS BOUNDARY LAYER CONTROL
- Experimental and numerical investigation of an oblique shock wave/turbulent boundary layer interaction with continuous suction
- p 296 A89-28407 [AIAA PAPER 89-0357] POSITION (LOCATION)
- PLANS '88 IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record p 339 A89-26701
- Advanced Fighter Technology Integration/Sandia Inertial Terrain-Aided Navigation (AFTI/SITAN) p 309 N89-17587 [DE89-004000]

PRESSURE OSCILLATIONS

POSITION ERRORS VERDICT - A plan for gravity compensation of inertial p 307 A89-26724 navigation systems Correction for deflections of the vertical at the runup site p 307 A89-26725 POTENTIAL FLOW Applications of an efficient algorithm to transonic conservative full-potential flow past 3-D wings p 291 A89-25930 Applications of AF3 efficient iteration scheme to transonic nonconservative full-potential flow past airfoils p 292 A89-25940 Investigation of internal singularity methods for p 294 A89-27748 multielement airfoils Aerodynamic performance of wings of arbitrary planform in inviscid, incompressible, irrotational flow p 297 N89-16728 [AD-A200436] POTENTIAL THEORY Integral equation solution of the full potential equation for transonic flows [AIAA PAPER 89-0563] p 287 A89-25452 POWDER METALLURGY Superplasticity of HIPped PM superalloys made from p 341 A89-25915 attrited prealloy powder Material defects in a PM-nickel-base superalloy p 341 A89-25919 Review of existing NDT technologies and their p 349 N89-17255 capabilities POWER CONDITIONING Unbalanced and nonlinear loads in aircraft electrical systems [SAE PAPER 881413] p 325 A89-28262 High reliability aircraft generator system p 325 A89-28263 [SAE PAPER 881414] Secondary power - Benefits of digital control and vehicle management system integration SAE PAPER 881498 p 325 A89-28264 POWERED LIFT AIRCRAFT The current status of the flight test of the ASKA p 314 A89-28208 [SAE PAPER 881433] PREDICTION ANALYSIS TECHNIQUES Vortex dynamics for rotorcraft interactional erodynamics [AD-A2001281 p 297 N89-16726 Some difficulties in the wind tunnel prediction of modern civil aircraft buffeting: Proposed remedies p 301 N89-16869 PREDICTIONS prediction model Thermal barrier coating life p 351 N89-17333 development PREFLIGHT OPERATIONS Analysis of extreme wind shear p 352 A89-25549 [AIAA PAPER 89-0710] PRESSURE DISTRIBUTION Pressure and heat transfer investigation of a modified NASP baseline configuration at M = 6 --- National Aero-Space Plane [AIAA PAPER 89-0246] p 339 A89-25208 A model of pressure distributions on impeller blades for determining performance characteristics [AIAA PAPER 89-0840] p 346 A89-25609 Intake swirl and simplified methods for dynamic pressure p 299 N89-16742 distortion assessment Expriments on the DFVLR-F4 wing body configuration several European windtunnels p 337 N89-16848 An experimental investigation of the perpendicular in several European windtunnels vortex-airfoil interaction at transonic speeds p 301 N89-17569 PRESSURE EFFECTS Loss development in transonic compressor cascades p 328 N89-16826 PRESSURE GRADIENTS Diverging boundary layers with zero streamwise pressure radient [AIAA PAPER 89-0134] n 343 A89-25118 On the structure of two- and three-dimensional senaration p 280 A89-25244 [AIAA PAPER 89-0287] normal-shock/turbulent-boundary-layer Confined interaction followed by an adverse pressure gradient AIAA PAPER 89-035 p 282 A89-25299 PRESSURE MEASUREMENT Heat transfer and pressure comparisons between computation and wind tunnel for a research hypersonic aircraft [AIAA PAPER 89-0029] p 272 A89-25025 PRESSURE OSCILLATIONS Low frequency pressure oscillations in a model ramjet combustor - The nature of frequency selection [AIAA PAPER 89-0623] p 323 A89-25493 Evidence of a strange attractor in ramjet combustion p 323 A89-25494 [AIAA PAPER 89-0624] Acoustic-vortex interactions and low-frequency

oscillations in axisymmetric combustors --- of ramjet p 325 A89-28336 engines

PRESSURE REDUCTION

PRESSURE REDUCTION

An experimental study and prediction of a two-phase pressure drop in microgravity p 343 A89-25065

[AIAA PAPER 89-0074] Coolant passage heat transfer with rotation p 351 N89-17314

PRESSURE SENSORS

Miniaturized compact water-cooled pitot-pressure probe for flow-field surveys in hypersonic wind tunnels p 348 A89-27659

PROBLEM SOLVING

Integrating causal reasoning at different levels of abstraction ... in problem-solving system functioning as pilot assistant in commercial air transport emergencies p 355 A89-27609

Accuracy problems in wind tunnels during transport p 338 N89-16877 opment PROCUREMENT

- Aircraft airframe cost estimating relationships: All nission types
- p 269 N89-16719 [AD-A200262] Aircraft airframe cost estimating relationships: Fighters p 270 N89-16720 [AD-A200263]
- Aircraft airframe cost estimating relationships: Bombers and transports p 270 N89-16721 [AD-A200264]
- PRODUCT DEVELOPMENT
- The design and development of transonic multistage p 329 N89-16834 compressors

PROLATE SPHEROIDS

Drag measurements on a modified prolate spheroid using a magnetic suspension and balance system [AIAA PAPER 89-0648] p 335 A89 p 335 A89-25512 **PROP-FAN TECHNOLOGY**

- Prop-fan airfoil icing characteristics
- p 303 A89-25561 [AIAA PAPER 89-0753] Prop-fan structural results from PTA tests
- p 324 A89-28202 [SAE PAPER 881418] PROPELLER FANS
- A computational procedure for automated flutter p 348 A89-28070 analysis PROPELLERS
- Propeller/wing interaction
- p 311 A89-25429 [AIAA PAPER 89-0535] Laser velocimeter measurements of the flowfield generated by an advanced counterrotating propeller A89-26373 [AIAA PAPER 89-0434] p 293 Preliminary results in the development of a method to
- correct propeller inflow for improved unsteady force calculations [AIAA PAPER 89-0436] p 293 A89-26374
- and longitudinal forces оп Lift propeller/nacelle/wing/flap systems p 298 N89-16736 FSDU-880311
- PROPULSION SYSTEM CONFIGURATIONS Facility requirements for hypersonic propulsion system
- testing [AIAA PAPER 89-0184] p 335 A89-25159 Thermodynamics and wave processes in high Mach number propulsive ducts
- p 278 A89-25219 [AIAA PAPER 89-0261] Report of the Defense Science Board task force on the
- National Aerospace Plane (NASP) p 317 N89-17595 [AD-A201124] PROPULSION SYSTEM PERFORMANCE

- CFD applications Propulsion perspective p 343 A89-25082 TAIAA PAPER 89-00931 Considerations of control authority requirements in STOVL propulsion system sizing
- p 313 A89-28207 [SAE PAPER 881432] p 330 N89-16837 Supersonic throughflow fans PROTECTIVE COATINGS
- The effects of a compressor rebuild on gas turbine ngine performance p 327 N89-16803 engine performance PROTOTYPES
- An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition input

[AD-A200626]	р 309	N89-17588
MPC-75 feeder civil aircraft		
[AD A200007]	n 317	N89-17594

- PROVING
- Experimental verification of the thermodynamic properties for a jet-A fuel (NASA-TM-1014751 p 342 N89-17017
- PULSE CODE MODULATION Software control of a high speed, modular signal
- conditioner and PCM encoder system p 318 A89-27670

PULSE HEATING

- Electromagnetic emissions from a modular low voltage EIDI system --- Electro-Impulse Deicing p 303 A89-25564 [AIAA PAPER 89-0758]
- A-24

PUMPING

- Improved methods of characterizing ejector pumping performance
- [AIAA PAPER 89-0008] p 322 A89-25004 PYLON MOUNTING
- A transonic computational method for an aft-mounted nacelle/pylon configuration with propeller power effect [AIAA PAPER 89-0560] p 311 A89-25449

Q

- QUALITY CONTROL
- Aluminum quality breakthrough for aircraft structural p 348 A89-27745 reliability

R

- RADAR ANTENNAS Some new ideas in radar antenna technology p 347 Å89-26542
- for SAR motion Evaluation of a Kalman filter p 347 A89-26721 compensation RADAR EQUIPMENT
- LIRAS A proposal for an airport traffic safety system p 308 A89-28293
- RADAR IMAGERY Evaluation of a Kalman filter for SAR motion p 347 A89-26721 compensation RADAR MAPS
- Phase-only filters with improved signal to noise ratio p 356 A89-28382
- RADAR NAVIGATION A Kalman filter for an integrated Doppler/GPS navigation p 308 A89-26740 system
- RADIAL FLOW Turbulence measurements in a radial upwash p 294 A89-27706
- RADIO RECEIVERS EURONAV - A state of the art military GPS receiver
- p 340 A89-26711 RADIOMETERS
- The measurement of temperature from an aircraft in p 353 N89-17978 cloud RAIN
- The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment p 337 A89-28457
- [AIAA 89-0762] Effect of heavy rain on aviation engines
- p 326 A89-28462 [AIAA 89-0799] RAMJET ENGINES
- Flowfield modifications of combustion rates in unstable ramiets
- p 322 A89-25092 [AIAA PAPER 89-0105] Low frequency pressure oscillations in a model ramjet combustor - The nature of frequency selection
- p 323 A89-25493 [AIAA PAPER 89-0623] Evidence of a strange attractor in ramjet combustion p 323 A89-25494 [AIAA PAPER 89-0624]
- Acoustic-vortex interactions and low-frequency oscillations in axisymmetric combustors --- of ramjet p 325 A89-28336 enaines
- RAREFIED GAS DYNAMICS
- Three-dimensional flow simulation about the AFE vehicle in the transitional regime --- Aeroassist Flight Experiment [AIAA PAPER 89-0245] p 278 A89-25207
- Supersonic low-density flow over airfoils p 286 A89-25424 [AIAA PAPER 89-0530]
- RATIOS Axial velocity density ratio influence on exit flow angle
- p 329 N89-16830 in transonic/supersonic cascades REAL GASES Progress on a Taylor weak statement finite element
- algorithm for high-speed aerodynamic flows [AIAA PAPER 89-0654] p 289 A89-25517
- REAL TIME OPERATION Real-time comparison of X-29A flight data and simulation
- data p 332 A89-27736 Real-time simulation for survivable penetration [SAE PAPER 881515] p 333 A89-28236
- RECEIVERS Laser communication test system
- [AD-A199612] p 349 N89-17215 RECTANGULAR WINGS
- Effect of simulated glaze ice on a rectangular wing [AIAA PAPER 89-0750] p 303 A89-25560 The effects of aspect ratio on the stall of a finite wind p 296 A89-28434 [AIAA PAPER 89-0570] REDUCED GRAVITY
- An experimental study and prediction of a two-phase pressure drop in microgravity [AIAA PAPER 89-0074]
 - p 343 A89-25065

- REDUNDANCY Development of new redundant flight safety system using inertial sensors USAS.6341 p 306 N89-17585 REENTRY VEHICLES Prediction of supersonic/hypersonic viscous flows over RVs and decovs [AIAA PAPER 89-0028] p 272 A89-25024 International Instrumentation Symposiur Albuquerque, NM, May 2-6, 1988, Proceedings Symposium, 34th, p 348 A89-27651 REINFORCED PLATES Aeroelastic flutter of low aspect ratio cantilever composite plate p 347 A89-26281 RELAXATION METHOD (MATHEMATICS) An improved upwind finite volume relaxation method for high speed viscous flows [AIAA PAPER 89-0549] p 286 A89-25441 Three-dimensional viscous flow simulations using an implicit relaxation scheme p 291 A89-25865 RELIABILITY Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine p 350 N89-17257 discs RELIABILITY ANALYSIS p 269 A89-26673 Amber for long endurance RELIABILITY ENGINEERING Fault management in aircraft power plant controls p 327 N89-16809 REMOTE CONTROL A signal filter with zero phase lag p 336 A89-27674 REMOTELY PILOTED VEHICLES p 269 A89-26673 Amber for long endurance Condor for high altitudes p 269 A89-26674 Design and experimental results for a high-altitude, ng-endurance airfoil p 312 A89-27740 long-endurance airfoil Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study [AD-A200665] p 270 N89-17564 REQUIREMENTS An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 equirements and capabilities in unsteady windtunnel p 339 N89-16878 testina RESEARCH AIRCRAFT Heat transfer and pressure comparisons between computation and wind tunnel for a research hypersonic aircraft p 272 A89-25025 [AIAA PAPER 89-00291 Amber for long endurance . p 269 A89-26673 Prop-fan structural results from PTA tests p 324 A89-28202 [SAE PAPER 881418] The current status of the flight test of the ASKA p 314 A89-28208 [SAE PAPER 881433] Determination of longitudinal aerodynamic derivatives using flight data from an icing research aircraft [AIAA 89-0754] p 333 A89-28454 Modal control of an oblique wing aircraft [NASA-TP-2898] p 333 N89-16845 Flight measured downwash of the QSRA p 316 N89-17593 [NASA-TM-101050] p 317 N89-18387 The national aero-space plane RESEARCH AND DEVELOPMENT Recent results in the NASA research balloon program [AIAA PAPER 89-0233] p 269 A89-25199 RESEARCH MANAGEMENT Report of the Defense Science Board task force on the National Aerospace Plane (NASP) p 317 N89-17595 [AD-A201124] REYNOLDS NUMBER Reynolds number effects in transonic flow [AGARD-AG-303] p 300 N89-16760 RIGID BOTORS Aeroelastic optimization of a helicopter rotor p 316 N89-16778 ROCKET ENGINES Pattern-based fault diagnosis using neural networks p 354 A89-27602 ROLLING MOMENTS Rolling moment derivative Lxi, for plain ailerons at subsonic speeds p 297 N89-16731 [ESDU-88013] ROTARY ENGINES Adiabatic Wankel type rotary engine [NASA-CR-182233] p 330 N89-17599 ROTARY STABILITY Unsteady wall interference in rotary tests [AIAA PAPER 89-0046] p 273 A89-25040 Active suppression of aerodynamic instabilities in turbomachines p 295 A89-28341 ROTARY WING AIRCRAFT Vortex dynamics for rotorcraft interactional
- aerodynamics p 297 N89-16726 [AD-A200128]

ROTARY WINGS

Oscillatory flow field simulation in a blow-down wind tunnel and the passive shock wave/boundary layer control concept [AIAA PAPER 89-0214] p 278 A89-25188

- Source localization technique for impulsive multiple sources --- microphone arrays for helicopter rotor noise easurement p 356 A89-27741 The contribution of planform area to the performance measurement
- of the BERP rotor --- British Experimental Rotor Programme Blade p 314 A89-28350 Vortex dynamics for rotorcraft interactional
- aerodynamics p 297 N89-16726 [AD-A200128] Aeroelastic optimization of a helicopter rotor
- p 316 N89-16778 ROTATING CYLINDERS
- Supersonic, transverse jet from a rotating ogive cylinde p 294 A89-27728 in a hypersonic flow ROTATING DISKS
- Single and multiple jet impingement heat transfer on rotating disks
- p 344 A89-25150 [AIAA PAPER 89-0174] ROTATING SHAFTS
- Fiber optic torquemeter design and development p 348 A89-27661

ROTOR AERODYNAMICS

- A simple time-accurate turbomachinery algorithm with numerical solutions of an uneven blade count configuration [AIAA PAPER 89-0206] p 344 A89-25181
- Oscillatory flow field simulation in a blow-down wind tunnel and the passive shock wave/boundary layer control concept
- [AIAA PAPER 89-0214] p 278 A89-25188 Grid refinement studies of turbine rotor-stator interaction
- [AIAA PAPER 89-0325] p 281 A89-25274 Design and development of a compressible dynamic stall facility
- [AIAA PAPER 89-0647] p 335 A89-25511 The contribution of planform area to the performance
- of the BERP rotor --- British Experimental Rotor Programme p 314 A89-28350 Blade The free-wake prediction of rotor hover performance
- using a vortex embedding method [AIAA PAPER 89-0638] p 296 A89-28443 Application of a Comprehensive Analytical Model of
- Rotor Aerodynamics and Dynamics (CAMRAD) to the McDonnell Douglas AH-64A helicopter
- p 301 N89-17578 [NASA-CR-177455] Tip aerodynamics and acoustics test: A report and data survey [NASA-RP-1179]
- p 302 N89-17579 ROTOR BLADES
- Measurement and modelling of turbulent spot growth on a gas turbine blade
- [AIAA PAPER 89-0328] p 281 A89-25276 ROTOR BLADES (TURBOMACHINERY)
- Computations of 3D viscous flows in rotating urbomachinery blades [AIAA PAPER 89-03231 p 281 A89-25273
- A model of pressure distributions on impeller blades for determining performance characteristics [AIAA PAPER 89-0840] p
- ALAA PAPER 89-0840 p 346 A89-25609 Application of a Comprehensive Analytical Model of otor Aerodynamics and December 2010 Rotor Aerodynamics and Dynamics (CAMRAD) to the McDonnell Douglas AH-64A helicopter
- NASA-CB-1774551 p 301 N89-17578 ROTOR BODY INTERACTIONS
- Measurement of transient vortex-surface interaction henomena [AIAA PAPER 89-0833] p 289 A89-25603
- Influence of vane/blade spacing and injection on stage p 325 A89-28342 heat-flux distributions
- ROTORCRAFT AIRCRAFT
- A signal filter with zero phase lag p 336 A89-27674 Analysis of structures with rotating, flexible substructures applied to rotorcraft aeroelasticity p 312 A89-27695
- ROTORS
- Automatic generation of component modes rotordynamic substructures p 343 A89-24995 On a distributed parameter model for detecting cracks
- in a rotor p 354 A89-25870 Wake model for helicopter rotors in high speed flight p 301 N89-17577
- [NASA-CR-177507] RUNGE-KUTTA METHOD
- Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
- p 291 A89-25867 Effect of sidewall boundary layer on a wing in a wind p 294 A89-27742
- RUNWAY CONDITIONS
- A summary of recent aircraft/ground vehicle friction measurement tests

[SAE PAPER 881403]	p 336	A89-28196

SABOTAGE

- Aviation security: A system's perspective p 306 N89-16766 [DE89-002020] SAFETY FACTORS
- Airport accident-potential and safety areas [SAE PAPER 881388] p 336 A89-28193
- Materials for interiors A brief review of their current p 342 A89-28433 status Kinematics of U.S. Army helicopter crashes - 1979-85 p 306 A89-28486
- SATELLITE ANTENNAS
- Ranging and Processing Satellite (RAPSAT) p 340 A89-26738
- SATELLITE COMMUNICATION
- Ranging and Processing Satellite (RAPSAT) p 340 A89-26738 communication for The emergence of satellite
- commercial aircraft [SAE PAPER 881370] p 308 A89-28183
- SCALE MODELS Numerical and experimental study of the crash behavior
- of helicopters and fixed-wing aircraft p 309 A89-24919
- SCALING LAWS Problems in understanding aircraft icing dynamics [AIAA PAPER 89-0735] p 302 A89-25553
- SEAT BELTS Results of the AIA/ATA/FAA Dynamic Seat Testing
- Program [SAE PAPER 881375] p 304 A89-28187
- SEATS Results of the AIA/ATA/FAA Dynamic Seat Testing
- Program [SAE PAPER 881375] p 304 A89-28187 Measurement of dynamic reactions in passenger seat
- [SAE PAPER 881376] p 305 A89-28188 Discussion of transport passenger seat performance
- characteristics [SAE PAPER 881378] p 305 A89-28190
- Effects of aircraft size on cabin floor dynamic pulses [SAE PAPER 881379] p 305 A89-28191 SECONDARY FLOW
- Improved methods of characterizing ejector pumping performance
- p 322 A89-25004 AIAA PAPER 89-0008] SEGMENTS
- Structural response of an advanced combustor liner: p 351 N89-17329 Test and analysis SELF ALIGNMENT
- Correction for deflections of the vertical at the runup p 307 A89-26725 SENSITIVITY
- Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine p 350 N89-17257 discs

SEPARATED FLOW

- Visualization measurements of vortex flows
- [AIAA PAPER 89-0191] p 276 A89-25166 The separated flow field on a slender wing undergoing transient pitching motions
- p 276 A89-25169 AIAA PAPER 89-01941 Unsteady, separated flow behind an oscillating, two-dimensional flap
- [AIAA PAPER 89-0288] p 280 A89-25245 Mach number dependence of flow separation induced normal shock-wave/turbulent boundary-layer bv
- interaction at a curved wall
- [AIAA PAPER 89-0353] p 282 A89-25298 Navier-Stokes computations of separated vortical flows ast prolate spheroid at incidence
- AIAA PAPER 89-05531 p 286 A89-25443 A one equation turbulence model for transonic airfoil ficers
- [AIAA PAPER 89-0557] p 287 A89-25446 Prediction of separated transonic wing flows with a non-equilibrium algebraic model
- [AIAA PAPER 89-0558] p 287 A89-25447 Comparison of two different Navier-Stokes methods for
- the simulation of 3-D transonic flows with separation A89-25448 [AIAA PAPER 89-0559] p 287 Control of laminar separation over airfoils by acoustic
- excitation [AIAA PAPER 89-0565] p 288 A89-25454
- Evaluation of three turbulence models for the prediction of steady and unsteady airloads [AIAA PAPER 89-0609] p 288 A89-25485
- Computation for supersonic and turbulent separated flow over a compression corner p 292 A89-25931 Experimental research of flow separation, heat transfer
- and ablation on flat plate-wedges in supersonic, turbulent flow p 292 A89-25938 Asymptotics of stationary separated flow past a body t large Reynolds numbers p 293 A89-26163 at large Reynolds numbers

- Technique for the prediction of airfoil flutter characteristics in separated flow p 348 A89-27744 Turbulence modeling in separated flow behind strong p 294 A89-27746 shocks Low-speed vortical flow over a 5-degree cone with tip geometry variations [SAE PAPER 881422] p 295 A89-28203 The effects of aspect ratio on the stall of a finite wing [AIAA PAPER 89-0570] p 296 A89-28434 SERVICE LIFE Service life calculator for the M53 turbofan engine p 326 N89-16796 Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study [AD-A200665] p 270 N89-17564 SHEAR FLOW Direct numerical simulation of compressible free shear flows p 283 A89-25317 [AIAA PAPER 89-0374] The influence of freestream vorticity on particle lift, drag, nd heat transfer [AIAA PAPER 89-05551 p 345 A89-25445 Finite element simulation of 3D turbulent free shear p 294 A89-26946 flows SHEAR LAYERS Computational studies of a localized supersonic shear laver [AIAA PAPER 89-0125] p 275 A89-25110 Structure of the compressible turbulent shear layer [AIAA PAPER 89-0126] p 275 A89-25111 Numerical simulation of the growth of instabilities in supersonic free shear lavers [AIAA PAPER 89-0376] p 283 A89-25319 Effects of a downstream disturbance on the structure p 348 A89-27692 of a turbulent plane mixing layer SHEAR STRENGTH Test specimens for bearing and by-pass stress interaction in carbon fibre reinforced plastic laminates p 342 N89-17696 SHIELDING Intake-airframe integration p 315 N89-16744 SHOCK LAYERS Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies [AIAA PAPER 88-0460] p 2 p 295 A89-28251 SHOCK TUNNELS Hypersonic scramjet inlet flow investigations, M1 = 16-26 [AIAA PAPER 89-0003] p 270 A89-25002 SHOCK WAVE ATTENUATION Shock capturing using a pressure-correction method [AIAA PAPER 89-0561] p 345 A89-25450 SHOCK WAVE INTERACTION An experimental study of shock wave/vortex interaction p 273 A89-25072 [AIAA PAPER 89-0082] Mach number dependence of flow separation induced by normal shock-wave/turbulent interaction at a curved wall boundary-layer [AIAA PAPER 89-0353] p 282 A89-25298 normal-shock/turbulent-boundary-layer Confined Interaction followed by an adverse pressure gradient [AIAA PAPER 89-0354] p 282 A89-25299 An LDV investigation of a multiple normal shock wave/turbulent boundary layer interaction p 282 A89-25300 [AIAA PAPER 89-0355]
- An exploratory study of corner bleed on a fin generated three-dimensional shock wave turbulent boundary layer interaction [AIAA PAPER 89-0356] p 282 A89-25301
- Adaptive H-refinement on 3-D unstructured grids for transient problems
- [AIAA PAPER 89-0365] p 283 A89-25309 Numerical solutions to three-dimensional shock
- wave/vortex interaction at hypersonic speeds [AIAA PAPER 89-0674] p 289 A89-25534 Euler flow solutions for transonic shock wave-boundary
- p 295 A89-28074 layer interaction p 295 A89-28074 Experimental and numerical investigation of an oblique shock wave/turbulent boundary layer interaction with continuous suction
- [AIAA PAPER 89-0357] p 296 A89-28407 Shock losses in transonic and supersonic compressor p 329 N89-16829 cascades

SHOCK WAVES

- Effect of dynamic changes in body configuration on shock structure
- [AIAA PAPER 89-0526] p 285 A89-25421 Full-potential integral solutions for steady and unsteady transonic airfoils with and without embedded Euler p 301 N89-17566 domains

SHORT HAUL AIRCRAFT

Flight measured downwash of the QSRA [NASA-TM-101050] p 316 N89-17593

SHORT TAKEOFF AIRCRAFT

SHORT TAKEOFF AIRCRAFT

- Departure resistance and spin characteristics of the F-15 S/MTD
- [AIAA PAPER 89-0012] p 331 A89-25008 Characteristics of the ground vortex formed by a jet
- moving over a fixed ground plane [AIAA PAPER 89-0650] p 288 A89-25514 Simulation evaluation of transition and hover flying qualities of the E-7A STOVL aircraft
- [SAE PAPER 881430] p 333 A89-28205 Conceptual design of a STOVL fighter/attack aircraft [SAE PAPER 881431] p 313 A89-28206
- Considerations of control authority requirements in STOVL propulsion system sizing p 313 A89-28207 [SAE PAPER 881432]
- The current status of the flight test of the ASKA p 314 A89-28208 [SAE PAPER 881433] SIDESLIP
- Multiple solutions for aircraft sideslip behaviour at high angles of attack [AIAA PAPER 89-0645]
- p 331 A89-25510 SIGNAL ANALYSIS
- Miniature PCM compatible wideband spectral analyzer p 318 A89-27664 for hypersonic flight research SIGNAL MEASUREMENT
- A signal filter with zero phase lag p 336 A89-27674 SIGNAL PROCESSING
- Gas path condition monitoring using electrostatic techniques p 321 N89-16817 SIGNAL TO NOISE RATIOS
- Phase-only filters with improved signal to noise ratio p 356 A89-28382
- SIMULATION
- Navier-Stokes simulation of transonic wing flow fields sing a zonal grid approach p 290 A89-25862 using a zonal grid approach Accuracy requirements for high-speed test with engine simulation on transport aircraft models in the NLR-HST p 338 N89-16870
- SINGLE CRYSTALS
- Constitutive modelling of single crystal and directionally p 342 N89-17325 solidified superallovs High temperature constitutive and crack initiation modeling of coated single crystal superalloys p 342 N89-17334
- SINGLE STAGE TO ORBIT VEHICLES NASP natural environment definitions for design [AIAA PAPER 89-0764] p 339 A89p 339 A89-25568
- SINGULARITY (MATHEMATICS) Investigation of internal singularity methods for
- multielement airfoils p 294 A89-27748 SKIN (STRUCTURAL MEMBER)
- p 317 N89-17693 Typical joints in a wing structure p 317 N89-17693 Test specimens for bearing and by-pass stress interaction in carbon fibre reinforced plastic laminates p 342 N89-17696
- SKIN TEMPERATURE (NON-BIOLOGICAL)
- Infrared technique to measure the skin temperature on an electrothermal de-icer - Comparison with numerical simulations
- [AIAA PAPER 89-0760] p 303 A89-25566 SLENDER BODIES
- Numerical simulation of vortex unsteadiness on slender bodies of revolution at large incidence p 276 A89-25170 [AIAA PAPER 89-0195]
- Effect of nose bluntness on flow field over slender bodies in hypersonic flows
- p 279 A89-25228 [AIAA PAPER 89-0270] Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies
- p 295 A89-28251 [AIAA PAPER 88-0460] SLENDER WINGS
- The separated flow field on a slender wing undergoing transient pitching motions [AIAA PAPER 89-0194]
- p 276 A89-25169 The effects of aspect ratio on the stall of a finite wing p 296 A89-28434 [AIAA PAPER 89-0570]
- SLIP FLOW
- Supersonic low-density flow over airfoils p 286 A89-25424 [AIAA PAPER 89-0530]
- SLOPES
- An experimental investigation of the aerodynamic characteristics of slanted base ogive cylinders using magnetic suspension technology [NASA-CR-184624] p 300 N89-16758
- SMALL PERTURBATION FLOW
- Derivation of an integral equation for large disturbing transonic flow and its numerical method of undercritical p 293 A89-25944 flow
- SOFTWARE TOOLS profile implementation Aircraft vertical usina p 332 A89-25683 directed-graph methods EURONAV - A state of the art military GPS receiver
- p 340 A89-26711 The Honeywell/DND helicopter integrated navigation
- p 308 A89-26741 system (HINS)

- Utilization of wind tunnel instrumentation with software p 335 A89-27654 verifications Software control of a high speed, modular signal
- conditioner and PCM encoder system p 318 A89-27670
- Measurements of gas turbine combustor and engine augmentor tube sooting characteristics p 328 N89-16821 [AD-A199768]
- SPACE NAVIGATION PLANS '88 - IEEE Position Location and Navigation Symposium, Orlando, FL, Nov. 29-Dec. 2, 1988, Record
- p 339 A89-26701 SPACE PLASMAS
- Merging of aircraft vortex trails Similarities to magnetic p 356 A89-26630 field merging SPACE SHUTTLES
- Analysis of extreme wind shear
- p 352 A89-25549 TAIAA PAPER 89-07101 SPACECRAFT CONTROL
- Feedback control of vibrations in an extendible cantileve p 332 A89-26193 sweptback wing SPACECRAFT DESIGN
 - Structural reliability in aerospace design p 340 A89-27175
- SPACECRAFT LAUNCHING
 - Analysis of extreme wind shear [AIAA PAPER 89-0710] p 352 A89-25549 National lightning detection - A real-time service to aerospace
- [AIAA PAPER 89-0787] p 352 A89-25578 SPACECRAFT POWER SUPPLIES
- Aerospace power systems technology; Proceedings of the Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988
- p 324 A89-28254 [SAE SP-758] SPACECRAFT PROPULSION
- Combined propulsion for hypersonic and space p 322 A89-24917 vehicles
- SPANWISE BLOWING A flow visualization and aerodynamic force data evaluation of spanwise blowing on full and half span delta wings
- [AIAA PAPER 89-0192] p 276 A89-25167 SPATIAL FILTERING
- Phase-only filters with improved signal to noise ratio p 356 A89-28382
- SPATIAL MARCHING A set of strongly coupled, upwind algorithms for
- computing flows in chemical nonequilibrium p 277 A89-25174 [AIAA PAPER 89-0199]
- SPECTROMETERS
- Performance of the forward scattering spectrometer probe in NASA's Icing Research Tunnel p 346 A89-25570 [AIAA PAPER 89-0769]
- SPECTRUM ANALYSIS
- Miniature PCM compatible wideband spectral analyzer for hypersonic flight research p 318 A89-27664 SPEECH RECOGNITION
- An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition
- input p 309 N89-17588 (AD-A2006261 SPOILERS
- Vortical flows past normal plate and spoiler of time dependent height
- [AIAA PAPER 89-0291] p 280 A89-25248 SPRAYED COATINGS
- Thermal barrier coating life prediction model p 351 N89-17333 development STABILIZERS (FLUID DYNAMICS)
- Elevator deflection effects on the icing process [AIAA PAPER 89-0846] p 290 A89-25615
- STANDARDS Need for common AGARD approach and actions
- p 350 N89-17260 STANTON NUMBER
- Influence of vane/blade spacing and injection on stage p 325 A89-28342 heat-flux distributions STATE ESTIMATION
- A state-space model of unsteady aerodynamics in a compressible flow for flutter analyses
- p 271 A89-25018 [AIAA PAPER 89-0022] STATISTICAL ANALYSIS
- CF-18/F404 transient performance trending p 328 N89-16814 STATORS
- Grid refinement studies of turbine rotor-stator interaction [AIAA PAPER 89-0325] p 281 A89-25274
- STEADY FLOW Evaluation of an OH grid formulation for viscous cascade
- [AIAA PAPER 89-0207] p 277 A89-25182

On the solution of nonequilibrium hypersonic inviscid steady flows p 289 A89-25532

SUBJECT INDEX

p 313 A89-28176

p 317 N89-17691

p 342 N89-17696

p 317 N89-17693

p 324 A89-28202

p 351 N89-17298

p 351 N89-17316

p 351 N89-17329

p 317 N89-17691

p 340 A89-27175

p 340 A89-27175

p 348 A89-27745

p 316 N89-16778

p 346 A89-26273

p 314 A89-28252

p 323 A89-27694

p 298 N89-16735

- [AIAA PAPER 89-0671] Asymptotics of stationary separated flow past a body p 293 A89-26163 at large Reynolds numbers
- Full-potential integral solutions for steady and unsteady transonic airfoils with and without embedded Euler p 301 N89-17566 domains STEELS
- Mechanism of single shear fastened joints p 352 N89-17700

STIFFNESS

- Fore-and-aft stiffness and damping characteristics of 30 x 11.5-14.5, Type VIII, bias-ply and radial-belted aircraft tirae
- [SAE PAPER 881357]
- STORMS (METEOROLOGY) Severe weather - Impact on aviation and FAA programs
- in response [AIAA PAPER 89-0794] p 352 A89-25583 Impact of severe weather on aviation - An NWS
 - perspective p 304 A89-25584 [AIAA PAPER 89-0795]
 - The effects of inclement weather on airline operations [AIAA PAPER 89-0797] p 304 A89-25585 STRAKES
 - A numerical method for calculating the low-speed the strake-wing p 292 A89-25941 aerodynamic characteristics of the configurations
 - An Euler analysis of leading-edge vortex flows on a forebody-strake at supersonic speeds AIAA PAPER 89-03431 p 293 A89-26371
 - STRANGE ATTRACTORS
 - Evidence of a strange attractor in ramjet combustion p 323 A89-25494 AIAA PAPER 89-06241 STREAM FUNCTIONS (FLUIDS)
 - Streamlines and streamribbons in aerodynamics
 - [AIAA PAPER 89-0140] p 276 A89-25123 The influence of freestream vorticity on particle lift, drag.
 - and heat transfer p 345 A89-25445 [AIAA PAPER 89-0555] STREAMLINING
 - Modification of compressible turbulent boundary layer structures by streamlined devices [AIAA PAPER 89-0212] p 277 A89-25186

An analysis method for bolted joints in primary composite

Test specimens for bearing and by-pass stress

Vibration and aeroelastic tailoring of advanced

Three-dimensional inelastic analysis methods for hot

Structural response of an advanced combustor liner:

An analysis method for bolted joints in primary composite

Aluminum quality breakthrough for aircraft structural

Vibration and flutter analysis of composite wing panels

Vibration and aeroelastic tailoring of advanced

Spanload optimization for strength designed lifting

Analytical wing weight prediction/estimation using

Subcritical swirling flows in convergent, annular

Boundaries of linear characteristics of cambered and

twisted wings at subcritical Mach numbers

computer based design techniques p 316 N89-17589

composite plate-like lifting surfaces p 351 N89-17263

composite plate-like lifting surfaces p 351 N89-17263

Turbine Engine Hot Section Technology, 1987

interaction in carbon fibre reinforced plastic laminates

Typical joints in a wing structure

Prop-fan structural results from PTA tests

Structural reliability in aerospace design

Structural reliability in aerospace design

Aeroelastic optimization of a helicopter rotor

STRESS ANALYSIS

aircraft structure

STRUCTURAL ANALYSIS

[SAE PAPER 881418]

[NASA-CP-2493]

Test and analysis

aircraft structure

reliability

surfaces

STRUCTURAL DESIGN

STRUCTURAL RELIABILITY

STRUCTURAL STABILITY

STRUCTURAL VIBRATION

STRUCTURAL WEIGHT

SUBCRITICAL FLOW

[ESDU-88030]

[AIAA PAPER 88-2512]

section components

STRESSES

SUBSONIC FLOW		
An experimental investigation of the	he effect	ts of a base
cavity on the near-wake flowfield of	a body	at subsonic
and transonic speeds		
[AIAA PAPER 89-0210]	p 277	A89-25184
Modeling of subsonic flow through a	a compa	ct offset inlet
diffuser	- 000	
[AIAA PAPER 89-0639]	p 288	A89-2000
A computational procedure for	autom	ARC TIUTTER
analysis	p 340	A09-20070
CFD application to subsonic inlet	ainrame	e integration
computational fluid dynamics (CFI	7 200	N90-16753
	h 599	1403-10733
Bolling moment derivative vi fo	v nlein	ailerons at
subsonic speeds	n piani	anerens at
[ESDU-88013]	p 297	N89-16731
Vawing moment coefficient for plain	n aileron	s at subonic
speeds	anoron	0 41 04201.00
[ESDU-88029]	p 298	N89-16734
SUBSONIC WIND TUNNELS	-	
Development of a new subsonic ic	ing wind	tunnel
[AIAA 89-0773]	p 337	A89-28458
New design of the nozzle section	of a lar	ge subsonic
wind tunnel		
{F+W-TF-1926}	p 339	N89-17601
SUCTION		
Experimental and numerical invest	igation o	f an oblique
shock wave/turbulent boundary la	ayer inte	raction with
	n 90e	400.00407
[AIAA PAPEH 89-0357]	p 296	A69-26407
V/STOL aircraft and the prob		Jet-Induced
	p 317	N69-16360
SUPERCHITICAL AIRFOILS		
Sidewall boundary-layer remova		is on wall
adaptation in the Langley 0.3-meter	transon	ic cryogenic
	n 334	480-25131
Turbulance modeling in constant	flow be	bind strong
shocks	n 294	489-27746
NASA SC(2) 0714 sideil data con	rootod f	or sidewall
has SC(2)-07 14 airfoir data cor	03.mei	or sidewall
cryogenic tunnel	0.3-110	
[NASA-TP-2890]	p 301	N89-17568
SUPERCRITICAL FLOW		
Inverse methods for blade design.	control	led diffusion
blading for supercritical compressor	low	
blading for supercritical compressor	llow p 329	N89-16832
blading for supercritical compressor is	p 329	N89-16832
blading for supercritical compressor the superplasticity of HIPped PM supe	p 329 peralloys	N89-16832 made from
blading for supercritical compressor to SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder	p 329 p 329 peralloys p 341	N89-16832 made from A89-25915
blading for supercritical compressor to SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi	p 329 p 329 p 341 um aircr	N89-16832 made from A89-25915 aft structure
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245]	p 329 p 329 p 341 um aircr p 316	N89-16832 made from A89-25915 aft structure N89-17591
blading for supercritical compressor to SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi (AD-A200245) SUPERSONIC AIRCRAFT	p 329 peralloys p 341 um aircr p 316	N89-16832 made from A89-25915 aft structure N89-17591
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithin [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe	p 329 peralloys p 341 um aircr p 316 erature-c	N89-16832 made from A89-25915 aft structure N89-17591
blading for supercritical compressor to SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b	llow p 329 peralloys p 341 um aircr p 316 erature-c oundary	N89-16832 made from A89-25915 aft structure N89-17591 ompensated -layer flow
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic aim	p 329 p 329 p 329 p 341 um aircr p 316 erature-cc oundary ccraft	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi (AD-A200245) SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRCOLLS	p 329 p 329 p 341 um aircr p 316 erature-co oundary craft p 318	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-27668
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithin (AD-A200245) SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Superposite low-density flow over a	p 329 peralloys p 341 um aircr p 316 srature-c oundary craft p 318 sirfoils	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-27668
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 8-0530]	p 329 peralloys p 341 um aircr p 316 srature-c oundary craft p 318 uirfoils p 286	N89-16832 made from A89-25915 aft structure N89-17591 ompensated ,-layer flow A89-27668
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BAUNDARY LAYERS	p 329 p 329 p 341 um aircr p 316 rature-coundary craft p 318 uirfoils p 286	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-27668 A89-25424
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi (AD-A200245) SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turk	p 329 p 329 p 341 um aircr p 316 rature-c oundary craft p 318 uirfoils p 286 pulent bo	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-27668 A89-25424 undary layer
blading for supercritical compressor to SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi (AD-A200245) SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition	p 329 p 329 p 341 um aircr p 316 vature-c oundary craft p 318 uirfoils p 286 pulent bo	N89-16832 made from A89-25915 aft structure N89-17591 ompensated -layer flow A89-27668 A89-25424 undary layer
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anernometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turb with mass addition [AIAA PAPER 89-0135]	p 329 p 341 um aircr p 316 erature-c oundary craft p 318 uirfoils p 286 pulent bo p 344	N89-16832 made from A89-25915 aft structure N89-17591 ompensated -layer flow A89-27668 A89-2568 A89-25119
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BUPDRAY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s	p 329 p 329 p 329 p 341 um aircr p 316 vature-co oundary craft p 318 uirfoils p 286 pulent bo p 344 superson	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 pic boundary
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turk with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a ss layer	p 329 p 329 p 341 um aircr p 316 rature-c oundary craft p 318 uirfoils p 286 oulent bo p 344 superson p 293	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-26011
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s	p 329 p 329 p 341 um aircr p 316 rature-c oundary craft p 318 uirfoils p 286 pulent bo p 344 superson p 293 uurface ir	N89-16832 made from A89-25915 aft structure N89-17591 ompensated -layer flow A89-27668 A89-25424 undary layer A89-25119 pic boundary A89-26011 supersonic
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BUNDARY LAYERS Measurements of a supersonic turt with mass addition (AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s flow	p 329 p 329 p 329 p 341 um aircr p 316 erature-c oundary craft p 318 p 318 p 318 p 286 pulent bo p 344 superson p 293 uurface in p 294	N89-16832 made from A89-25915 aft structure N89-17591 ompensated ,-layer flow A89-27668 A89-25424 undary layer A89-25119 jic boundary A89-26011 supersonic A89-27384
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BUDDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION	p 329 p 329 p 341 um aircr p 316 rature-co oundary craft p 318 airfoils p 286 oulent bo p 344 superson p 293 surface in p 294	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-26111 supersonic A89-27384 bigb Mach
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic ail SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce	p 329 p 329 p 341 um aircr p 316 rature-c oundary craft p 318 airfoils p 286 pulent bo p 344 superson p 293 uurface ir p 294 asses in	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-26011 o supersonic A89-27384 high Mach
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anernometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turb with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261]	p 329 peralloys p 341 um aircr p 316 erature-c oundary craft p 318 uirfoils p 286 pulent bo p 344 superson p 293 surface ir p 294 esses in	N89-16832 made from A89-25915 aft structure N89-17591 ompensated -layer flow A89-27668 A89-25424 undary layer A89-25119 sic boundary A89-25111 supersonic A89-27384 high Mach A89-25219
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0535] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramit analysis with chemie	p 329 p 329 p 341 um aircr p 316 rature-c oundary craft p 318 airfoils p 286 pulent bo p 344 superson p 293 unface in p 294 esses in p 278 cal reac	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-25424 undary layer A89-25119 jic boundary A89-25119 jic boundary A89-25119 hich boundary A89-25119 jic boundary A89-25119 jic boundary A89-25011 A89-25219 bigh Mach A89-25219
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic ail SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC AURDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemik three-dimensional approximate facto	p 329 peralloys p 341 um aircr p 316 rature-coundary craft p 318 airfoils p 286 pulent bo p 344 superson p 293 reurface ir p 294 esses in p 278 cal rearization	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25219 clion using
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemit three-dimensional approximate facto [AIAA PAPER 89-0672]	p 329 p 329 p 341 um aircr p 316 rature-c oundary craft p 318 irfoils p 286 pulent bo p 344 superson p 293 uurface ir p 294 esses in p 278 cal rea- rization p 324	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 dic boundary A89-26011 hsupersonic A89-27384 high Mach A89-25219 ction using A89-25533
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anernometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemic three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE	p 329 p 329 p 341 um aircr p 316 rature-c oundary craft p 318 uirfoils p 286 pulent bo p 344 superson p 293 surface ir p 294 p 278 cal reac rization p 323 T ENGI	N89-16832 made from A89-25915 aft structure N89-17591 ompensated A89-27668 A89-25424 undary layer A89-25119 dic boundary A89-25119 dic boundary A89-25119 dic boundary A89-25119 dic boundary A89-25119 dic boundary A89-2519 dic boundary A89-2533 NES
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BUNDARY LAYERS Measurements of a supersonic turt with mass addition (AIAA PAPER 89-0535] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMEE Hypersonic scramjet inlet flow in	p 329 p 329 p 341 um aircr p 316 p 316 p 316 p 316 p 316 p 318 uirfoils p 286 p 286 p 286 p 286 p 286 p 293 uirfoils p 293 uirface in p 293 cal reas rization p 323 T ENGI Westigat	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-2553 ic boundary A89-2553
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC AURDORARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s flow SUPERSONIC COMBUSTION Thermodynamics and wave procen number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemie three-dimensional approximate factor [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic Scramjet inlet flow in 16-26	p 329 p 329 p 341 um aircr p 316 rature-coundary craft p 318 uirfoils p 286 p 286 p 286 p 286 p 286 p 283 rurface ir p 293 surface ir p 294 p 278 cal rearization p 323 T ENGII westigat	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25219 ction using A89-2533 VES
blading for supercritical compressor if SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemit three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003]	p 329 p 329 p 341 um aircr p 316 rature-c oundary craft p 318 irfoils p 286 pulent bo p 344 superson p 293 urface ir p 294 esses in p 278 cal rearization p 323 T ENGII twestigat	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-2533 NES ions, M1 = A89-25002
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attried prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anernometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turk with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemic three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispe	p 329 p 329 p 341 um aircr p 316 vature-coundary craft p 318 uirfoils p 286 pulent bo p 344 superson p 293 urface ir p 294 p 278 cal reac rization p 323 T ENGI vestigat p 270 ccies mat	N89-16832 made from A89-25915 aft structure N89-17591 ompensated r-layer flow A89-27668 A89-25424 undary layer A89-25119 dic boundary A89-25119 dic boundary A89-2533 NES ions, M1 = A89-25002 ing between
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition (AIAA PAPER 89-0530] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispersonic [AIAA PAPER 89-0003]	p 329 peralloys p 341 um aircr p 316 prature-co oundary craft p 318 airfoils p 286 builent bo p 344 superson p 293 surface in p 293 cal reas rization p 323 T ENGII T ENGII p 270 ccies mix c freestr p 370	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25219 ction using A89-25533 NES ions, M1 = A89-25002 ing between eam
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemid three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispe scramjet nozzle flows and hypersoni [AIAA PAPER 89-0009] Parformance notential of air turb.	p 329 peralloys p 341 um aircr p 316 rature-coundary craft p 318 irfoils p 286 p 286 p 286 p 286 p 286 p 283 rurface ir p 293 rurface ir p 293 rurface ir p 323 T ENGII p 323 T ENGII p 270 coies mix c freestr p 322 or amic	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ction using A89-2533 VES A89-25002 ing between eam A89-25005
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemid three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow ir 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispe scramjet nozzle flows and hypersoni [AIAA PAPER 89-0009] Performance potential of air turb supersonic throud-flow fan	p 329 p 329 p 341 um aircr p 316 rature-c oundary craft p 318 irfoils p 286 pulent bo p 344 superson p 293 urface ir p 294 asses in p 278 cal rearization p 323 T ENGII twestigat p 270 ccies mix c freestr p 322 o-ramjet	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25011 in using A89-25002 ing between eam A89-25005 i employing
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attried prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anenometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemit three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispe scramjet nozzle flows and hypersoni [AIAA PAPER 89-0009] Performance potential of air turb supersonic through-flow fan [AIAA PAPER 89-0010]	p 329 peralloys p 341 um aircr p 316 prature-co oundary craft p 318 airfoils p 286 bulent bo p 344 superson p 293 urface in p 294 asses in p 323 T ENGI westigat p 322 o-ramjet	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-27668 A89-25424 undary layer A89-25119 jic boundary A89-25119 jic boundary A89-25119 jic boundary A89-25219 dich auser A89-25219 ction using A89-25533 NES ions, M1 = A89-25002 ing between eam A89-25005
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0530] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemit three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispes scramjet nozzle flows and hypersoni [AIAA PAPER 89-0003] Performance potential of air turb supersonic through-flow fan [AIAA PAPER 89-0010] The effect of exhaust plume/afte	p 329 peralloys p 341 um aircr p 316 rature-co oundary craft p 318 airfoils p 286 oulent bo p 344 superson p 293 surface ir p 293 surface ir p 293 cal rea rization p 323 T ENGI vestigat p 270 ccies mix c freestr p 322 rbody in	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-2533 VES ions, M1 = A89-25005 iemploying A89-25006 teraction on
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BUDDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s flow SUPERSONIC COMBUSTION Thermodynamics and wave procen number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemie three-dimensional approximate factor [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic Scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispe scramjet nozzle flows and hypersoni [AIAA PAPER 89-0003] Adaptive computation of air turb supersonic through-flow fan [AIAA PAPER 89-001] The effect of exhaust plume/aftet installed scramjet performance	p 329 peralloys p 341 um aircr p 316 rature-coundary craft p 318 irfoils p 286 oulent bo p 344 superson p 293 rurface ir p 294 esses in p 278 cal rearization p 323 T ENGII twestigat p 322 rbody in	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25015 ic molecular A89-25005 c employing A89-25006 teraction on
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anernometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemie three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispe scramien nozzle flows and hypersoni [AIAA PAPER 89-0009] Performance potential of air turb supersonic through-flow fan [AIAA PAPER 89-0010] The effect of exhaust plume/afte installed scramjet performance [AIAA PAPER 89-00032]	p 329 p 341 um aircr p 341 um aircr p 316 rature-c oundary craft p 318 irfoils p 286 pulent bo p 344 superson p 293 urface ir p 293 urface ir p 294 asses in p 278 cal rearization p 323 T ENGII p 322 rbody in p 272	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-27668 A89-25424 undary layer A89-25119 dic boundary A89-25119 dic boundary A89-25002 ding between eam A89-25006 teraction on A89-25028
blading for supercritical compressor is SUPERPLASTICITY Superplasticity of HIPped PM sup attried prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition (AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave procent number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemine three-dimensional approximate facto [AIAA PAPER 89-0261] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multisper scramjet nozzle flows and hypersonic [AIAA PAPER 89-0003] Deformance potential of air turb supersonic through-flow fan [AIAA PAPER 89-0010] The effect of exhaust plume/afte installed scramjet performance [AIAA PAPER 89-0032] Laser holographic interferometric for [AIAA PAPER 89-0032]	p 329 peralloys p 341 um aircr p 316 p 316 p 316 p 316 p 316 p 316 p 318 p 318 p 286 p 286 p 286 p 286 p 286 p 288 surfoils p 286 p 288 surfoils p 293 surface in p 293 surface in p 293 p 278 cal reast p 323 T ENGI to esting at p 322 rbody in p 322 reasure	N89-16832 made from A89-25915 aft structure N89-17591 ompensated /-layer flow A89-25424 undary layer A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25005 ic employing A89-25006 teraction on A89-25028 ments of the
blading for supercritical compressor i SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s layer Evolution of perturbations near a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemit three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispe scramjet nozzle flows and hypersoni [AIAA PAPER 89-0003] Madaptive computations of multispe scramjet nozzle flows fan [AIAA PAPER 89-0003] Deformance potential of air turb supersonic through-flow fan [AIAA PAPER 89-0003] The effect of exhaust plume/afte installed scramjet performance [AIAA PAPER 89-0010] The effect of exhaust plume/afte installed scramjet performance [AIAA PAPER 89-0010] The offect of exhaust plume/afte installed scramjet inlet at Mach 4	p 329 peralloys p 341 um aircr p 316 rature-co oundary craft p 318 airfoils p 286 oulent bo p 344 superson p 293 aurface ir p 293 aurface ir p 294 p 293 cal rea rization p 293 T ENGI nvestigat p 272 roody in p 322 rbody in	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-25424 undary layer A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-25119 ic boundary A89-2503 VES ions, M1 = A89-25005 i employing A89-25006 teraction on A89-25028 ments of the
blading for supercritical compressor if SUPERPLASTICITY Superplasticity of HIPped PM sup attrited prealloy powder Superplastic formed aluminum-lithi [AD-A200245] SUPERSONIC AIRCRAFT The design and use of a tempe hot-film anemometer system for b transition detection on supersonic air SUPERSONIC AIRFOILS Supersonic low-density flow over a [AIAA PAPER 89-0530] SUPERSONIC BOUNDARY LAYERS Measurements of a supersonic turt with mass addition [AIAA PAPER 89-0135] Unsteady separation wave in a s flow SUPERSONIC COMBUSTION Thermodynamics and wave proce number propulsive ducts [AIAA PAPER 89-0261] Scramjet analysis with chemit three-dimensional approximate facto [AIAA PAPER 89-0672] SUPERSONIC COMBUSTION RAMJE Hypersonic scramjet inlet flow in 16-26 [AIAA PAPER 89-0003] Adaptive computations of multispe scramjet nozzle flows and hypersoni [AIAA PAPER 89-0003] Adaptive computations of multispe scramjet nozzle flows and hypersoni [AIAA PAPER 89-0003] The effect of exhaust plume/aftet installed scramjet performance [AIAA PAPER 89-0032] Laser holographic interferometric I flow in a scramjet inlet at Mach 4 [AIAA PAPER 89-0043]	p 329 peralloys p 341 um aircr p 316 rature-coundary craft p 318 irfoils p 286 oulent bo p 344 superson p 293 urface ir p 294 esses in p 278 cal rearization p 323 T ENGII twestigat p 322 rbody in p 272 measure p 273	N89-16832 made from A89-25915 aft structure N89-17591 ompensated (-layer flow A89-25424 undary layer A89-25119 ic boundary A89-25119 ic boundary A89-2503 ic mage devices ing between eam A89-25005 ic employing A89-25028 ments of the A89-25035

Supersonic sudden-expansion flow with fluid injection -An experimental and computational study [AIAA PAPER 89-0389] p 284 A89-25328 Scramjet analysis with chemical reaction using three-dimensional approximate factorization p 323 A89-25533 [AIAA PAPER 89-0672] Modular analysis of scramjet flowfields p 325 A89-28337 The effect of exhaust plume/afterbody interaction on installed Scramiet performance [NASA-TM-101033] p 330 N89-17600 SUPERSONIC COMPRESSORS Incidence angle rules in supersonic cascades p 328 N89-16827 Exit angle rules in supersonic cascades p 329 N89-16828 Shock losses in transonic and supersonic compressor p 329 N89-16829 cascades Axial velocity density ratio influence on exit flow angle in transonic/supersonic cascades p 329 N89-16830 p 330 N89-16836 Supersonic compressors p 330 N89-16837 Supersonic throughflow fans Variable geometry in supersonic compressors p 330 N89-16838 SUPERSONIC DRAG Theoretical investigation for the effects of sweep. leading-edge geometry, and spanwise pressure gradients on transition and wave drag transonic, and supersonic speed with experimental correlations [SAE PAPER 881484] p 295 A89-28229 SUPERSONIC FLIGHT Flow-field characteristics and normal-force correlations for delta wings from Mach 2.4 to 4.6 [AIAA PAPER 89-0026] p 272 A89-25022 Aerodynamic prediction rationale for analyses of hypersonic configurations [AIAA PAPER 89-0525] p 285 A89-25420 Inlet-engine compatibility p 314 N89-16741 p 330 N89-16837 Supersonic throughflow fans SUPERSONIC FLOW Stability and transition of two-dimensional laminar boundary layers in compressible flow over an adiabatic p 270 A89-24922 Evaluation of leading- and trailing-edge flaps on flat and ambered delta wings at supersonic speeds p 272 A89-25023 AIAA PAPER 89-00271 Prediction of supersonic/hypersonic viscous flows over RVs and decoys [AIAA PAPER 89-0028] p 272 A89-25024 An experimental study of shock wave/vortex interaction [AIAA PAPER 89-0082] p 273 A89-25072 Supersonic inlet calculations using an upwind finite-volume method on adaptive unstructured grids p 274 A89-25100 [AIAA PAPER 89-0113] Computational studies of a localized supersonic shear [AIAA PAPER 89-0125] p 275 A89-25110 Three-dimensional hybrid finite volume solutions to the Euler equations for supersonic/hypersonic aircraft p 280 A89-25238 [AIAA PAPER 89-0281] The effects of walls on a compressible mixing layer [AIAA PAPER 89-0372] p 283 A89-25315 Numerical simulation of the growth of instabilities in supersonic free shear layers [AIAA PAPER 89-0376] p 283 A89-25319 Supersonic sudden-expansion flow with fluid injection -An experimental and computational study p 284 A89-25328 [AIAA PAPER 89-0389] Conflicting stepsize requirements for stable PNS

computations [AIAA PAPER 89-0445] p 284 A89-25363 A multigrid and upwind viscous flow solver on 3-D embedded and overlapped grids

lave

p 285 A89-25379 [AIAA PAPER 89-0464] Supersonic low-density flow over airfoils

p 286 A89-25424 [AIAA PAPER 89-0530] Determination of aerodynamic sensitivity coefficients in the transonic and supersonic regimes

[AIAA PAPER 89-0532] p 286 A89-25426 Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic flows

[AIAA PAPER 89-0562] p 287 A89-25451 Combined tangential-normal injection into a supersonic flow

p 288 A89-25492 [AIAA PAPER 89-0622] Simple turbulence models for supersonic and hypersonic flows - Bodies at incidence and compression corners [AIAA PAPER 89-0669] p 289 A89-25530 Droplet impaction on a supersonic wedge Consideration of similitude

p 304 A89-25567 [AIAA PAPER 89-0763] Computation for supersonic and turbulent separated flow p 292 A89-25931 over a compression corner

SWEPT WINGS

Experimental research of flow separation, heat transfer and ablation on flat plate-wedges in supersonic, turbulent p 292 A89-25938 flow An Euler analysis of leading-edge vortex flows on a forebody-strake at supersonic speeds p 293 A89-26371 [AIAA PAPER 89-0343] Evolution of perturbations near a surface in supersonic p 294 A89-27384 flow Diagonal implicit multigrid calculation of inlet flowfields p 294 A89-27716 Theoretical investigation for the effects of sweep, leading-edge geometry, and spanwise pressure gradients on transition and wave drag transonic, and supersonic speed with experimental correlations [SAE PAPER 881484] p 295 A89-28229 F-14 flow field simulation p 296 A89-28444 IAIAA PAPER 89-06421 SUPERSONIC INLETS Intake Aerodynamics, volume 1 --- conference p 298 N89-16738 [VKI-LS-1988-04-VOL-1] Intake swirl and simplified methods for dynamic pressure p 299 N89-16742 distortion assessment p 299 N89-16743 Jaquar/Tornado intake design p 315 N89-16745 Intakes for high angle of attack p 315 N89-16746 Transonic cowl design CFD application to supersonic/hypersonic inlet airframe integration --- computational fluid dynamics (CFD) p 299 N89-16754 Variable geometry in supersonic compressors p 330 N89-16838 p 330 N89-16839 Axial supersonic inlet compound SUPERSONIC JET FLOW Supersonic, transverse jet from a rotating ogive cylinder p 294 A89-27728 in a hypersonic flow SUPERSONIC NOZZLES Comparison of 3D computation and experiment for non-axisymmetric nozzles p 325 A89-28403 [AIAA PAPER 89-0007] SUPERSONIC SPEED Influence of wing geometry on leading-edge vortices and vortex-induced aerodynamics at supersonic speeds p 274 A89-25075 [AIAA PAPER 89-0085] SUPERSONIC TRANSPORTS Stability of 3D wing boundary layer on a SST configuration p 272 A89-25031 [AIAĂ PAPER 89-0036] SUPERSONIC WAKES The effect of Mach number on the stability of a plane supersonic wave p 280 A89-25242 [AIAA PAPER 89-0285] SUPERSONIC WIND TUNNELS Structure of the compressible turbulent shear layer p 275 A89-25111 [AIAA PAPER 89-0126] SUPPORT SYSTEMS Supportability design requirements for army aircraft and equipment [SAE PAPER 881447] p 356 A89-28217 SURFACE NAVIGATION Advanced Fighter Technology Integration/Sandia Inertial Terrain-Aided Navigation (AFTI/SITAN) p 309 N89-17587 [DE89-004000] SURFACE ROUGHNESS Investigation of surface water behavior during glaze ice p 304 A89-27739 accretion SURFACE ROUGHNESS EFFECTS A numerical investigation of the influence of surface roughness on heat transfer in ice accretion p 346 A89-25554 [AIÃA PAPER 89-0737] Modeling of surface roughness effects on glaze ice accretion [AIAA 89-0734] p 305 A89-28451 SÜRGES Active suppression of aerodynamic instabilities in turbomachines p 295 A89-28341 SWEPT WINGS An interactive three-dimensional boundary-layer method for transonic flow over swept wings [AIAA PAPER 89-0112] p 274 A89-25099 Three-dimensional compressible boundary layer calculations to fourth order accuracy on wings and fuselages [AIAA PAPER 89-0130] p 275 A89-25115 DFVLR-F5 test wing configuration - The boundary value p 290 A89-25858 problem A numerical method for unsteady transonic flow about p 291 A89-25929 tapered wings Applications of an efficient algorithm to transonic conservative full-potential flow past 3-D wings p 291 A89-25930 Wing rock generated by forebody vortices

p 312 A89-27735 Effect of sidewall boundary layer on a wing in a wind p 294 A89-27742 tunnel

SWEPTBACK WINGS

Theoretical investigation for the effects of sweep, leading-edge geometry, and spanwise pressure gradients on transition and wave drag transonic, and supersonic speed with experimental correlations [SAE PAPER 881484] n 295 A89-28229

The contribution of planform area to the performance of the BERP rotor --- British Experimental Rotor Programme p 314 A89-28350 Blade SWEPTBACK WINGS

Feedback control of vibrations in an extendible cantilever p 332 A89-26193 sweptback wing SWIRLING

- Viscous swirling nozzle flow
- p 279 A89-25237 [AIAA PAPER 89-0280] An experimental and computational investigation of isothermal swirling flow in an axisymmetric dump combustor
- [AIAA PAPER 89-0620] p 323 A89-25491 Subcritical swirling flows in convergent, annular p 323 A89-27694 nozzles Intake swirl and simplified methods for dynamic pressure
- distortion assessment p 299 N89-16742 Aerothermal modeling program. Phase 2, element B: p 351 N89-17304 Flow interaction experiment SYNTAX
- An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition innut
- [AD-A200626] p 309 N89-17588 SYNTHETIC APERTURE RADAR
- Evaluation of a Kalman filter for SAR motion p 347 A89-26721 compensation SYSTEMS ENGINEERING
- Inverse methods for blade design, controlled diffusion blading for supercritical compressor flow p 329 N89-16832
- Design of critical compressor stages p 330 N89-16835
- SYSTEMS INTEGRATION
- CFD in design An airframe perspective [AIAA PAPER 89-0092] p 310 A89-25081 Secondary power - Benefits of digital control and vehicle
- management system integration [SAE PAPER 881498] p 325 A89-28264 X-29A subsystems integration - An example for future
- aircraft [SAE PAPER 881504] p 314 A89-28269 System considerations for integrated machinery health
- p 327 N89-16804 monitoring SYSTEMS SIMULATION
- Integrating causal reasoning at different levels of abstraction --- in problem-solving system functioning as pilot assistant in commercial air transport emergencie p 355 A89-27609
- Real-time simulation for survivable penetration D 333 A89-28236 [SAE PAPER 881515]

Т

- TAIL ROTORS
- Helicopter tail rotor blade-vortex interaction noise p 356 N89-18167 [NASA-CR-183178] TAKFOFF
- Departure resistance and spin characteristics of the F-15 S/MTD
- [AIAA PAPER 89-0012] p 331 A89-25008 Airport accident-potential and safety areas
- p 336 A89-28193 [SAE PAPER 881388] Analysis of Arrow Air DC-8-63 accident Gander, lewfoundland on 12 December 1985
- p 305 A89-28448 [AIAA PAPER 89-0706] Overview of optimal trajectories for flight in a windshear
- [AIAA 89-0812] p 306 A89-28464 TANDEM WING AIRCRAFT
- Dragonfly unsteady aerodynamics The role of the wing phase relations in controlling the produced flows [AIAA PAPER 89-0832] p 289 A89-25602
- **TECHNOLOGY UTILIZATION** Utilization of wind tunnel instrumentation with software
- verifications p 335 A89-27654 TEFLON (TRADEMARK)
- Nonequilibrium viscous hypersonic flows over ablating Teflon surfaces p 293 A89-26368 [AIAA PAPER 89-0314]
- TELECOMMUNICATION Laser communication test system
- [AD-A199612] p 349 N89-17215 TEMPERATURE COMPENSATION
- The design and use of a temperature-compensated hot-film anemometer system for boundary-layer flow transition detection on supersonic aircraft p 318 A89-27668

- TEMPERATURE CONTROL
- Temperature compensation using GaAs MMIC devices p 347 A89-26548 Topics of aircraft thermal management
- [SAF PAPER 881381] p 314 A89-28255 TEMPERATURE MEASUREMENT
- Infrared technique to measure the skin temperature on an electrothermal de-icer - Comparison with numerical simulations
- [AIAA PAPER 89-0760] p 303 A89-25566 The measurement of temperature from an aircraft in
- p 353 N89-17978 cloud **TEMPERATURE PROFILES**
- Experimental and analytical study on exit radial temperature profile of experimental 2D combustor p 340 A89-25403 [AIAA PAPER 89-0493] TERMINAL FACILITIES
- LIRAS A proposal for an airport traffic safety system p 308 A89-28293
- TERRAIN ANALYSIS
 - Photo-based three dimensional graphics models for multi-sensor simulation --- terrain data bases for flight simulator p 348 A89-27787 Advanced Fighter Technology Integration/Sandia
- Inertial Terrain-Aided Navigation (AFTI/SITAN) p 309 N89-17587 [DE89-004000]
- TERRAIN FOLLOWING AIRCRAFT Real-time simulation for survivable penetration
- [SAE PAPER 881515] p 333 A89-28236 TEST FACILITIES
- Facility requirements for hypersonic propulsion system testina
- [AIAA PAPER 89-0184] p 335 A89-25159 International Instrumentation Symposium, 34th, Albuquerque, NM, May 2-6, 1988, Proceedings p 348 A89-27651
- TEST VEHICLES
- Recoverable test vehicle, an innovative approach to a low cost composite airframe for aerospace application [AIAA PAPER 89-0378] p 311 A89-25320 THERMAL ANALYSIS
- Thermal analysis of engine inlet anti-icing systems [AIAA PAPER 89-0759] p 311 A89-25565
- THERMAL CONDUCTIVITY Thermal conductivity and microstructure stability of heat treated AMZIRC copper-based alloys
- p 341 A89-26361 THERMAL CONTROL COATINGS Turbine Engine Hot Section Technology, 1987
- p 351 N89-17298 [NASA-CP-2493] prediction model Thermal barrier coating life development p 351 N89-17333 High temperature constitutive and crack initiation modeling of coated single crystal superalloys
- p 342 N89-17334 THERMAL CYCLING TESTS Structural response of an advanced combustor liner:
- p 351 N89-17329 Test and analysis Creep fatigue life prediction for engine hot section materials (ISOTROPIC) fifth year progress review p 352 N89-17336
- THERMAL ENERGY Thermal-energy management for air breathing
- hyper-velocity vehicle TAIAA PAPER 89-01831 p 310 A89-25158 THERMAL FATIGUE
 - Turbine Engine Hot Section Technology, 1987
- p 351 N89-17298 [NASA-CP-2493] Creep fatigue life prediction for engine hot section materials (ISOTROPIC) fifth year progress review p 352 N89-17336
- THERMAL STABILITY
- An investigation of the physical and chemical factors affecting the perfomance of fuels in the JFTOT --- Jet Fuel Thermal Oxidation Tester
- p 341 A89-28242 [SAE PAPER 881533] THERMODYNAMIC EFFICIENCY
- Engineering ceramics Applications and testing requirements p 347 A89-27632 THERMODYNAMIC PROPERTIES
- Experimental verification of properties for a jet-A fuel [NASA-TM-101475] the thermodynamic
- p 342 N89-17017 THERMOGRAPHY
- Infrared thermography in blowdown and intermittent hypersonic facilities [AIAA PAPER 89-0042] p 334 A89-25036
- A novel infrared thermography heat transfer measurement technique [AIAA PAPER 89-0601] p 345 A89-25478
- THERMOMETERS
- The measurement of temperature from an aircraft in cloud p 353 N89-17978 THIN AIRFOILS
 - Elevator deflection effects on the icing process
- [AIAA PAPER 89-0846] p 290 A89-25615

THIN WALLS Local buckling and crippling of thin-walled composite structures under axial compression p 341 A89-27733 THREE DIMENSIONAL BODIES

SUBJECT INDEX

- Large-angle-of-attack viscous hypersonic flows over complex lifting configurations [AIAA PAPER 89-0269]
- p 279 A89-25227 THREE DIMENSIONAL BOUNDARY LAYER Stability of 3D wing boundary layer on a SST configuration
- p 272 A89-25031 [AIAA PAPER 89-0036] An interactive three-dimensional boundary-layer method
- for transonic flow over swept wings [AIAA PAPER 89-0112] p 274 A89-25099
- Three-dimensional compressible boundary laver calculations to fourth order accuracy on wings and iuselage [AIAA PAPER 89-0130]
- p 275 A89-25115 An exploratory study of corner bleed on a fin generated three-dimensional shock wave turbulent boundary layer interaction
- [AIAA PAPER 89-0356] p 282 A89-25301 Effect of sidewall boundary layer on a wing in a wind p 294 A89-27742 tunnel

THREE DIMENSIONAL FLOW

- Evaluation of leading- and trailing-edge flaps on flat and cambered delta wings at supersonic speeds
- [AIAA PAPER 89-0027] p 272 A89-25023 Efficient finite-volume parabolized Navier-Stokes solutions for three-dimensional, hypersonic, chemically reacting flowfields
- p 274 A89-25090 [AIAA PAPER 89-0103] Application of continuous vorticity panels in
- three-dimensional lifting flows with partial separation p 275 A89-25104 [AIAA PAPER 89-0117] Prediction of 3D multi-stage turbine flow field using a
- multiple-grid Euler solver p 277 A89-25178 [AIAA PAPER 89-0203]
- Three-dimensional flow simulation about the AFE vehicle in the transitional regime --- Aeroassist Flight Experiment
- [AIAA PAPER 89-0245] p 278 A89-25207 Analysis of three-dimensional aerospace configurations
- using the Euler equations [AIAA PAPER 89-0268] p 279 A89-25226 Comparison of LDV measurements and Navier-Stokes
- solutions in a two-dimensional 180-degree turn-around duct
- [AIAA PAPER 89-0275] p 279 A89-25232 Computations of 3D viscous flows in rotating turbomachinery blades
- p 281 A89-25273 [AIAA PAPER 89-0323] Navier-Stokes solutions for vortical flows over a
- tangent-ogive cylinder p 281 A89-25284 [AIAA PAPER 89-0337]
- Navier-Stokes solutions about the F/A-18 forebody-LEX configuration --- Leading Edge Extension [AIAA PAPER 89-0338] p 281 A89-25285
- An adaptive implicit/explicit finite element scheme for compressible viscous high speed flow
- [AIAA PAPER 89-0363] p 344 A89-25307 Modifications to transonic flow codes for unsteady perturbations around an experimental mean

A multigrid and upwind viscous flow solver on 3-D

Numerical solutions to three-dimensional shock

Dragonfly unsteady aerodynamics - The role of the wing

Boundary layer transition and turbulence modelling in

Finite element simulation of 3D turbulent free shear

Transonic store separation using a three-dimensional

Analysis of 3D viscous flows in transonic compressors

3-D combustor performance validation with high density

Three-dimensional hybrid finite volume solutions to the

Numerical solutions on a Pathfinder and other

Numerical study of single impinging jets through a

configurations using unstructured grids and a finite element

Euler equations for supersonic/hypersonic aircraft

wave/vortex interaction at hypersonic speeds

phase relations in controlling the produced flows

[AIAA PAPER 89-0447]

[AIAA PAPER 89-0464]

[AIAA PAPER 89-0674]

[AIAA PAPER 89-0832]

three-dimensional flow

chimera grid scheme [AIAA PAPER 89-0637]

[AIAA PAPER 89-0219]

[AIAA PAPER 89-0281]

[AIAA PAPER 89-0362]

[AIAA PAPER 89-0449]

THREE DIMENSIONAL MODELS

flows

fuels

solver

crossflow

embedded and overlapped grids

p 284 A89-25365

p 285 A89-25379

p 289 A89-25534

p 289 A89-25602

p 346 A89-25860

p 294 A89-26946

p 296 A89-28442

p 329 N89-16831

p 340 A89-25193

p 280 A89-25238

p 282 A89-25306

p 284 A89-25367

A model for 3-D sonic/supersonic transverse fuel
inication inte a supersonia air stream
[AIAA PAPER 03-0400] p 040 not 20010
diffusor
[AIAA PAPER 89-0639] D 288 A89-25505
A three dimensional upwind finite element point implicit
A three-official solution in the element point implicit
Scramjet analysis with chemical reaction using
three-dimensional approximate factorization
[AIAA PAPER 89-06/2] p 323 A89-25533
Three-dimensional viscous flow simulations using an
implicit relaxation scheme p 291 A89-25865
Photo-based three dimensional graphics models for
multi-sensor simulation terrain data bases for flight
simulator p 348 A89-27787
F-14 flow field simulation
[AIAA PAPER 89-0642] p 296 A89-28444
THRUST
Estimation of drag arising from asymmetry in thrust or
airframe configuration
[ESDU-88006] p 297 N89-16730
The advantage of a thrust rating concept used on the
RB199 engine p 327 N89-16800
Installed thrust as a predictor of engine health for iet
engines p 327 N89-16806
THRUST AUGMENTATION
The turbulent free jet issuing from a sharp-edged
elliptical slot
[AIAA PAPER 89-0664] p 345 A89-25526
THRUST VECTOR CONTROL
Results from NASA Langley experimental studies of
multiaxis thrust vectoring nozzles
[SAE PAPER 881481] p 324 A89-28228
THUNDERSTORMS
National lightning detection - A real-time service to
aerosnace
(AIAA PAPER 89-0787) p 352 A89-25578
Lightning initiation on aircraft in thunderstorms
p 353 A89-26214
Lightning triggered by the presence of aerospace
vehicles n 353 A89-26215
Electric charge acquired by airplanes penetrating
thunderstorms p 304 A89-26231
Cockpit display of ground-based weather data during
thunderstorm research flights
thunderstorm research flights (AIAA 89-0806) p 269 A89-28463
thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING
thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time
thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation
thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085
thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for
thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174
thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL
thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft
thunderstorm research llights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014
thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0996] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 TOLERANCES (MECHANICS)
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 TOLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques
thunderstorm research llights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25667 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 TOLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25667 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 TOLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 TOLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs p 350 N89-17257 TOLLMEIN-SCHLICHTING WAVES
thunderstorm research llights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
thunderstorm research llights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25667 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 TOLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs p 350 N89-17257 TOLLMEIN-SCHLICHTING WAVES Stability of 3D wing boundary layer on a SST configuration
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
thunderstorm research llights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 TOLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs Stability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Short term developments in non-destructive evaluation
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
thunderstorm research llights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
thunderstorm research llights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25667 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft Using a singular perturbation feedback control law [AIAA PAPER 89-0018] [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 TOLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs p 350 N89-17257 TOLLMEIN-SCHLICHTING WAVES Stability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Short term developments in non-destructive evaluation applicable to turbine engine parts p 350 N89-17258 Fiber optic torquemeter design and development Fiber optic torquemeter design and development
faiAa 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS A49-24995 TOLEFANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs mortance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of sub-917257 TOLLERANCES (MECHANICS) Importance of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Shability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Shot term developments in non-destructive evaluation applicable to turbine engine parts p 350 N89-17258
faiAa 89-0806 p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-018] p 331 A89-25014 TIMOSHENKO BEAMS p 343 A89-24995 TOLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs on damage tolerance based life prediction of a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOLLMEIN-SCHLICHTING WAVES Stability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Short term developments in non-destructive evaluation asplicable to turbine engine parts p 350 N89-17257 TOLLMEIN-SCHLICHTING WAVES Fiber optic torquemeter design and development p 348 A89-27661
faiAa 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AlAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AlAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25667 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 TOLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs p 350 N89-17257 TOLLMEIN-SCHLICHTING WAVES Stability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Short term developments in non-destructive evaluation applicable to turbine engine parts p 350 N89-17257 TOMOGRAPHY Short term development in non-destructive evaluation applicable to turbine engine parts p 350 N89-172561 TOMOGRAPHY<
faiAa 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures [Montace of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs [AIAA PAPER 89-0036] p 272 A89-25031 TOLEFANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs Stability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Sho N89-17258 TORQUEMETERS p 348 A89-27661 TOROULMENTERS p 348 A89-27661
tunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
thunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
faiAa 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures [Montace of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs [AIAA PAPER 89-0036] p 272 A89-25031 TOLEFANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs stability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Shability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 248 A89-27661 TOROUEMETERS <td< td=""></td<>
tunderstorm research lights [AIAA 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
faiAa 89-0806) p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for inviscid flow computation [AlAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AlAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 201 A89-25667 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures P 343 A89-24995 TOLLERANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs p 350 N89-17257 TOLLMEIN-SCHLICHTING WAVES Stability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Short term developments in non-destructive evaluation applicable to turbine engine parts p 350 N89-17258 TOLLMEIN-SCHLICHTING WAVES Fiber optic torquemeter design and development p 348 A89-27661 p 348 A89-27661 TOMOGRAPHY Short term development gas and development p
faiAa 89-0806] p 269 A89-28463 TIME MARCHING Convergence acceleration through the use of time inclining for invisid flow computation [AIAA PAPER 89-0096] p 274 A89-25085 A set of strongly coupled, upwind algorithms for computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] [AIAA PAPER 89-0199] p 277 A89-25174 Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 TIME OPTIMAL CONTROL Fast half-loop maneuvers for a high alpha fighter aircraft using a singular perturbation feedback control law [AIAA PAPER 89-018] p 331 A89-25014 TIMOSHENKO BEAMS Automatic generation of component modes for rotordynamic substructures [AIAA PAPER 89-0018] p 343 A89-24995 TOLEFANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs [AIAA PAPER 89-0036] p 272 A89-25031 TOLEFANCES (MECHANICS) Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of substructures [AIAA PAPER 89-0036] p 272 A89-25031 TOMOGRAPHY Shot term developments in non-destructive evaluation applicable to turbine engine parts p 348 A89-27661 TORSIONAL STRESS Fiber optic torquemeter design and developmen

Flow measurements of an airfoil with single-slotted flap [AIAA PAPER 89-0533] p 286 A89-25427

TRAILING EDGES Turbulence modeling in separated flow behind strong

shocks p 294 A89-27746

TRAJECTORIES

Notes on a theoretical parachute opening force analysis applied to a general trajectory [AD-A201050] p 302 N89-17582

TRAJECTORY ANALYSIS Precision trajectory reconstruction

P 307 A89-26726

- The development of an automated flight test management system for flight test planning and monitoring p 312 A89-27613 TRAJECTORY OPTIMIZATION
- Overview of optimal trajectories for flight in a windshear [AIAA 89-0812] p 306 A89-28464
- TRANSATMOSPHERIC VEHICLES The effect of Mach number on the stability of a plane
- supersonic wave [AIAA PAPER 89-0285] p 280 A89-25242
- TRANSIENT RESPONSE Adaptive H-refinement on 3-D unstructured grids for
- transient problems [AIAA PAPER 89-0365] p 283 A89-25309
- Measurement of transient vortex-surface interaction phenomena [AIAA PAPER 89-0833] p 289 A89-25603
- TRANSITION FLOW An interactive boundary-layer procedure for oscillating
- airfoils including transition effects [AIAA PAPER 89-0020] p 271 A89-25016 Three-dimensional flow simulation about the AFE vehicle
- in the transitional regime --- Aeroassist Flight Experiment [AIAA PAPER 89-0245] p 278 A89-25207 Nonequilibrium effects for hypersonic transitional flows
- using continuum approach [AIAA PAPER 89-0461] p 284 A89-25377
- The design and use of a temperature-compensated hot-film anemometer system for boundary-layer flow transition detection on supersonic aircraft
- p 318 A89-27668
 - Electromagnetic emissions from a modular low voltage EIDI system --- Electro-Impulse Deicing
- [AIAA PAPER 89-0758] p 303 A89-25564 TRANSMITTERS
- Laser communication test system [AD-A199612] p 349 N89-17215 TRANSONIC COMPRESSORS
- Transonic Compressors, volume 1 --- conference [VKI-LS-1988-03-VOL-1] p 328 N89-16825
- Loss development in transonic compressor cascades p 328 N89-16826 Shock losses in transonic and supersonic compressor
- cascades p 329 N89-16829 Axial velocity density ratio influence on exit flow angle
- in transonic/supersonic cascades p 329 N89-16830 Analysis of 3D viscous flows in transonic compressors p 329 N89-16831
- Inverse methods for blade design, controlled diffusion blading for supercritical compressor flow p 329 N89-16832
- Transonic Compessors, volume 2 --- conference [VKI-LS-1988-03-VOL-2] p 329 N89-16833
- The design and development of transonic multistage compressors p 329 N89-16834
- Design of critical compressor stages p 330 N89-16835
- Design methodology for advanced High Pressure (HP) compressor first stage p 330 N89-16840
- TRANSONIC FLIGHT Transonic cowl design p 315 N89-16746
- TRANSONIC FLOW An interactive three-dimensional boundary-layer method
- for transonic flow over swept wings [AIAA PAPER 89-0112] p 274 A89-25099 An acceleration method for solving the Euler equations
- An acceleration method for solving the Euler equations on an unstructured mesh by applying multigrid on an auxiliary structured mesh [AIAA PAPER 89-0116] p 275 A89-25103
- A solution to water vapor in the National Transonic Facility
- [AIAA PAPER 89-0152] p 334 A89-25135 An experimental investigation of the effects of a base cavity on the near-wake flowfield of a body at subsonic and transonic speeds
- [AIAA PAPER 89-0210] p 277 A89-25184 TranAir and Euler computations of a generic fighter including comparisons with experimental data ---full-potential equations for transport flow
- full-potential equations for transonic flow [AIAA PAPER 89-0263] p 310 A89-25221 Transonic Euler solutions on mutually interfering finned
- bodies [AIAA PAPER 89-0264] p 278 A89-25222 Modifications to transonic flow codes for unsteady perturbations around an experimental mean [AIAA PAPER 89-0447] p 284 A89-25365

- Determination of aerodynamic sensitivity coefficients in the transonic and supersonic regimes [AIAA PAPER 89-0532] D 286 A89-25426
- [AIAA PAPER 89-0532] p 286 A89-25426 An investigation of cell centered and cell vertex multigrid schemes for the Navier-Stokes equations
- [AIAA PAPER 89-0548] p 345 A89-25440 A one equation turbulence model for transonic airfoil
- flows [AIAA PAPER 89-0557] p 287 A89-25446 Prediction of separated transonic wing flows with a
- Prediction of separated transonic wing hows with a non-equilibrium algebraic model [AIAA PAPER 89-0558] p 287 A89-25447
- Comparison of two different Navier-Stokes methods for the simulation of 3-D transonic flows with separation
- [AIAA PAPER 89-0559] p 287 A89-25448 A transonic computational method for an aft-mounted nacelle/pylon configuration with propeller power effect [AIAA PAPER 89-0560] p 311 A89-25449
- [AIAA PAPER 89-0560]
 p 311
 A89-25449

 Shock capturing using a pressure-correction method
 [AIAA PAPER 89-0561]
 p 345
 A89-25450
- Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic flows
- [AIAA PAPER 89-0562] p 287 A89-25451 Integral equation solution of the full potential equation for transport flows
- [AIAA PAPER 89-0563] p 287 A89-25452 Direct solution of unsteady transonic flow equations in
- frequency domain [AIAA PAPER 89-0641] p 288 A89-25507
- A self-adaptive computational method applied to transonic turbulent projectile aerodynamics [AIAA PAPER 89-0837] p 290 A89-25606
- DFVLR-F5 test wing experiment for computational aerodynamics p 290 A89-25857
- Navier-Stokes simulation of transonic wing flow fields using a zonal grid approach p 290 A89-25862
- Numerical simulation of viscous transonic flow over the DFVLR F5 wing p 291 A89-25863 Navier-Stokes simulation of wind-tunnel flow using
- LU-ADI factorization algorithm p 291 A89-25864 Navier-Stokes calculations for DFVLR F5-wing in wind
- Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme
 - p 291 A89-25867 A numerical method for unsteady transonic flow about
- tapered wings p 291 A89-25929 Applications of an efficient algorithm to transonic
- conservative full-potential flow past 3-D wings p 291 A89-25930
- Applications of AF3 efficient iteration scheme to transonic nonconservative full-potential flow past airfoils p 292 A89-25940
- Derivation of an integral equation for large disturbing transonic flow and its numerical method of undercritical
- flow p 293 A89-25944 Experimental investigation of transonic oscillating
- cascade aerodynamics [AIAA PAPER 89-0321] p 293 A89-26369
- [AIAA PAPER 89-0321] p 293 A89-26369 Measurements of the oscillatory lateral derivatives of a high incidence research model (HIRM 1) at speeds up
- to M = 0.8 p 332 A89-26688 Unsteady transonic algorithm improvements for realistic
- aircraft applications p 312 A89-27738 Effect of sidewall boundary layer on a wing in a wind tunnel p 294 A89-27742
- tunnel p 294 A89-27742 Euler flow solutions for transonic shock wave-boundary layer interaction p 295 A89-28074
- layer interaction p 295 A89-28074 Theoretical investigation for the effects of sweep, leading-edge geometry, and spanwise pressure gradients on transition and wave drag transonic, and supersonic
- on transition and wave drag transonic, and supersonic speed with experimental correlations [SAE PAPER 881484] p 295 A89-28229
- Transonic store separation using a three-dimensional chimera grid scheme
- [AIAA PAPER 89-0637] p 296 A89-28442 The free-wake prediction of rotor hover performance using a vortex embedding method
- [AIAA PAPER 89-0638] p 296 A89-28443 Reynolds number effects in transonic flow
- [AGARD-AG-303] p 300 N89-16760 Expriments on the DFVLR-F4 wing body configuration
- in several European windtunnels p 337 N89-16848 Full-potential integral solutions for steady and unsteady transonic airfoils with and without embedded Euler
- domains p 301 N89-17566 TRANSONIC FLUTTER
- Technique for the prediction of airfoil flutter characteristics in separated flow p 348 A89-27744 TRANSONIC SPEED
- Development of direct-inverse 3-D methods for applied transonic aerodynamic wing design and analysis
- [NASA-CR-184788] p 300 N89-16761 An experimental investigation of the perpendicular vortex-airfoil interaction at transonic speeds p 301 N89-17569

TRANSONIC SPEED

TRANSONIC WIND TUNNELS

TRANSONIC WIND TUNNELS

Sidewall boundary-layer removal effects on wall adaptation in the Langley 0.3-meter transonic cryogenic tunnel [AIAA PAPER 89-0148] p 334 A89-25131

- Flow quality measurements for the Langley 8-foot transonic pressure tunnel LFC experiment [AIAA PAPER 89-0150] p 27
- p 276 A89-25133 Preliminary test results of NDA cryogenic wind tunnel and its system
- [SAE PAPER 881449] p 336 A89-28219 Emerging technology for transonic wind-tunnel-wall interference assessment and corrections
- p 336 A89-28220 [SAE PAPER 881454] Development of testing techniques in a large transonic wind tunnel to achieve a required drag accuracy and flow
- standards for modern civil transports p 337 N89-16857 TRANSPORT AIRCRAFT
- High-lift aerodynamics for transport aircraft by interactive experimental and theoretical tool development
- [AIAA PAPER 89-0267] p 278 A89-25225 The intelligent wing - Aerodynamic developments for future transport aircraft
- [AIAA PAPER 89-0534] p 269 A89-25428 Measurement of dynamic reactions in passenger seat leas
- p 305 A89-28188 [SAE PAPER 881376] Transport airplane fuselage section longitudinal impact test
- p 305 A89-28189 [SAE PAPER 881377] p 315 N89-16749 Transport aircraft intake design Development of testing techniques in a large transonic
- vind tunnel to achieve a required drag accuracy and flow standards for modern civil transports p 337 N89-16857 Precision improvement of transport aircraft drag
- p 300 N89-16858 measurements Accuracy of various wall-correction methods for 3D
- subsonic wind-tunnel testing p 338 N89-16863 Accuracy requirements for high-speed test with engine simulation on transport aircraft models in the NLR-HST p 338 N89-16870
- Balance accuracy and repeatability as a limiting parameter in aircraft development force measurements in conventional and cryogenic wind tunnels
- p 338 N89-16873 Accuracy problems in wind tunnels during transport p 338 N89-16877 aircraft development Particular flight mechanics specifications related to wind p 339 N89-16879 tunnel test results
- MPC-75 feeder civil aircraft p 317 N89-17594 [AD-A200907] TRENDS
- Trend monitoring of a turboprop engine at low and mean p 321 N89-16801 power
- TRUNCATION ERRORS Viscous-inviscid interaction and local grid refinement via truncation error injection
- AIAA PAPER 89-04681 p 285 A89-25383 TURBINE BLADES
- Influence of clearance leakage on turbine heat transfer at and near blade tips - Summary of recent results p 344 A89-25275 [AIAA PAPER 89-0327]
- Measurement and modelling of turbulent spot growth on a das turbine blade p 281 A89-25276 [AIAA PAPER 89-0328] Review of existing NDT technologies p 349 N89-17255 capabilities
- Turbine Engine Hot Section Technology, 1987 p 351 N89-17298 [NASA-CP-2493] Measurement of airfoil heat transfer coefficients on a p 351 N89-17311 turbine stage
- Coolant passage heat transfer with rotation p 351 N89-17314 Three-dimensional inelastic analysis methods for hot p 351 N89-17316 section components
- Constitutive modelling of single crystal and directionally p 342 N89-17325 solidified superalloys TURBINE ENGINES
- NNEPEQ Chemical equilibrium version of the Navy/NASA Engine Program p 322 A89-24989 [ASME PAPER 88-GT-314]
- TURBOCOMPRESSORS Active suppression of aerodynamic instabilities in
- turbomachines p 295 A89-28341 Design of critical compressor stages p 330 N89-16835
- Axial supersonic inlet compound p 330 N89-16839 TURBOFAN ENGINES Performance potential of air turbo-ramjet employing supersonic through-flow fan [AIAA PAPER 89-0010] p 322 A89-25006
- The CFM 56-5 on the A-320 at Air France p 320 N89-16793

Service life calculator for the M53 turbofan engine p 326 N89-16796

- CF-18/F404 transient performance trending p 328 N89-16814
- COMPASS (Trademark): A generalized ground-based p 321 N89-16819 monitoring system TURBOFANS
- Supersonic throughflow fans p 330 N89-16837 TURBOJET ENGINES
- Relation between diffusor losses and the inlet flow p 322 A89-24916 conditions of turboiet combustors Installed thrust as a predictor of engine health for jet p 327 N89-16806 engines
- TURBOMACHINERY
 - A simple time-accurate turbomachinery algorithm with numerical solutions of an uneven blade count configuration
 - [AIAA PAPER 89-0206] p 344 A89-25181 Grid refinement studies of turbine rotor-stator interaction
- p 281 A89-25274 [AIAA PAPER 89-0325] A study of turbomachine flow velocities
- [AIAA PAPER 89-0839] p 346 A89-25608 TURBOPROP ENGINES
- Trend monitoring of a turboprop engine at low and mea p 321 N89-16801 power TURBULENCE EFFECTS
- The effects of enroute turbulence reports on air carrier flight operations
- [AIAA PAPER 89-0741] p 303 A89-25557 TURBULENCE METERS
- Measurement and modelling of turbulent spot growth on a gas turbine blade p 281 A89-25276
- [AIAA PAPER 89-0328] TURBUI ENCE MODELS
- Computation of turbulent incompressible wing-body unction flow [AIAA PAPER 89-0279]
- p 310 A89-25236 Computations of 3D viscous flows in rotating chinery blade: turboma
- [AIAA PAPER 89-0323] p 281 A89-25273 Measurement and modelling of turbulent spot growth on a gas turbine blade
- [AIAA PAPER 89-0328] p 281 A89-25276 A one equation turbulence model for transonic airfoil
- flows [AIAA PAPER 89-0557] p 287 A89-25446
- Prediction of separated transonic wing flows with a non-equilibrium algebraic model
- [AIAA PAPER 89-0558] p 287 A89-25447 Modeling of subsonic flow through a compact offset inlet diffuser
- p 288 A89-25505 [AIAA PAPER 89-0639] Simple turbulence models for supersonic and hypersonic
- Bodies at incidence and compression corners p 289 A89-25530 [AIAA PAPER 89-0669]
- Boundary layer transition and turbulence modelling in three-dimensional flow p 346 A89-25860 Turbulence modeling in separated flow behind strong
- p 294 A89-27746 shocks Combustor air flow prediction capability comparing p 349 A89-28345 several turbulence models TURBULENT BOUNDARY LAYER
- Vortex/boundary layer interactions
- [AIAA PAPER 89-0083] p 273 A89-25073 Diverging boundary layers with zero streamwise pressure radien
- [AIAA PAPER 89-0134] p 343 A89-25118 Measurements of a supersonic turbulent boundary layer with mass addition
- [AIAA PAPER 89-0135] p 344 A89-25119 Modification of compressible turbulent boundary layer
- structures by streamlined devices [AIAA PAPER 89-0212] p 277 A89-25186
- Mach number dependence of flow separation induced normal shock-wave/turbulent boundary-layer interaction at a curved wall
- [AIAA PAPER 89-0353] p 282 A89-25298 Confined normal-shock/turbulent-boundary-layer interaction followed by an adverse pressure gradie
- p 282 A89-25299 AIAA PAPER 89-0354 An LDV investigation of a multiple normal shock ave/turbulent boundary layer interaction
- p 282 A89-25300 [AIAA PAPER 89-0355] An exploratory study of corner bleed on a fin generated three-dimensional shock wave turbulent boundary layer interaction
- [AIAA PAPER 89-0356] p 282 A89-25301 An integral method for calculating turbulent boundary p 292 A89-25942 laver flow on practical wings
- Experimental and numerical investigation of an oblique shock wave/turbulent boundary layer interaction with continuous suction [AIAA PAPER 89-0357]
 - p 296 A89-28407

SUBJECT INDEX

TURBULENT FLOW Zonal modelling of flows through multiple inlets and nozzles [AIAA PAPER 89-0005] p 271 A89-25003 Efficient finite-volume parabolized Navier-Stokes solutions for three-dimensional, hypersonic, chemically reacting flowfields p 274 A89-25090 [AIAA PAPER 89-0103] Structure of the compressible turbulent shear layer p 275 A89-25111 [AIAA PAPER 89-0126] Computation of turbulent incompressible wing-body iunction flow [AIAA PAPER 89-0279] p 310 A89-25236 A one equation turbulence model for transonic airfoil flows [AIAA PAPER 89-0557] p 287 A89-25446 Evaluation of three turbulence models for the prediction of steady and unsteady airloads [AIAA PAPER 89-0609] p 288 A89-25485 A self-adaptive computational method applied to transonic turbulent projectile aerodynamics [AIAA PAPER 89-0837] p 290 A89-25606 Computation for supersonic and turbulent separated flow p 292 A89-25931 over a compression corner p 292 A89-25931 Experimental research of flow separation, heat transfer and ablation on flat plate-wedges in supersonic, turbulent p 292 A89-25938 flow Finite element simulation of 3D turbulent free shear flows p 294 A89-26946 Effects of a downstream disturbance on the structure of a turbulent plane mixing laver p 348 A89-27692 Turbulence measurements in a radial upwash p 294 A89-27706 Aerothermal modeling program. Phase 2, element B: p 351 N89-17304 Flow interaction experiment Measurement of airfoil heat transfer coefficients on a p 351 N89-17311 turbine stage TURBULENT JETS The turbulent free jet issuing from a sharp-edged lliptical slot [AIAA PAPER 89-0664] p 345 A89-25526 TURBULENT MIXING Turbulent mixing in supersonic combustion systems [AIAA PAPER 89-0260] p 323 A89-25218 Effects of a downstream disturbance on the structure of a turbulent plane mixing layer p 348 A89-27692 TURNING FLIGHT Agile Fighter Aircraft Simulation [AIAA PAPER 89-0015] p 331 A89-25011 TWISTED WINGS Boundaries of linear characteristics of cambered and twisted wings at subcritical Mach numbers [ESDU-88030] p 298 N89-16735 TWO DIMENSIONAL BODIES Two-dimensional Euler computations on a triangular nesh using an upwind, finite-volume scheme [AIAA PAPER 89-0470] p 354 A89-25385 A critical assessment of wind tunnel results for the NACA p 300 N89-16847 0012 airfoil TWO DIMENSIONAL BOUNDARY LAYER Stability and transition of two-dimensional laminar boundary layers in compressible flow over an adiabatic p 270 A89-24922 wall TWO DIMENSIONAL FLOW An acceleration method for solving the Euler equations on an unstructured mesh by applying multigrid on an auxiliary structured mesh AIAA PAPER 89-01161 p 275 A89-25103 Low Reynolds number numerical solutions of chaotic flow p 275 A89-25108 [AIAA PAPER 89-0123] Comparison of LDV measurements and Navier-Stokes solutions in a two-dimensional 180-degree turn-around duct p 279 A89-25232 [AIAA PAPER 89-0275] Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic [AIAA PAPER 89-0562] p 287 A89-25451 Progress on a Taylor weak statement finite element algorithm for high-speed aerodynamic flows [AIAA PAPER 89-0654] p 289 A89-25517 Droplet impaction on a supersonic wedge Consideration of similitude [AIAA PAPER 89-0763] p 304 A89-25567 TWO DIMENSIONAL MODELS Zonal modelling of flows through multiple inlets and nozzles [AIAA PAPER 89-0005] p 271 A89-25003 Computational studies of a localized supersonic shear [AIAA PAPER 89-0125] p 275 A89-25110 Moving surface boundary-layer control as applied to two-dimensional airfoils [AIAA PAPER 89-0296] p 281 A89-25253

The compressible mixing laye	r - Linear theo	ry and direct
simulation		•
[AIAA PAPER 89-0371]	p 283	A89-25314
TWO PHASE FLOW		

An experimental study and prediction of a two-phase pressure drop in microgravity [AIAA PAPER 89-0074]

p 343 A89-25065

U

ULTRASONIC TESTS

Short term developments in non-destructive evaluation applicable to turbine engine parts p 350 N89-17258 ULTRASONICS

Long term possibilities for nondestructive evaluation for US Navy aircraft p 350 N89-17259 UNIVERSITIES

Aircraft design education at North Carolina State University [AIAA PAPER 89-0649]

p 357 A89-25513 UNSTEADY AERODYNAMICS

A state-space model of unsteady aerodynamics in a compressible flow for flutter analyses [AIAA PAPER 89-0022] p 271 A89-25018

Extended pitch axis effects on flow about a pitching airfoil

[AIAA PAPER 89-0025] p 272 A89-25021 The design and development of a dynamic plunge-pitch-roll model mount

[AIAA PAPER 89-0048] p 334 A89-25042 Unsteady Navier-Stokes computations past oscillating

delta wing at high incidence [AIAA PAPER 89-0081] p 273 A89-25071 Unsteady Euler airfoil solutions using unstructured

dynamic meshes [AIAA PAPER 89-0115] p 275 A89-25102

Low Reynolds number numerical solutions of chaotic flow [AIAA PAPER 89-0123] p 275 A89-25108

Numerical simulation of vortex unsteadiness on slender bodies of revolution at large incidence

[AIAA PAPER 89-0195] p 276 A89-25170 Modification of compressible turbulent boundary layer structures by streamlined devices

[AIAA PAPER 89-0212] p 277 A89-25186 Unsteady, separated flow behind an oscillating,

two-dimensional flan [AIAA PAPER 89-0288] p 280 A89-25245

Oscillating aerodynamics and flutter of an aerodynamically detuned cascade in an incompressible flow

[AIAA PAPER 89-0289] p 280 A89-25246 Vortical flows past normal plate and spoiler of time dependent height

[AIAA PAPER 89-0291] p 280 A89-25248 Modifications to transonic flow codes for unsteady perturbations around an experimental mean AIAA PAPER 89-0447] p 284 A89-25365

Navier-Stokes computations of separated vortical flows past prolate spheroid at incidence [AIAA PAPER 89-0553] p 286 A89-25443

Study of the vortical wake patterns of an oscillating airfoil [AIAA PAPER 89-0554]

p 287 A89-25444 Boundary layer measurements on an airfoil at low Reynolds numbers in an accelerating flow from a nonzero base velocity [AIAA PAPER 89-0569]

p 288 A89-25458 Direct solution of unsteady transonic flow equations in frequency domain

[AIAA PAPER 89-06411 p 288 A89-25507 Dragonfly unsteady aerodynamics - The role of the wing phase relations in controlling the produced flows

AIAA PAPER 89-08321 p 289 A89-25602 Unsteady separation wave in a supersonic boundary p 293 A89-26011 layer

Experimental investigation of transonic oscillating cascade aerodynamics (AIAA PAPER 89-0321)

p 293 A89-26369 Preliminary results in the development of a method to correct propeller inflow for improved unsteady force calculations

[AIAA PAPER 89-0436] p 293 A89-26374 Measurements of the oscillatory lateral derivatives of

a high incidence research model (HIRM 1) at speeds up to M = 0.8p 332 A89-26688 Unsteady transonic algorithm improvements for realistic

aircraft applications p 312 A89-27738 Numerical analysis of flow through oscillating cascade sections

[AIAA PAPER 89-0437] p 296 A89-28413 AIAA PAPER 69-0437 j p 200 Nite and capabilities in unsteady windtunnel p 339 N89-16878 testing

UNSTEADY FLOW

Theoretical and numerical studies of oscillating airfoils [AIAA PAPER 89-0021] p 27 Compressible studies on dynamic stall p 271 A89-25017

The design and development of a dynamic plunge-pitch-roll model mount [AIAA PAPER Records]

[AIAA PAPER 89-0048] p 334 A89-25042 Modifications to transonic flow codes for unsteady perturbations around an experimental mean

[AIAA PAPER 89-0447] p 284 A89-25365 Numerical simulation of vortical flows on flexible wings [AIAA PAPER 89-0537] p 286 A89-25431 Direct solution of unsteady transonic flow equations in

frequency domain [AIAA PAPER 89-0641] p 288 A89-25507

A numerical method for unsteady transonic flow about tapered wings p 291 A89-25929 An effective modeling method of unsteady aerodynamics

for state-space aeroelastic models p 293 A89-25946 Preliminary results in the development of a method to correct propeller inflow for improved unsteady force calculations

[AIAA PAPER 89-0436] p 293 A89-26374 A free-trailing vane flow direction indicator employing a linear output Hall effect transducer

p 336 A89-27675 Unsteady Euler cascade analysis

[AIAA PAPER 89-0322] p 295 A89-28406 Full-potential integral solutions for steady and unsteady p 295 A89-28406 transonic airfoils with and without embedded Euler p 301 N89-17566 domains

UPLINKING

Weather data dissemination to aircraft [AIAA PAPER 89-0809] p 304 A89-25592 UPPER SURFACE BLOWING

The turbulent free jet issuing from a sharp-edged elliptical slot

[AIAA PAPER 89-0664] p 345 A89-25526

The current status of the flight test of the ASKA [SAE PAPER 881433] p 314 A89 p 314 A89-28208 UPWASH

Turbulence measurements in a radial upwash p 294 A89-27706

V/STOL AIRCRAFT

The turbulent free jet issuing from a sharp-edged elliptical slot

[AIAA PAPER 89-0664] p 345 A89-25526 Turbulence measurements in a radial upwash

p 294 A89-27706 V/STOL aircraft and the problem of jet-induced uckdown p 317 N89-18380 suckdown VANES

Three-dimensional inelastic analysis methods for hot section components p 351 N89-17316 VAPOR DEPOSITION

Thermal barrier coating life prediction model p 351 N89-17333 development VARIABLE GEOMETRY STRUCTURES

Variable geometry in supersonic compressors p 330 N89-16838

VARIABLE SWEEP WINGS

Scissor wing - An alternative to variable sweep [AIAA PAPER 89-0013] p 310 A8 p 310 A89-25009

VARIATIONAL PRINCIPLES

An alternative method to solve a variational inequality applied to an air traffic control example p 354 A89-26196

VERTICAL AIR CURRENTS

The effect of a ground-based inversion layer on an impacting microburst

[AIAA PAPER 89-0810] p 352 A89-25593 Numerical simulation of microburst downdrafts Application to on-board and look ahead sensor

technology [AIAA PAPER 89-0821] p 353 A89-25599 VERTICAL LANDING

Simulation evaluation of transition and hover flying qualities of the E-7A STOVL aircraft

[SAE PAPER 881430] p 333 A89-28205 Conceptual design of a STOVL fighter/attack aircraft

[SAE PAPER 881431] p 313 A89-28206 Considerations of control authority requirements in

STOVL propulsion system sizing [SAE PAPER 881432] p 313 A89-28207

VERTICAL MOTION Correction for deflections of the vertical at the runup

site p 307 A89-26725 VERTICAL MOTION SIMULATORS

The vertical motion simulator p 339 N89-18384

sweptback wing p 332 A89-26193 VIBRATION MODE Automatic generation of component modes rotordynamic substructures p 343 A89-24 p 343 A89-24995 VISCOUS FLOW Prediction of supersonic/hypersonic viscous flows over RVs and decoys [AIAA PAPER 89-0028] p 272 A89-25024 Adaptive grid embedding Navier-Stokes technique for cascade flows [AIAA PAPER 89-0204] p 277 A89-25179 Evaluation of an OH grid formulation for viscous cascade flows [AIAA PAPER 89-0207] p 277 A89-25182 Large-angle-of-attack viscous hypersonic flows over complex lifting configurations (AIAA PAPER 89-0269) p 279 A89-25227 An implicit flux-vector splitting scheme for the computation of viscous hypersonic flow AIAA PAPER 89-02741 p 279 A89-25231 Viscous swirling nozzle flow [AIAA PAPER 89-0280] p 279 A89-25237 Computations of 3D viscous flows in rotating turbomachinery blades [AIAA PAPER 89-0323] p 281 A89-25273 An adaptive implicit/explicit finite element scheme for compressible viscous high speed flow [AIAA PAPER 89-0363] p 344 A89-25307 A multigrid and upwind viscous flow solver on 3-D embedded and overlapped grids [AIAA PAPER 89-0464] p 285 A89-25379 Viscous-inviscid interaction and local grid refinement via truncation error injection [AIAA PAPER 89-0468] p 285 A89-25383 An improved upwind finite volume relaxation method for high speed viscous flows [AIAA PAPER 89-0549] AIAA PAPER 89-0549] p 286 A89-25441 Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987 p 290 A89-25856 Numerical simulation of viscous transonic flow over the FVLR F5 wing p 291 A89-25863 DFVLR F5 wing Three-dimensional viscous flow simulations using an implicit relaxation scheme plicit relaxation scheme p 291 A89-25865 Nonequilibrium viscous hypersonic flows over ablating Teflon surfaces [AIAA PAPER 89-0314] p 293 A89-26368 Analysis of 3D viscous flows in transonic compressors p 329 N89-16831 VOIDS An analysis method for bolted joints in primary composite p 317 N89-17691 aircraft structure Test specimens for bearing and by-pass stress interaction in carbon fibre reinforced plastic laminates p 342 N89-17696 VORTEX BREAKDOWN Effects of leading-edge shape and vortex burst on the flowfield of a 70-degree-sweep delta-wing [AIAA PAPER 89-0086] p 2 p 274 A89-25076 The effects of a contoured apex on vortex breakdown [AIAA PAPER 89-0193] p 276 A89-25168 Vortex generator jets - A means for passive and active control of boundary layer separation [AIAA PAPER 89-0564] p 287 A89-25453 VORTEX RINGS An unsteady vortex-ring model for microburst simulation p 353 A89-25594 VORTEX SHEDDING On the structure of two- and three-dimensional [AIAA PAPER 89-0287] p 280 A89-25244 An Euler analysis of leading-edge vortex flows on a forebody-strake at supersonic speeds

VORTEX SHEETS

Visualization measurements of vortex flows [AIAA PAPER 89-0191] p 276 A89-25166 VORTICES

An experimental study of shock wave/vortex

interaction [AIAA PAPER 89-0082] p 273 A89-25072 Vortex/boundary layer interactions

[AIAA PAPER 89-0083] p 273 A89-25073 An experimental investigation of delta wing vortex flow with and without external jet blowing

[AIAA PAPER 89-0084] p 273 A89-25074 Diverging boundary layers with zero streamwise pressure

[AIAA PAPER 89-0134] p 343 A89-25118

VIBRATION DAMPING

Feedback control of vibrations in an extendible cantilever

VORTEX GENERATORS

[AIAA PAPER 89-0811]

separation

[AIAA PAPER 89-0343] p 293 A89-26371

VORTICITY

Numerical simulation of vortex unsteadiness on slender bodies of revolution at large incidence

- [AIAA PAPER 89-0195] p 276 A89-25170 Upwind Navier-Stokes solutions for leading-edge vortex flows
- p 278 A89-25223 [AIAA PAPER 89-0265] Vortical flows past normal plate and spoiler of time dependent height
- p 280 A89-25248 [AIAA PAPER 89-0291] Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow
- p 282 A89-25288 [AIAA PAPER 89-0341] Study of the vortical wake patterns of an oscillating airfoil
- p 287 A89-25444 [AIAA PAPER 89-0554] Characteristics of the ground vortex formed by a jet moving over a fixed ground plane
- n 288 A89-25514 [AIAA PAPER 89-0650] Numerical solutions to three-dimensional shock
- wave/vortex interaction at hypersonic speeds n 289 A89-25534 [AIAA PAPER 89-0674]
- Wing rock generated by forebody vortices p 312 A89-27735 Acoustic-vortex interactions and low-frequency
- oscillations in axisymmetric combustors --- of ramjet p 325 A89-28336 enaines The free-wake prediction of rotor hover performance
- using a vortex embedding method [AIAA PAPER 89-0638] p 296 A89-28443 Vortex dynamics rotorcraft interactional for
- aerodynamics p 297 N89-16726 [AD-A200128]
- VORTICITY Aerodynamic visualization for impulsively started
- p 270 A89-24925 airfoils Flowfield modifications of combustion rates in unstable ramiote
- p 322 A89-25092 [AIAA PAPER 89-0105] Application of continuous vorticity panels three-dimensional lifting flows with partial separation vorticity panels in
- p 275 A89-25104 [AIAA PAPER 89-0117] Navier-Stokes solutions for vortical flows over a
- tangent-ogive cylinde p 281 A89-25284 [AIAA PAPER 89-0337] Direct numerical simulation of compressible free shear
- flows [AIAA PAPER 89-0374] p 283 A89-25317 A numerical study of the contrarotating vortex pair
- associated with a jet in a crossflow p 284 A89-25366 [AIAA PAPER 89-0448]
- Navier-Stokes computations of separated vortical flows past prolate spheroid at incidence p 286 A89-25443 [AIAA PAPER 89-0553]
- The influence of freestream vorticity on particle lift, drag, and heat transfe p 345 A89-25445
- [AIAA PAPER 89-0555] Measurement of transient vortex-surface interaction phenomen
- [AIAA PAPER 89-0833] n 289 A89-25603 Flow visualization investigation of dynamic stall on a pitching airfoil
- p 290 A89-25611 [AIAA PAPER 89-0842] Low-speed vortical flow over a 5-degree cone with tip
- geometry variations p 295 A89-28203 SAE PAPER 8814221
- VORTICITY TRANSPORT HYPOTHESIS Merging of aircraft vortex trails - Similarities to magnetic p 356 A89-26630 field merging

W

WAKES

A-32

- rotorcraft interactional Vortex dvnamics for aerodynamics p 297 N89-16726 [AD-A200128] Wake model for helicopter rotors in high speed flight
- p 301 N89-17577 [NASA-CR-177507] WALL FLOW
- Unsteady wall interference in rotary tests p 273 A89-25040 [AIAA PAPER 89-0046] The effects of walls on a compressible mixing layer p 283 A89-25315 [AIAA PAPER 89-0372] Navier-Stokes simulation of wind-tunnel flow using
- p 291 A89-25864 LU-ADI factorization algorithm Wind tunnel-sidewall-boundary-layer effects in transonic airfoil testing-some correctable, but some not
- p 338 N89-16864 WALL JETS
- Wind tunnel wall boundary layer control by Coanda wall iets
- p 334 A89-25132 [AIAA PAPER 89-0149] WANKEL ENGINES
- Adiabatic Wankel type rotary engine p 330 N89-17599 [NASA-CR-182233]

- WARNING SYSTEMS
- On design and projected use of Doppler radar and low-level windshear alert systems in aircraft terminal operations
 - [AIAA PAPER 89-0704] p 302 A89-25545 Numerical simulation of microburst downdrafts -Application to on-board and look ahead sensor echnology
 - p 353 A89-25599 [AIAA PAPER 89-0821] Sensor consideration in the design of a windshear detection and guidance system
- p 319 A89-28201 [SAE PAPER 881417] WARPAGE
- Some implications of warping restraint on the behavior p 312 A89-27747 of composite anisotropic beams WATER
- Development of a laboratory method for studying water coalescence of aviation fuel p 341 A89-28243
- (SAE PAPER 881534] WFAPON SYSTEMS
- Recoverable test vehicle, an innovative approach to a low cost composite airframe for aerospace application p 311 A89-25320 [AIAA PAPER 89-0378]
- WEAR TESTS
- Ball-on-cylinder testing for aviation fuel lubricity p 341 A89-28244 ISAF PAPER 8815371 WEATHER FORECASTING
- The effects of enroute turbulence reports on air carrier flight operations
- p 303 A89-25557 [AIAA PAPER 89-0741] WEDGE FLOW
- Experimental research of flow separation, heat transfer and ablation on flat plate-wedges in supersonic, turbulent p 292 A89-25938 flow WEDGES
- Droplet impaction on a supersonic wedge -Consideration of similitude
- p 304 A89-25567 [AIAA PAPER 89-0763] WEIGHT ANALYSIS
- Analytical wing weight prediction/estimation using omputer based design techniques p 316 N89-17589 WEST GERMANY
- Activities report in air traffic control
- p 309 N89-17586 FTN-89-93513] WIND EFFECTS
- Analysis of windshear from airline flight data p 332 A89-27734
- WIND MEASUREMENT The effect of a ground-based inversion layer on an
- impacting microburst p 352 A89-25593 [AIAA PAPER 89-0810]
- WIND SHEAR Inertial energy distribution error control for optimal wind shear penetration
- [AIAA PAPER 89-0016] p 331 A89-25012 On design and projected use of Doppler radar and low-level windshear alert systems in aircraft terminal
- p 302 A89-25545 [AIAA PAPER 89-0704] Analysis of extreme wind shear
- p 352 A89-25549 [AIAA PAPER 89-0710] TDWR display experiences --- Terminal Doppler Weather Radar
- p 346 A89-25590 [AIAA PAPER 89-0807] The effect of a ground-based inversion layer on an
- impacting microburst p 352 A89-25593 [AIAA PAPER 89-0810] An unsteady vortex-ring model for microburst simulation
- [AIAA PAPER 89-0811] p 353 A89-25594 Numerical simulation of microburst downdrafts Application to on-board and look ahead sensor chnolog
- [AIAA PAPER 89-0821] p 353 A89-25599 Sensor consideration in the design of a windshear detection and guidance system
- p 319 A89-28201 [SAE PAPER 881417] Overview of optimal trajectories for flight in a windehoor
- p 306 A89-28464 [ALAA 89-0812] Piloted-simulation evaluation of escape guidance for
- microburst wind shear encounters p 321 N89-16820 [NASA-TP-2886]
- WIND TUNNEL APPARATUS The design and development of a dynamic plunge-pitch-roll model mount
- p 334 A89-25042 [AIAA PAPER 89-0048] International Instrumentation Symposium, 34th,
- Albuquerque, NM, May 2-6, 1988, Proceedings p 348 A89-27651 Utilization of wind tunnel instrumentation with software p 335 A89-27654 verifications A microprocessor-based proportional-integral controller
- for hydraulically actuated mechanisms p 335 A89-27655

Miniaturized compact water-cooled pitot-pressure probe for flow-field surveys in hypersonic wind tunnels p 348 A89-27659

WIND TUNNEL CALIBRATION

- Investigation of the flow in the diffuser section of the NASA Lewis Icing Research Tunnel p 336 A89-28455
- [AIAA 89-0755] A critical assessment of wind tunnel results for the NACA p 300 N89-16847
- 0012 airfoil Comparison of the results of tests on A300 aircraft in the RAE 5 metre and the ONERA F1 wind tunnels
 - p 300 N89-16849 Wind tunnel predicted air vehicle performance: A review
- p 337 N89-16852 of lessons learned Development of testing techniques in a large transonic
- wind tunnel to achieve a required drag accuracy and flow standards for modern civil transports p 337 N89-16857
- WIND TUNNEL MODELS.
- Lateral oscillations of sting-mounted models at high aloha
 - p 310 A89-25041 [AIAA PAPER 89-0047]
 - Numerical simulation of viscous transonic flow over the n 291 A89-25863 DFVLR F5 wing
 - Testing on two dimensional vertical models in conventional wind tunnel p 292 A89-259
 - p 292 A89-25939 Euler flow solutions for transonic shock wave-boundary
 - p 295 A89-28074 layer interaction LDV surveys over a fighter model at moderate to high
 - angles of attack p 295 A89-28218 [SAE PAPER 881448]
 - An experimental investigation of the aerodynamic characteristics of slanted base ogive cylinders using magnetic suspension technology
- [NASA-CR-184624] p 300 N89-16758 The accurate measurement of drag in the 8 ft x 8 ft
 - p 337 N89-16855 tunnel WIND TUNNEL TESTS
 - Extended pitch axis effects on flow about a pitching airfoil
 - p 272 A89-25021 [AIAA PAPER 89-0025] Heat transfer and pressure comparisons between computation and wind tunnel for a research hypersonic aircraft
 - p 272 A89-25025 [AIAA PAPER 89-0029] Unsteady wall interference in rotary tests p 273 A89-25040
 - [AIAA PAPER 89-0046] Measurements of a supersonic turbulent boundary layer with mass addition
 - p 344 A89-25119 [AIAA PAPER 89-0135] Flow quality measurements for the Langley 8-foot

cavity on the near-wake flowfield of a body at subsonic

Oscillatory flow field simulation in a blow-down wind

Pressure and heat transfer investigation of a modified

Evaluation of an analysis method for low-speed airfoils

Low speed wind tunnel investigation of the flow about

Flow measurements of an airfoil with single-slotted

Design and development of a compressible dynamic stall

Effect of simulated glaze ice on a rectangular wing

DFVLR-F5 test wing configuration - The boundary value

Simulation of the DFVLR-F5 wing experiment using a

Navier-Stokes calculations for DFVLR F5-wing in wind

Testing on two dimensional vertical models in a

Measurements of the oscillatory lateral derivatives of

a high incidence research model (HIRM 1) at speeds up to M = 0.8 p 332 A89-26688

block structured explicit Navier-Stokes method

tunnel using Runge-Kutta time-stepping scheme

delta wing, oscillating in pitch to very high angle of

comparison with wind tunnel results

NASP baseline configuration at M = 6 --- National

tunnel and the passive shock wave/boundary layer control

p 277 A89-25184

p 278 A89-25188

p 339 A89-25208

p 278 A89-25224

p 281 A89-25252

p 286 A89-25427

p 335 A89-25511

p 303 A89-25560

p 303 A89-25561

p 290 A89-25858

p 291 A89-25866

p 291 A89-25867

p 292 A89-25939

transonic pressure tunnel LFC experiment p 276 A89-25133 AIAA PAPER 89-01501 An experimental investigation of the effects of a base

and transonic speeds

concept

attack

flan

facility

problem

to M = 0.8

[AIAA PAPER 89-0210]

[AIAA PAPER 89-0214]

[AIAA PAPER 89-0246]

AIAA PAPER 89-02661

[AIAA PAPER 89-0295]

[AIAA PAPER 89-0533]

[AIAA PAPER 89-0647]

[AIAA PAPER 89-0750]

[AIAA PAPER 89-0753]

conventional wind tunnel

Prop-fan airfoil icing characteristics

Aero-Space Plane

Low speed aerodynamics of canard configurations p 294 A89-26689 National full-scale aerodynamic complex integrated systems test data system p 335 A89-27653 Software control of a high speed, modular signal conditioner and PCM encoder system p 318 A89-27670 A signal filter with zero phase lag p 336 A89-27674 Investigation of surface water behavior during glaze ice p 304 A89-27739 accretion Effect of sidewall boundary layer on a wing in a wind tunnel p 294 A89-27742 Preliminary test results of NDA cryogenic wind tunnel and its system [SAE PAPER 881449] p 336 A89-28219

Modeling of surface roughness effects on glaze ice accretion [AIAA 89-0734]

p 305 A89-28451 An experimental investigation of multi-element airfoil ice accretion and resulting performance degradation

p 297 A89-28453 [AIAA 89-0752] Investigation of the flow in the diffuser section of the NASA Lewis Icing Research Tunnel

[AIAA 89-0755] p 336 A89-28455 Development of a new subsonic icing wind tunnel p 337 A89-28458 [AIAA 89-0773]

Wind tunnel air intake test techniques p 299 N89-16751 Study of the aerodynamic situation along the C 160 aircraft in parachuting configuration

[DAT-88-06] o 299 N89-16756 An experimental investigation of the aerodynamic characteristics of slanted base ogive cylinders using

magnetic suspension technology [NASA-CR-184624] p 300 N89-16758

Reynolds number effects in transonic flow p 300 N89-16760 [AGARD-AG-303] A critical assessment of wind tunnel results for the NACA

p 300 N89-16847 0012 airfoil Expriments on the DFVLR-F4 wing body configuration

in several European windtunnels p 337 N89-16848 Comparison of the results of tests on A300 aircraft in the RAE 5 metre and the ONERA F1 wind tunnels

p 300 N89-16849 Wind tunnel predicted air vehicle performance: A review of lessons learned p 337 N89-16852

The accurate measurement of drag in the 8 ft x 8 ft p 337 N89-16855 tunnel Accurate drag estimation using a single component drag

p 337 N89-16856 model technique Development of testing techniques in a large transonic

wind tunnel to achieve a required drag accuracy and flow standards for modern civil transports p 337 N89-16857

Precision improvement of transport aircraft drag p 300 N89-16858 measurements

Accuracy of various wall-correction methods for 3D subsonic wind-tunnel testing p 338 N89-16863 Wind tunnel-sidewall-boundary-layer effects in transonic

airfoil testing-some correctable, but some not p 338 N89-16864

Some difficulties in the wind tunnel prediction of modern civil aircraft buffeting: Proposed remedies

p 301 N89-16869 Accuracy requirements for high-speed test with engine simulation on transport aircraft models in the NLR-HST p 338 N89-16870

Balance accuracy and repeatability as a limiting parameter in aircraft development force measurements in conventional and cryogenic wind tunnels

p 338 N89-16873 Accuracy problems in wind tunnels during transport aircraft development p 338 N89-16877

Requirements and capabilities in unsteady windtunnel p 339 N89-16878 testina Particular flight mechanics specifications related to wind

p 339 N89-16879 tunnel test results An experimental investigation of the perpendicular

vortex-airfoil interaction at transonic speeds p 301 N89-17569

The wind tunnels of the national full-scale aerodynamics p 339 N89-18388 WIND TUNNEL WALLS

Unsteady wall interference in rotary tests [AIAA PAPER 89-0046]

AIAA PAPER 89-0046] p 273 A89-25040 Sidewall boundary-layer removal effects on wall adaptation in the Langley 0.3-meter transonic cryogenic tunnel [AIAA PAPER 89-0148] p 334 A89-25131

Wind tunnel wall boundary layer control by Coanda wall

p 334 A89-25132 [AIAA PAPER 89-0149] Emerging technology for transonic wind-tunnel-wall interference assessment and corrections

p 336 A89-28220 [SAE PAPER 881454]

Wind tunnel-sidewall-boundary-layer effects in transonic airfoil testing-some correctable, but some not p 338 N89-16864

NASA SC(2)-0714 airfoil data corrected for sidewall boundary-layer effects in the Langley 0.3-meter transonic cryogenic tunnel

[NASA-TP-2890] p 301 N89-17568 New design of the nozzle section of a large subsonic wind tunnel

[F+W-TF-1926] p 339 N89-17601 WIND TUNNELS

Performance of the forward scattering spectrometer probe in NASA's Icing Research Tunnel

p 346 A89-25570 [AIAA PAPER 89-0769] The wind tunnels of the national full-scale aerodynamics p 339 N89-18388 complex WIND VANES

A free-trailing vane flow direction indicator employing a linear output Hall effect transducer

p 336 A89-27675 WING CAMBER

Aerodynamic performance of wings of arbitrary planform in inviscid, incompressible, irrotational flow [AD-A200436] p 297 N89-16728

WING FLAPS and lonoitudinal Lift forces on

ropeller/nacelle/wing/flap systems p 298 N89-16736 ESDU-880311 WING LOADING

Propeller/wing interaction

[AIAA PAPER 89-0535]

p 311 A89-25429 The effects of aft-loaded airfoils on aircraft trim drag [AIAA PAPER 89-0836] p 312 A89-25605 Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects

p 313 A89-27925 Spanload optimization for strength designed lifting

surfaces [AIAA PAPER 88-2512] p 314 A89-28252

Aeroelastic optimization of a helicopter rotor p 316 N89-16778

WING OSCILLATIONS

Wing rock generated by forebody vortices p 312 A89-27735 WING PANELS

Vibration and flutter analysis of composite wing panels p 346 A89-26273

Free vibration and panel flutter of quadrilateral laminated plates p 347 A89-26274 The design, construction and test of a postbuckled,

carbon fibre reinforced plastic wing box p 315 N89-16773

WING PLANFORMS

Upwind Navier-Stokes solutions for leading-edge vortex flow

[AIAA PAPER 89-0265] p 278 A89-25223 Computational design of low aspect ratio wing-winglets for transonic wind-tunnel testing

[AIAA PAPER 89-0644] p 311 A89-25509 DFVLR-F5 test wing configuration - The boundary value p 290 A89-25858 problem

Simulation of the DFVLR-F5 wing experiment using a block structured explicit Navier-Stokes method p 291 A89-25866

The contribution of planform area to the performance of the BERP rotor --- British Experimental Rotor Programme Riada p 314 A89-28350

WING PROFILES

Scissor wing - An alternative to variable sweep [AIAA PAPER 89-0013] p 310 A89 p 310 A89-25009

Influence of wing geometry on leading-edge vortices and vortex-induced aerodynamics at supersonic speeds [AIAA PAPER 89-0085] p 274 A89-25075 [AIAA PAPER 89-0085]

Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, p 290 A89-25856 Sept. 30-Oct. 2, 1987

DFVLR-F5 test wing experiment for computational p 290 A89-25857 aerodynamics Numerical simulation of viscous transonic flow over the

DFVLR F5 wing p 291 A89-25863 Navier-Stokes calculations for DFVLR F5-wing in wind

tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867

Theoretical investigation for the effects of sweep, leading-edge geometry, and spanwise pressure gradients on transition and wave drag transonic, and supersonic speed with experimental correlations

[SAE PAPER 881484] p 295 A89-28229 Rolling moment derivative Lxi, for plain ailerons at subsonic speeds [ESDU-88013] p 297 N89-16731

WING SPAN

flow visualization and aerodynamic force data evaluation of spanwise blowing on full and half span delta winas

ZIRCONIUM ALLOYS

[AIAA PAPER 89-0192] p 276 A89-25167 WING TIP VORTICES

Influence of wing geometry on leading-edge vortices and ortex-induced aerodynamics at supersonic speeds [AIAA PAPER 89-0085]

AIAA PAPER 89-0085] p 274 A89-25075 Tip vortex/airfoil interaction for a canard//wing configuration at low Reynolds numbers

[AIAA PAPER 89-0536] p 286 A89-25430 Numerical simulation of vortical flows on flexible wings [AIAA PAPER 89-0537] p 286 A89-25431

Dragonfly unsteady aerodynamics - The role of the wing phase relations in controlling the produced flows

[AIAA PAPER 89-0832] p 289 A89-25602 WINGLETS

Computational design of low aspect ratio wing-winglets for transonic wind-tunnel testing [AIAA PAPER 89-0644] p 311 A89-25509

WINGS The intelligent wing - Aerodynamic developments for

future transport aircraft [AIAA PAPER 89-0534] p 269 A89-25428

Propeller/wing interaction [AIAA PAPER 89-0535] p 311 A89-25429

A numerical investigation of the influence of surface roughness on heat transfer in ice accretion p 346 A89-25554 A PAPER 89-0737] [AI

Navier-Stokes simulation of transonic wing flow fields using a zonal grid approach p 290 A89-25862 A numerical method for calculating the low-speed

aerodynamic characteristics of the the strake-wing p 292 A89-25941 configurations

An integral method for calculating turbulent boundary layer flow on practical wings p 292 A89-25942 The development of a capability for aerodynamic testing

of large-scale wing sections in a simulated natural rain environment

[AIAA 89-0762] p 337 A89-28457 Aerodynamic performance of wings of arbitrary planform in inviscid, incompressible, irrotational flow

AD-A200436] p 297 N89-16728 Development of direct-inverse 3-D methods for applied [AD-A200436]

transonic aerodynamic wing design and analysis [NASA-CR-184788] p 300 N89-16761

Vibration and aeroelastic tailoring of advanced composite plate-like lifting surfaces p 351 N89-17263 Analytical wing weight prediction/estimation using computer based design techniques p 316 N89-17589

Typical joints in a wing structure p 317 N89-17693 Test specimens for bearing and by-pass stress interaction in carbon fibre reinforced plastic laminates

p 342 N89-17696

Х

X RAY INSPECTION

Short term developments in non-destructive evaluation applicable to turbine engine parts p 350 N89-17258 X-29 AIRCRAFT

Real-time comparison of X-29A flight data and simulation data ata p 332 A89-27736 X-29A subsystems integration - An example for future ircraft

p 314 A89-28269

p 298 N89-16734

p 341 A89-26361

A-33

Ζ

Thermal conductivity and microstructure stability of heat

YAWING MOMENTS Yawing moment coefficient for plain ailerons at subonic

[ESDU-88029]

ZIRCONIUM ALLOYS

treated AMZIRC copper-based alloys

speeds

[SAE PAPER 881504]

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 240)

June 1989

Δ

Ũ

ĩ

H O

R

Typical Personal Author Index Listing

PERSONAL AUTHOR

BOURNE, SIMON M.

Helicopter roll control effectiveness criteria program summary



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title. Under any one author's name the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

А

ABID, RIDHA

- Prediction of separated transonic wing flows with a non-equilibrium algebraic model [AIAA PAPER 89-0558] p 287 A89-25447
- ABRAMS, ADRIAN A.
- Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study p 270 N89-17564 [AD-A200665]
- ADDY, HAROLD E., JR. Investigation of the flow in the diffuser section of the NASA Lewis Icing Research Tunnel [AIAA 89-0755] p 336 A89-28455
- ADELFANG, STANLEY I. Analysis of extreme wind shear
- [AIAA PAPER 89-0710] p 352 A89-25549 AFFELDT, E.
- Material defects in a PM-nickel-base superalloy p 341 A89-25919

AGARWAL, RAMESH K.

Efficient finite-volume parabolized Navier-Stokes solutions for three-dimensional, hypersonic, chemically reacting flowfields [AIAA PAPER 89-0103] p 274 A89-25090

AGGARWAL, ANIL K. EURONAV - A state of the art military GPS receiver p 340 A89-26711

AHMED. S. A.

- An experimental and computational investigation of isothermal swirling flow in an axisymmetric dump combustor
- [AIAA PAPER 89-0620] p 323 A89-25491 AHN, SEUNGKI
- The design and development of a dynamic plunge-pitch-roll model mount [AIAA PAPER 89-0048] p 334 A89-25042
- AIKAWA, MIKIE
- VERDICT A plan for gravity compensation of inertial navigation systems p 307 A89-26724 AL-KHALIL KAMEL M.
- Thermal analysis of engine inlet anti-icing systems [AIAA PAPER 89-0759] p 311 A89-25565

AL-SHARIF, M. M.

- An experimental study and prediction of a two-phase pressure drop in microgravity [AIAA PAPER 89-0074] p 343 A89-25065
- ALCORN. CHARLES W. An experimental investigation of the aerodynamic
- characteristics of slanted base ogive cylinders using magnetic suspension technology [NASA-CR-184624] p 300 N89-16758
- ALI, M.
- Pattern-based fault diagnosis using neural networks p 354 A89-27602 Hierarchical representation and machine learning from
- faulty jet engine behavioral examples to detect real time p 355 A89-27622 abnormal conditions MLS, a machine learning system for engine fault
- p 355 A89-27623 diagnosis Automatic acquisition of domain and procedural
- p 318 A89-27624 knowledge ANDERSON, BERNHARD H.
- CFD application to subsonic inlet airframe integration p 299 N89-16753 ANDERSON, J. M.
- A cell-vertex multigrid Euler scheme for use with multiblock grids
- p 285 A89-25387 [AIAA PAPER 89-0472] ANDERSON, JOHN D., JR.
- Numerical solutions to three-dimensional shock wave/vortex interaction at hypersonic speeds [AIAA PAPER 89-0674] p 289 A89-25534 ANDERSON, JOSEPH A.
- Agile Fighter Aircraft Simulation [AIAA PAPER 89-0015] p 331 A89-25011
- ANDRISANI, DOMINICK, II Real-time comparison of X-29A flight data and simulation
- data p 332 A89-27736 ANTON, CLAIRE
- Superplastic formed aluminum-lithium aircraft structure [AD-A200245] p 316 N89-17591 p 316 N89-17591 ANTONIEWICZ, ROBERT F.
- The development of an automated flight test management system for flight test planning and p 312 A89-27613 monitoring ARAYA, ROBERTO
- On a distributed parameter model for detecting cracks p 354 A89-25870 in a rotor ARMAND, C.
- Precision improvement of transport aircraft drag p 300 N89-16858 measurements ARNAL, D.
- Stability and transition of two-dimensional laminar boundary layers in compressible flow over an adiabatic p 270 A89-24922 Boundary laver transition and turbulence modelling in three-dimensional flow p 346 A89-25860
- ARNTZ, NEIL Condor for high altitudes p 269 A89-26674
- ARTHUR. M. T. A cell-vertex multigrid Euler scheme for use with

multiblock grids [AIAA PAPER 89-0472] p 285 A89-25387

- ARZT. E.
- Material defects in a PM-nickel-base superalloy p 341 A89-25919 ASHBY, GEORGE C.
- Miniaturized compact water-cooled pitot-pressure probe for flow-field surveys in hypersonic wind tunnel
- p 348 A89-27659 ASHBY. M. J.
- Military engine monitoring status at GE Aircraft Engines, Cincinnati, Ohio p 320 N89-16798 ASHILL, P. R.
- Expriments on the DFVLR-F4 wing body configuration in several European windtunnels p 337 N89-16848 ASHWORTH, D. A.
- Measurement and modelling of turbulent spot growth on a gas turbine blad [AIAA PAPER 89-0328] p 281 A89-25276
- ASLUND, CHRISTER A new technique for the production of gas atomized
- powder p 340 A89-25902

ATASSI, H. M.

- Modification of compressible turbulent boundary layer structures by streamlined devices [AIAA PAPER 89-0212] p 277 A89-25186
- AULEHLA, F. Intake swirl and simplified methods for dynamic pressure
- p 299 N89-16742 distortion assessment

B

BABCOCK, MICHAEL R.

- Numerical simulation of microburst downdrafts Application to on-board and look ahead sensor technology [AIAA PAPER 89-0821] p 353 A89-25599
- BABU. B. J. C. Free vibration and panel flutter of guadrilateral laminated
- p 347 A89-26274 plates BACH. R. E., JR.
- Analysis of windshear from airline flight data p 332 A89-27734 BADGLEY, P.
- Adiabatic Wankel type rotary engine [NASA-CR-182233] p 330 N89-17599
- BAGLIO, V. P. Real-time simulation for survivable penetration
- [SAE PAPER 881515] p 333 A89-28236 BAHRI, ZOUHIR
- Phase-only filters with improved signal to noise ratio p 356 A89-28382

BAILEY, J. E.

- Inertial energy distribution error control for optimal wind shear penetration [AIAA PAPER 89-0016]
- p 331 A89-25012 BAIRSTO, N. A.
- Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 BAKER, A. J.
- Progress on a Taylor weak statement finite element algorithm for high-speed aerodynamic flows p 289 A89-25517 [AIAA PAPER 89-0654]
- BAKER, D. E. Parallel operation of VSCF electrical power generators
- [SAE PAPER 881410] p 324 Å89-28259 BALL, C. L.
- The design and development of transonic multistage compressors p 329 N89-16834 p 330 N89-16837 Supersonic throughflow fans
- BAMPTON, C. C. Superplastic formed aluminum-lithium aircraft structure
- p 316 N89-17591 (AD-A2002451 BANDYOPADHYAY, G.
- Low speed aerodynamics of canard configurations p 294 A89-26689 **BAO, HANLING**
- An integral method for calculating turbulent boundary layer flow on practical wings p 292 A89-25942
- BARATA, J. M. M. Numerical study of single impinging jets through a
- crossflow [AIAA PAPER 89-0449] p 284 A89-25367
- BARBATO, GREGORY J.
- Mechanization, design and methodological lessons learned from a dynamic cockpit mock-up evaluation [SAE PAPER 881438] p 319 A89-28213
- BARREAU, R.
- Some difficulties in the wind tunnel prediction of modern civil aircraft buffeting: Proposed remedies p 301 N89-16869

BARTH, TIMOTHY J.

- Application of direct solvers to unstructured meshes for the Euler and Navier-Stokes equations using upwind schemes
- [AIAA PAPER 89-0364] p 283 A89-25308 The design and application of upwind schemes on unstructured meshes
- [AIAA PAPER 89-0366] p 354 A89-25310 BASS, R. W. Thermal-energy management for air breathing hyper-velocity vehicles
 - [AIAA PAPER 89-0183] p 310 A89-25158

BASSETT, DUANE E.

Application of a Comprohensive		
Rotor Aerodynamics and Dynamics	Analytic: (CAMR	al Model of AD) to the
McDonnell Douglas AH-64A helicopte	er.	
[NASA-CR-177455]	p 301	N89-17578
Navier-Stokes solutions about the F	/A-18 fo	rebody-LEX
configuration	o 281	A89-25285
BATILL, S. M.	P 2 0 1	
The separated flow field on a slend transient pitching motions	der wing	undergoing
[AIAA PAPER 89-0194]	p 276	A89-25169
BATINA, JOHN T. Unsteady Fuler airfoil solutions	usina (instructured
dynamic meshes	uonigi	
[AIAA PAPER 89-0115] Lipsteady transonic algorithm impro	p 275 vements	A89-25102 for realistic
aircraft applications	p 312	A89-27738
BATTERSON, J. G. Determination of longitudinal aero	dvnamic	derivatives
using flight data from an icing research	ch aircra	ft
[AIAA 89-0754] BAUER J	p 333	A89-28454
Mechanism of single shear fastene	d joints	
	p 352	N89-17700
Real-time comparison of X-29A fligh	t data an	d simulation
data BALIER KENNETH G	p 332	A89-27736
National lightning detection - A re	al-time	service to
aerospace	n 352	A89-25578
BAUER, STEVEN X. S.	P 002	
Influence of wing geometry on leadin	ng-edge i rsonic s	vortices and
[AIAA PAPER 89-0085]	p 274	A89-25075
BAUWENS, L.	e in a m	odel ramiet
combustor - The nature of frequency	selectio	n
[AIAA PAPER 89-0623]	p 323	A89-25493
Adaptive computations of multisper	cies mixi	ng between
scramjet nozzle flows and hypersonic	freestre	am
BAYSAL OKTAY	POLL	100 20000
A multigrid and upwind viscous	flow so	lver on 3-D
[AIAA PAPER 89-0464]	p 285	A89-25379
BEALS, M.		t a aitabiaa
Extended pitch axis effects on tic airfoil	w abou	t a pitching
[AIAA PAPER 89-0025]	p 272	A89-25021
BEAM, JERRY E. Topics of aircraft thermal managen	nent	
[SAE PAPER 881381]	p 314	A89-28255
BECK, J. Airblast atomization at conditions	of low	air velocitv
[AIAA PAPER 89-0217]	р 344	A89-25191
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv	p 344 ersion la	A89-25191
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst	p 344 ersion la	A89-25191 ayer on an
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810]	p 344 ersion la p 352	A89-25191 ayer on an A89-25593
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil	p 344 ersion la p 352 ity of ND	A89-25191 ayer on an A89-25593 I techniques
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p	p 344 ersion la p 352 ity of ND prediction	A89-25191 ayer on an A89-25593 I techniques n of turbine
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T.	p 344 ersion la p 352 ity of ND prediction p 350	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Lasere communication test system	p 344 ersion la p 352 ity of ND prediction p 350	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BETHACHML DRISS	p 344 ersion 1a p 352 ity of ND prediction p 350 p 349	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest	p 344 ersion la p 352 ity of ND prediction p 350 p 349 gation o	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction	p 344 ersion la p 352 ity of ND prediction p 350 p 349 gation o er inter	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357]	p 344 ersion la p 352 ity of ND prediction p 350 p 349 gation o er inter p 296	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical investi shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary convar, Benefite of disit	p 344 ersion 1a p 352 ity of ND prediction p 350 p 349 gation o er inter p 296	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical investi shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digita management system integration	p 344 ersion la p 352 ity of ND prediction p 350 p 349 gation o er inter p 296 al control	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digita management system integration [SAE PAPER 881499] BENSON	p 344 ersion 1a p 352 ity of ND prediction p 350 p 349 gation o er inter p 296 al control p 325	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle A89-28264
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digite management system integration [SAE PAPER 801498] BENSON, THOMAS J. CFD application to supersonic/hyp	p 344 ersion 14 p 352 ity of ND prediction p 350 p 349 gation o er inter p 296 al control p 325 ersonic i	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle A89-28264 nlet airframe
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digite management system integration [SAE PAPER 89-1498] BENSON, THOMAS J. CFD application to supersonic/hyp integration	p 344 ersion 14 p 352 ity of ND prediction p 350 p 349 gation o er inter p 296 al control p 325 ersonic in p 299	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle A89-28264 niet airframe N89-16754
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digite management system integration [SAE PAPER 89-0353] BENSON, THOMAS J. CFD application to supersonic/hyp integration BERGER, J. Some difficulties in the wind tunnel	p 344 ersion la p 352 ity of ND orediction p 350 p 349 gation o er inter p 296 al control p 325 ersonic li p 299 predictic	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle A89-28264 niet airframe N89-16754 on of modern
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digita management system integration [SAE PAPER 881498] BENSON, THOMAS J. CFD application to supersonic/hyp integration BERGER, J. Some difficulties in the wind tunnel civil aircraft buffeting: Proposed remo	p 344 ersion la p 352 ity of ND orediction p 350 p 349 gation o er inter p 296 at control p 325 ersonic in p 299 prediction	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle A89-28264 niet airframe N89-16754 on of modern
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digita management system integration [SAE PAPER 881498] BENSON, THOMAS J. CFD application to supersonic/hyp integration BERGER, J. Some difficulties in the wind tunnel civil aircraft buffeting: Proposed remo	p 344 ersion la p 352 ity of ND orediction p 350 p 349 gation o er inter p 296 al control p 325 ersonic li p 299 predictico adies p 301	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17215 f an oblique action with A89-28407 and vehicle A89-28264 niet airframe N89-16754 on of modern N89-16869
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digita management system integration [SAE PAPER 881498] BENSON, THOMAS J. CFD application to supersonic/hyp integration BERGER, J. Some difficulties in the wind tunnel civil aircraft buffeting: Proposed remo	p 344 p 352 ity of ND p 352 ity of ND prediction p 349 gation o er inter p 296 al control p 325 ersonic in p 299 prediction odies p 301 effects of	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17215 f an oblique action with A89-28407 and vehicle A89-28264 nlet airframe N89-16754 on of modern N89-16869 on glaze ice
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digita management system integration [SAE PAPER 881498] BENSON, THOMAS J. CFD application to supersonic/hyp integration BERGER, J. Some difficulties in the wind tunnel civil aircraft buffeting: Proposed remu BERKOWITZ, BRIAN Modeling of surface roughness accretion [AIAA 89-07341]	p 344 p 352 ity of ND p 352 ity of ND prediction p 349 gation o er inter p 296 al control p 325 ersonic in p 299 prediction odies p 301 effects of p 305	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle A89-28264 mot airframe N89-16754 on of modern N89-16869 on glaze ice A89-28451
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/turbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digita management system integration [SAE PAPER 881498] BENSON, THOMAS J. CFD application to supersonic/hyp integration BERGER, J. Some difficulties in the wind tunnel civil aircraft buffeting: Proposed remu BERKOWITZ, BRIAN Modeling of surface roughness accretion [AIAA 89-0734] BERKOWITZ, BRIAN M.	p 344 p 352 ity of ND p 352 ity of ND prediction p 349 gation o er inter p 296 al control p 325 ersonic in p 299 prediction odies p 301 effects of p 305	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle A89-28264 mot airframe N89-16754 on of modern N89-16869 on glaze ice A89-28451
[AIAA PAPER 89-0217] BEDARD, A. J., JR. The effect of a ground-based inv impacting microburst [AIAA PAPER 89-0810] BELLINGER, N. Importance of sensitivity and reliabil on damage tolerance based life p discs BENGUHE, P. T. Laser communication test system [AD-A199612] BENHACHMI, DRISS Experimental and numerical invest shock wave/lurbulent boundary lay continuous suction [AIAA PAPER 89-0357] BENSON, JAMES M. Secondary power - Benefits of digita management system integration [SAE PAPER 881498] BENSON, THOMAS J. CFD application to supersonic/hyp integration BERGER, J. Some difficulties in the wind tunnel civil aircraft buffeting: Proposed remus BERKOWITZ, BRIAN Modeling of surface roughness accretion [AIAA 89-0734] BERKOWITZ, BRIAN M. An experimental investigation of mage	p 344 p 352 ity of ND p 352 ity of ND prediction p 349 gation o er inter p 296 at control p 325 ersonic in p 299 prediction odies p 301 effects of p 305 ulti-elem	A89-25191 ayer on an A89-25593 I techniques n of turbine N89-17257 N89-17215 f an oblique action with A89-28407 and vehicle A89-28264 nlet airframe N89-16754 on of modern N89-16869 on glaze ice A89-28451 ent airfoil ice tion

[AIAA 89-0752]

BERMINGHAM, E.

Stability	of	3D	wing	boundary	layer	on	а	SST	
configuratio	n	~~ ~			- 070	•	~ ~	5004	
[AIAA PAP	EH	89-00)36 J		p 2/2	AS	9-2	5031	
REPRIER R	ORF	IV F							

- Results from NASA Langley experimental studies of multiaxis thrust vectoring nozzles [SAE PAPER 881481] p 324 A89-28228
- BERTELRUD, A. Flow measurement on the fuselage of a Boeing 737
- airplane p 295 A89-28404 [AIAA PAPER 89-0209]
- BEYERS, MARTIN E.
- Unsteady wall interference in rotary tests p 273 A89-25040 [AIAA PAPER 89-0046]
- BEZOS, GAUDY M. The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment
- p 337 A89-28457 [AIAA 89-0762] BHAUMIK, PRADEEP K. Building aircraft assembly tools from a 3-D database [SAE PAPER 881428] p 269 A89-28204 BHUTTA, BILAL A.
- Prediction of supersonic/hypersonic viscous flows over RVs and decoys
- p 272 A89-25024 [AIAA PAPER 89-0028] Large-angle-of-attack viscous hypersonic flows over complex lifting configurations [AIAA PAPER 89-0269] p 279 A89-25227 Nonequilibrium viscous hypersonic flows over ablating Teflon surfaces p 293 A89-26368
- [AIAA PAPER 89-0314] BIHARI, B. L. F-14 flow field simulation [AIAA PAPER 89-0642] p 296 A89-28444
- BILANIN, ALAN J. Problems in understanding aircraft icing dynamics
- [AIAA PAPER 89-0735] p 302 A89-25553 BILLIG, F. S.
- Combined tangential-normal injection into a supersonic flow p 288 A89-25492 [AIAA PAPER 89-0622]
- BILLIG. FREDERICK S. Modular analysis of scramjet flowfields p 325 A89-28337
- BINION, T. W., JR. Reynolds number effects in transonic flow
- p 300 N89-16760 [AGARD-AG-303] BITER. CLEON
- TDWR display experiences p 346 A89-25590 [AIAA PAPER 89-0807] BLACODON, D.
- Source localization technique for impulsive multiple p 356 A89-27741 sources BLAIR, MICHAEL F.
- Measurement of airfoil heat transfer coefficients on a turbine stage p 351 N89-17311 BLAKER, JIM
- Transport airplane fuselage section longitudinal impact test
- p 305 A89-28189 [SAE PAPER 881377] BLANCHARD, ROBERT C. Three-dimensional flow simulation about the AFE vehicle
- in the transitional regime [AIAA PAPER 89-0245] p 278 A89-25207
- BLAYLOCK, T. A cell-vertex multigrid Euler scheme for use with multiblock grids [AIAA PAPER 89-0472]
- p 285 A89-25387 BLISS, DONALD B.
- Vortex dynamics for rotorcraft interactional aerodynamics p 297 N89-16726 [AD-A200128]
- BLOM, HENK A. P. An alternative method to solve a variational inequality
- applied to an air traffic control example p 354 A89-26196
- BOBBITT, P. J. Theoretical investigation for the effects of sweep, leading-edge geometry, and spanwise pressure gradients on transition and wave drag transonic, and supersonic speed with experimental correlations
- [SAE PAPER 881484] p 295 A89-28229 BOBO, STEPHEN N.
- Comparative tests of aircraft radial and bias ply tires p 313 A89-28178 [SAE PAPER 881359] BOGAR, T. J.
- normal-shock/turbulent-boundary-layer Confined interaction followed by an adverse pressure gradient [AIAA PAPER 89-0354] p 282 A89-25299 [AIAA PAPER 89-0354] BOGDONOFF, S. M.
- An exploratory study of corner bleed on a fin generated three-dimensional shock wave turbulent boundary layer interaction [AIAA PAPER 89-0356] p 282 A89-25301

PERSONAL AUTHOR INDEX BOGOIAN, JEFFREY C.

Prediction of 3D multi-stage turbine flow field using a multiple-arid Euler solver [AIAA PAPER 89-0203] p 277 A89-25178 BÒND, LEONARD J. Review of existing NDT technologies and their p 349 N89-17255 capabilities BOND, T. H. Determination of longitudinal aerodynamic derivatives using flight data from an icing research aircraft [AIAA 89-0754] p 333 A89-28454 BORIS, J. P. Computational studies of a localized supersonic shear layer [AIAA PAPER 89-0125] p 275 A89-25110 Effects of energy release on high-speed flows in an axisymmetric combustor p 283 A89-25326 [AIAA PAPER 89-0385] Acoustic-vortex interactions and low-frequency oscillations in axisymmetric combustors p 325 A89-28336 BOYD, L. S. Prop-fan airfoil icing characteristics [AIAA PAPER 89-0753] p 303 A89-25561 BRABBS, THEODORE A. Experimental verification of the thermodynamic properties for a jet-A fuel [NASA-TM-101475] p 342 N89-17017 BRADSHAW, P. Vortex/boundary layer interactions [AIAA PAPER 89-0083] p 273 A89-25073 BRAGG, M. B. Effect of simulated glaze ice on a rectangular wing [AIAA PAPER 89-0750] p 303 A89-25560 BREUGELMANS, F. A. E. Variable geometry in supersonic compressors p 330 N89-16838 Axial supersonic inlet compound p 330 N89-16839 BREWSTER, L. T. Aircraft vertical profile implementation usina p 332 A89-25683 directed-graph methods BRIESSMANN, NORBERT GPS antenna problems for military aircraft p 309 A89-28297 BRITCHER, COLIN An experimental investigation of the aerodynamic characteristics of slanted base ogive cylinders using magnetic suspension technology p 300 N89-16758 [NASA-CR-184624] BRITTON, RANDALL K. Elevator deflection effects on the icing process [AIAA PAPER 89-0846] p 290 A89 p 290 A89-25615 BROEDE, J. Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring system p 320 N89-16789 BROOKS, CUYLER W., JR. Flow quality measurements for the Langley 8-foot transonic pressure tunnel LFC experiment [AIAA PAPER 89-0150] p 27 p 276 A89-25133 BROOKS, W. G. The design, construction and test of a postbuckled, carbon fibre reinforced plastic wing box p 315 N89-16773 BROWN, CHRISTOPHER K. Computational design of low aspect ratio wing-winglets for transonic wind-tunnel testing [AIAA PAPER 89-0644] p 311 A89-25509 BROWN, P. C. Prop-fan structural results from PTA tests [SAE PAPER 881418] p 324 A89-28202 BROWN, PHILIP W. Cockpit display of ground-based weather data during thunderstorm research flights [AIAA 89-0806] p 269 A89-28463 BRUCE, ROBERT A. A solution to water vapor in the National Transonic Facility [AIAA PAPER 89-0152] p 334 A89-25135 BRUMBAUGH, RANDAL W. The development of an automated flight test management system for flight test planning and p 312 A89-27613 monitoring BRUTTOMESSO, R. I. Local buckling and crippling of thin-walled composite structures under axial compression p 341 A89-27733 BUCCI. R. J. Aluminum quality breakthrough for aircraft structural reliability p 348 A89-27745 BUFFUM, DANIEL H. Experimental investigation of transonic oscillating

cascade aerodynamics [AIAA PAPER 89-0321] p 293 A89-26369

BURGSMUELLER, W.

Accuracy requirements for high-speed test with engine simulation on transport aircraft models in the NLR-HST p 338 N89-16870

BURKE, R. W.

Computation of turbulent incompressible wing-body junction flow

[AIAA PAPER 89-0279] p 310 A89-25236 BURKE. S.

The Honeywell/DND helicopter integrated navigation p 308 A89-26741 system (HINS)

BURKITT, G. P. Test specimens for bearing and by-pass stress interaction in carbon fibre reinforced plastic laminate p 342 N89-17696

BURNETT, T. S. A signal filter with zero phase lag p 336 A89-27674

BUSSING, THOMAS R. A. A model for 3-D sonic/supersonic transverse fuel

njection into a supersonic air stream p 345 A89-25376 [AIAA PAPER 89-0460]

- BUTLER, E. G. Engineering ceramics - Applications and testing puirements p 347 A89-27632 requirements
- BYRD. JAMES E. Influence of wing geometry on leading-edge vortices and vortex-induced aerodynamics at supersonic speeds

p 274 A89-25075 [AIAA PAPER 89-0085]

С

- CAIAFA, CAESAR A.
- Effects of aircraft size on cabin floor dynamic pulses SAE PAPER 881379] p 305 A89-28191 CALICO, ROBERT A.
- An analysis of lateral-directional handling qualities and eigenstructure of high performance aircraft
- p 331 A89-25013 [AIAA PAPER 89-0017] CALLAHAN, CYNTHIA B.
- Application of a Comprehensive Analytical Model of Rotor Aerodynamics and Dynamics (CAMRAD) to the McDonnell Douglas AH-64A helicopter
- p 301 N89-17578 [NASA-CR-177455] CALLINAN, R. J.
- Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925
- CALMON, J.
- Combined propulsion for hypersonic and space p 322 A89-24917 ehicles CAMAREO, RICARDO
- Finite element simulation of 3D turbulent free shear p 294 A89-26946
- CAMARERO, RICARDO
- Passage-averaged Navier-Stokes equations with finite element applications
- [AIAA PAPER 89-0208] p 344 A89-25183 CAMBELL, BRYAN A.
- The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment
- p 337 A89-28457 AIAA 89-07621 CAMPBELL, JAMES F.
- An interactive three-dimensional boundary-layer method for transonic flow over swept wings [AIAA PAPER 89-0112] p 274 A89-25099

CANNON, MARK R.

- Discussion of transport passenger seat performance characteristics
- p 305 A89-28190 SAE PAPER 8813781 CANTWELL, BRIAN J.
- The effect of Mach number on the stability of a plane supersonic wave
- [AIAA PAPER 89-0285] p 280 A89-25242 CÀO, QIPENG
- Computation for supersonic and turbulent separated flow p 292 A89-25931 over a compression corner CAPLOT, M.
- Source localization technique for impulsive multiple p 356 A89-27741 sources CAPPS, D. S.
- The accurate measurement of drag in the 8 ft x 8 ft p 337 N89-16855 tunnel CAPRIOTTI. D.
- Infrared thermography in blowdown and intermittent hypersonic facilities
- AIAA PAPER 89-00421 p 334 A89-25036 CARADONNA, F. X.
- The free-wake prediction of rotor hover performance using a vortex embedding method p 296 A89-28443 TAIAA PAPER 89-06381
- CAREY. G. F. Conflicting stepsize requirements for stable PNS
- computations [AIAA PAPER 89-0445] p 284 A89-25363

CARLISLE, CHERIANNE

- V/STOL aircraft and the problem of jet-induced suckdown p 317 N89-18380 CARLSON, LELAND A.
- Determination of aerodynamic sensitivity coefficients in the transonic and supersonic regimes
- p 286 A89-25426 [AIAA PAPER 89-0532] Development of direct-inverse 3-D methods for applied transonic aerodynamic wing design and analysis [NASA-CR-184788] p 300 N89-16761
- CAROL. M. Study of the aerodynamic situation along the C 160
- ircraft in parachuting configuration [DAT-88-06] n 299 N89-16756
- CARPENTER, P. W. Subcritical swirling flows in convergent, annular
- p 323 A89-27694 nozzles CARR. L. W.
- An interactive boundary-layer procedure for oscillating airfoils including transition effects p 271 A89-25016 [AIAA PAPER 89-0020]
- Flow visualization studies of the Mach number effects on the dynamic stall of an oscillating airfoil
- p 271 A89-25019 [AIAA PAPER 89-0023] Design and development of a compressible dynamic stall facility
- [AIAA PAPER 89-0647] p 335 A89-25511 CARROLL BRUCE F.
- An LDV investigation of a multiple normal shock
- vave/turbulent boundary layer interaction p 282 A89-25300 [AIAA PAPER 89-0355] CARTER. E. C.
- Development of testing techniques in a large transonic wind tunnel to achieve a required drag accuracy and flow standards for modern civil transports p 337 N89-16857
- CARTER, THOMAS J.
- Performance testing of an electrically actuated aircraft braking system
- [SAE PAPER 881399] p 313 A89-28194 CASSIE, A. M.
- Accurate drag estimation using a single component drag p 337 N89-16856 model technique CAUGHEY, D. A.
- Diagonal implicit multigrid calculation of inlet flowfields p 294 A89-27716
- CEBECI, TUNCER An interactive boundary-layer procedure for oscillating airfoils including transition effects
- TAIAA PAPER 89-00201 p 271 A89-25016 CELENLIGIL, M. CEVDET
- Three-dimensional flow simulation about the AFE vehicle in the transitional regime
- [AIAA PAPER 89-0245] p 278 A89-25207 CELIK. ZEKI Z.
- Flow measurements of an airfoil with single-slotted
- [AIAA PAPER 89-0533] p 286 A89-25427 CEMAN, DAVID L.
- A study of turbomachine flow velocities p 346 A89-25608 [AIAA PAPER 89-0839]
- CENKO, A.
- IFM applications to cavity flowfield predictions [AIAA PAPER 89-0477] p 285 A89-25390 CHADERJIAN, NEAL M. Navier-Stokes simulation of transonic wing flow fields sing a zonal grid approach p 290 A89-25862
- using a zonal grid approach CHAKRAVARTHY, S. R.
- E-14 flow field simulation [AIAA PAPER 89-0642] p 296 A89-28444
- CHAMIS, CHRISTOS C. Composite mechanics for engine structures
- p 341 A89-28344 CHAMPAGNE, G. A.
- Performance potential of air turbo-ramiet employing supersonic through-flow fan
- p 322 A89-25006 (AIAA PAPER 89-00101 CHANDLER, RICHARD F.
- Measurement of dynamic reactions in passenger seat legs
- [SAE PAPER 881376] p 305 A89-28188 CHANDRA, RAMESH
- Finite element analysis of composite rudder for DO 228 aircraft p 347 A89-26284 CHANDRASEKHARA, M. S.
- Flow visualization studies of the Mach number effects on the dynamic stall of an oscillating airfoil
- [AIAA PAPER 89-0023] p 271 A89-25019 Design and development of a compressible dynamic stall facility [AIAA PAPER 89-0647] p 335 A89-25511
- CHANG, CHAU-LYAN Viscous swirling nozzle flow [AIAA PAPER 89-0280] p 279 A89-25237

CHANG, SHYANG

CHEN, OING

CHEN. WUFAN

CHERNYSHENKO, S. I.

CHIANG, HSIAO-WEI D.

[AIAA PAPER 89-0289]

[AIAA PAPER 89-0526]

[AIAA PAPER 89-0197]

[AIAA PAPER 89-0493]

[SAE PAPER 881431]

[SAE PAPER 881432]

[AIAA PAPER 89-0323]

[AIAA PAPER 89-0003]

[AIAA PAPER 89-0048]

plunge-pitch-roll model mount

CHOI, KWANG-YOON

[NASA-CR-183178]

STOVL propulsion system sizing

CHIANG, TING-LUNG

shock structure

CHIAPPETTA, L. M.

CHILES, HARRY R.

CHIN. JU-SHAN

CHIN, S. B.

CHIN. Y. T.

CHOI. D.

CHOI, K. Y.

16-26

CHOU. S.-T.

at large Reynolds numbers

flow

CHETAIL, P.

flow

Active control of aeroelastic systems governed by functional differential equations p 332 A89-25871 CHANG. T. S.

CHOU, S.-T.

- Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic flows
- p 287 A89-25451 [AIAA PAPER 89-0562] CHAUMETTE, DANIEL
- Bolted scarf joints in carbon composite materials. Comparison between assemblies with an interference fit p 343 N89-17702 and those with play
- CHAWLA, KALPANA Vortical flows past normal plate and spoiler of time
- dependent height p 280 A89-25248 [AIAA PAPER 89-0291]
- CHEN, D.
- IFM applications to cavity flowfield predictions [AIAA PAPER 89-0477] p 285 A89-25390 CHEN. D. R.
- Investigation of internal singularity methods for p 294 A89-27748 multielement airfoils
- CHEN. I. Y. An experimental study and prediction of a two-phase essure drop in microgravity
- [AIAA PAPER 89-0074] p 343 A89-25065 CHEN, JACQUELINE H.
- The effect of Mach number on the stability of a plane supersonic wave
- [AIAA PAPER 89-0285] p 280 A89-25242 CHEN. L. T.
- A transonic computational method for an aft-mounted nacelle/pylon configuration with propeller power effect [AIAA PAPER 89-0560] p 311 A89-25449

An effective modeling method of unsteady aerodynamics

Derivation of an integral equation for large disturbing

Asymptotics of stationary separated flow past a body

The CFM 56-5 on the A-320 at Air France

Oscillating aerodynamics and flutter

aerodynamically detuned cascade in an incompressible

Effect of dynamic changes in body configuration on

Estimates of oxides of nitrogen formed in an inlet air

The design and use of a temperature-compensated

Experimental and analytical study on exit radial

Turbulent mixing in supersonic combustion systems [AIAA PAPER 89-0260] p 323 A89-25218

Conceptual design of a STOVL fighter/attack aircraft

Considerations of control authority requirements in

Computations of 3D viscous flows in rotating turbomachinery blades

Hypersonic scramjet inlet flow investigations, M1 =

The design and development of a dynamic

Helicopter tail rotor blade-vortex interaction noise

temperature profile of experimental 2D combustor

hot-film anemometer system for boundary-layer flow

stream for high Mach number flight conditions

transition detection on supersonic aircraft

p 293 A89-25944

p 293 A89-26163

p 320 N89-16793

p 280 A89-25246

p 285 A89-25421

p 277 A89-25172

p 318 A89-27668

p 340 A89-25403

p 323 A89-25218

p 313 A89-28206

p 313 A89-28207

p 281 A89-25273

p 270 A89-25002

p 334 A89-25042

p 356 N89-18167

B-3

of

for state-space aeroelastic models p 293 A89-25946

transonic flow and its numerical method of undercritica

CHOW, CHUEN-YEN

CHOW. CHUEN-YEN		
Vortical flows past normal plate a	nd spoil	er of time
[AIAA PAPER 89-0291]	p 280	A89-25248
Low-speed vortical flow over a 5-de	egree co	ne with tip
geometry variations [SAE PAPER 881422]	p 295	A89-28203
CHU, LI-CHUAN Integral equation solution of the full	potentia	al equation
for transonic flows	n 287	A89-25452
CHUANG, H. ANDREW	p 201	
delta wing at high incidence	ons past	oscillating
[AIAA PAPER 89-0081] CHUPP. R. E.	p 273	A89-25071
Influence of vane/blade spacing and heat-flux distributions	d injectio p 325	n on stage A89-28342
CHYU, M. K. Influence of clearance leakage on the	urbine he	at transfer
at and near blade tips - Summary of re [AIAA PAPER 89-0327]	ecent res p 344	sults A89-25275
Development of a panel meth	od for	modeling
configurations with unsteady component	ent motic	ons, phase
CLARK, RICHARD H.	p 315 I	10775
An investigation of the physical an affecting the performance of fuels in the	d chemi ie JFTO	cal factors
[SAE PAPER 881533]	р 341	A89-28242
Properties of aircraft tire materials		
[SAE PAPER 881358] CLINE, D. D.	р 313	A89-28177
Conflicting stepsize requirements computations	for st	able PNS
(AIAA PAPER 89-0445)	p 284	A89-25363
Flow quality measurements for	the Lang	gley 8-foot
[AIAA PAPER 89-0150]	p 276	A89-25133
COBLEY, GEORGE A. The emergence of satellite c	ommunia	ation for
commercial aircraft	D 308	A89-28183
COLLIER, ARNOLD S.	lont hou	ndan lavor
with mass addition		
[AIAA PAPER 89-0135] COLLINS, EDWARD	р 344	A89-25119
X-29A subsystems integration - An aircraft	example	for future
[SAE PAPER 881504]	p 314	A89-28269
Evaluation of leading- and trailing-ed	ge flaps	on flat and
cambered delta wings at supersonic s [AIAA PAPER 89-0027]	peeds p 272	A89-25023
CONNER, H. Measurements of gas turbine com	bustor a	nd enaine
augmentor tube sooting characteristic	s n 328	N89-16821
CORKER, KEVIN		
Integrating causal reasoning at abstraction	p 355	t levels of A89-27609
CORNWELL, DON S.	viation	- A pilot
viewpoint	0.252	APD 29461
CORPENING, GRIFFIN	p 353 .	A03-20401
Numerical solutions to three-d wave/vortex interaction at hypersonic	imensior speeds	nal shock
[AIAA PAPER 89-0674]	p 289	A89-25534
Supersonic sudden-expansion flow	with fluic	l injection -
[AIAA PAPER 89-0389]	p 284	A89-25328
COSTIGAN, MICHAEL J. An analysis of lateral-directional ha	ndling qu	ualities and
eigenstructure of high performance ai	rcraft p 331	A89-25013
COULTER, L. J.	, 	breathing
hyper-velocity vehicles	ur ann	Jieauning
[AIAA PAPER 89-0183] COUSTEIX, J.	p 310	A89-25158
Boundary layer transition and turbut	Jence m p 346	A89-25860
COVELL, PETER F. Flow-field characteristics and porma	al-force o	correlations

for delta wings from Mach 2.4 to 4.6 p 272 A89-25022 [AIAA PAPER 89-0026]

CRAIG, ANTHONY P. Spanload optimization for strength designed lifting surfaces [AIAA PAPER 88-2512] p 314 A89-28252 CRANDALL, S. H. Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 CRAWFORD, DAVID B. Real-time comparison of X-29A flight data and simulation p 332 A89-27736 data CRONIN, MICHAEL J. The all electric airplane revisited [SAE PAPER 881407] p 314 A89-28256 CROSS, JEFFREY L. Tip aerodynamics and acoustics test: A report and data survey [NASA-RP-1179] p 302 N89-17579 CROUSE, GILBERT L., JR. A state-space model of unsteady aerodynamics in a compressible flow for flutter analyses [AIAA PAPER 89-0022] p 271 A89-25018 CROXFORD, JOHN E. Zonal modelling of flows through multiple inlets and nozzles p 271 A89-25003 [AIAA PAPER 89-0005] CUE, ROBERT W. Canadian forces aircraft condition/health monitoring: p 326 N89-16784 Policy, plans and experience CF-18 engine performance monitoring p 326 N89-16787 CUMMINGS, RUSSELL M. Numerical simulation of high-incidence flow over the F-18 fuselage forebody p 282 A89-25286 [AIAA PAPER 89-0339] CUNDIFF, PATRICIA A. Applying evidential reasoning troubleshooting p to avionics p 355 A89-27629 CURREY, NORMAN S. Aircraft landing gear design: Principles and practices p 312 A89-26950 CUTLER, A. D. Vortex/boundary layer interactions p 273 A89-25073 [AIAA PAPER 89-0083] CUTLER, ANDREW D. Diverging boundary layers with zero streamwise pressure gradien [AIAA PAPER 89-0134] p 343 A89-25118 D DAILY, J. W. Low frequency pressure oscillations in a model ramjet combustor - The nature of frequency selection p 323 A89-25493 [AIAA PAPER 89-0623] DAILY, JOHN W. Evidence of a strange attractor in ramjet combustion [AIAA PAPER 89-0624] p 323 A89-25494 p 323 A89-25494 DALLMANN, U. Mach number dependence of flow separation induced by normal shock-wave/turbulent boundary-layer interaction at a curved wall

[AIAA PAPER 89-0353] p 282 A89-25298 DANDEKAR, A. J. Avionics display systems [SAE PAPER 881371] p 318 A89-28184 DANDY, DAVID S. The influence of freestream vorticity on particle lift, drag, and heat transfer [AIAA PAPER 89-0555] p 345 A89-25445 DÀNG, T. Q. A transonic computational method for an aft-mounted nacelle/pylon configuration with propeller power effect [AIAA PAPER 89-0560] p 311 A89-25449

DANNENHOFFER, JOHN F., III Convergence acceleration through the use of time

inclining [AIAA PAPER 89-0096] p 274 A89-25085 Adaptive grid embedding Navier-Stokes technique for

cascade flows [AIAA PAPER 89-0204] p 277 A89-25179 DAS. A. Numerical solution of flow fields around Delta wings

using Euler equations method [NAL-TM-FM-8701] p 299 N89-16757

DAVIS, HENRY W. An application of heuristic search techniques to the problem of flight path generation in a military hostile

environment p 355 A89-27611 DAVIS, PAMELA A. Fore-and-aft stiffness and damping characteristics of 30

x 11.5-14.5, Type VIII, bias-ply and radial-belted aircraft [SAE PAPER 881357]

p 313 A89-28176

PERSONAL AUTHOR INDEX

DAVIS, ROGER L.		
Adaptive grid embedding Navier-S	tokes to	echnique for
[AIAA PAPER 89-0204]	p 277	A89-25179
DAWES, W. N. Analysis of 2D viscous flows in tra-	neonic c	omprossors
DE WITT KENNETH J	p 329	N89-16831
Thermal analysis of engine inlet an	ti-icing :	systems
[AIAA PAPER 89-0759] DEFENBAUGH, JOHN F.	p 311	A89-25565
A dynamic model for vapor-cycle c	ooling s	ystems
[SAE PAPER 881001] DEGANI, DAVID	p 313	A89-27809
Numerical simulation of vortex unst bodies of revolution at large incidenc	eadines e	s on slender
[AIAA PAPER 89-0195]	p 276	A89-25170
An interactive three-dimensional bo	undary-l	ayer method
for transonic flow over swept wings [AIAA PAPER 89-0112]	p 274	A89-25099
DEMASI, J. T. Thermal barrier coating life	nredict	tion model
development	p 351	N89-17333
Requirements and capabilities in u	insteady	v windtunneł
testing	p 339	N89-16878
Improved methods of characterizin	ng eject	tor pumping
performance [AIAA PAPER 89-0008]	p 322	A89-25004
DERBYSHIRE, K.		NP0 16789
DESJARDINS, S. P.	h 219	1403-10700
Discussion of transport passenge characteristics	r seat	performance
[SAE PAPER 881378]	p 305	A89-28190
Some difficulties in the wind tunnel	oredictic	on of modern
civil aircraft buffeting: Proposed reme	p 301	N89-16869
DEVEZEAUX, D. Fast laminar near wake flow calcu	lation b	ov an implicit
method solving the Navier-Stokes eq	uations	AR0-24023
DIAMOND, JOHN K.	р <i>21</i> 0	
Miniature PCM compatible wideba	nd spec	tral analyzer
for hypersonic flight research	p 318	A89-27664
DIBATTISTA, JOHN D.	р 318 -	A89-27664
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic	р 318 s р 334	A89-27664 N89-18401
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L	p 318 s p 334	A89-27664 N89-18401
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments	p 318 s p 334 iation co	A89-27664 N89-18401
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R.	p 318 s p 334 jation co p 302	A89-27664 N89-18401 onsiderations A89-25555
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabil Environmental Contents	p 318 s p 334 iation co p 302 lity for fi	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999]	p 318 s p 334 iation cc p 302 lity for fi p 312	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis, of Arrow Air DC-8-63	p 318 s p 334 iation cc p 302 lity for fi p 312 accide	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander.
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1983	p 318 p 334 iation cc p 302 lity for fi p 312 accide	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander,
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1983 [AIAA PAPER 89-0706] DIETRICH, DONALD A.	p 318 p 334 jation cc p 302 lity for fi p 312 accide p 305	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-28448
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1983 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar IAIAA PAPER 80-0759]	p 318 p 334 jation cc p 302 lity for fi p 312 accide p 305 n 311	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-28448 systems A89-25565
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 88099] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundiand on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E.	p 318 p 334 jation cc p 302 lity for fi p 312 accide p 305 sti-icing p 311	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-28448 systems A89-25565
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880:999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1985 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using	p 318 p 334 jation cc p 302 lity for fi p 312 accide p 305 nti-icing p 311 g neural p 354	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-28448 systems A89-25655 networks A89-27602
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter	p 318 p 334 iation cc p 302 lity for fi p 312 accide p 305 sti-icing p 311 g neural p 354 for \$	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-28448 systems A89-25655 networks A89-27602 SAR motion
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments (AIAA PAPER 89-0738) DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1983 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation	p 318 p 334 iation cc p 302 lity for fi p 312 accide p 305 nti-icing p 311 g neural p 354 for S p 347	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-28448 systems A89-2565 networks A89-27602 SAR motion A89-26721
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETE, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure com	p 318 s p 334 hation cc p 302 p 302 accidu 5 p 302 accidu 5 p 305 tti-cing p 311 n eural p 354 for § p 347	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-28448 systems A89-25655 networks A89-25652 networks A89-27602 GAR motion A89-26721 ns between
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 88099] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundiand on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure com computation and wind tunnel for a aircraft	p 318 p 334 p 334 p 334 p 302 p 302 p 302 p 302 p 312 p 312 p 312 p 312 p 313 p 314 p 354 for § p 354 for § p 347 p 347 pariso	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 systems A89-25655 networks A89-25655 networks A89-25652 SAR motion A89-26721 ns between h hypersonic
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabil Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure com computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E.	p 318 p 334 p 334 p 302 p 302 p 302 accidi p 312 p 312 p 315 p 317 p 317 p 317 p 317 p 317 p 317 p 317 p 318 for \$2 p 327	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 systems A89-25655 networks A89-25655 SAR motion A89-26721 ns between h hypersonic A89-25025
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure con computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbant of a turbulent talnea mixing layer	p 318 p 334 p 334 p 302 p 302 p 302 p 302 p 302 p 305 p 305 p 305 p 305 p 307 p 307 p 307 p 307 p 307 p 307 p 307 p 307 p 302 p 305 p	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-28448 systems A89-25655 networks A89-25625 SAR motion A89-26721 ns between h hypersonic A89-25025 the structure A89-27692
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments (AIAA PAPER 89-0738) DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure con computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbar of a turbulent plane mixing layer DOBBS, VERLYNDA S.	p 318 p 334 p 334 p 302 p 302 accidut p 312 accidut p 312 p 305 tticing p 311 p 354 for § p 347 apariso researcion p 272 p 248	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 ent Gander, A89-25655 networks A89-25655 SAR motion A89-27602 SAR motion A89-25025 the structure A89-27692
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure com computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbat of a turbulent plane mixing layer DOBBS, VERLYNDA S. An application of heuristic searce problem of flight path generation i	p 318 p 334 p 334 p 334 p 332 p 302 p 302 p 302 p 312 p 312 p 312 p 312 p 312 p 313 p 312 p 313 p 314 for § p 312 p 314 for § p 312 p 312 p 312 p 312 p 312 p 314 for § p 312 p 314 p 354 p 347 p 348 p 348	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 ent Gander, A89-28448 systems A89-2565 networks A89-2565 GAR motion A89-27602 GAR motion A89-25025 the structure A89-27692 the structure A89-27692
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETEX, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure com computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbat of a turbulent plane mixing layer DOBBS, VERLYNDA S. An application of heuristic searc problem of flight path generation i environment DOOBBS, W. S.	p 318 p 334 p 334 p 334 p 302 p 302 p 302 p 302 p 312 p 312 p 312 p 312 p 312 p 313 p 354 for § p 347 p 347 p 272 ce on p 348 h techn n a mil p 355	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 systems A89-25655 networks A89-25655 networks A89-25655 SAR motion A89-26721 ns between h hypersonic A89-25025 the structure A89-27692 siques to the itary hostile A89-27611
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabil Environmental Control Systems [SAE PAPER 880099] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure com computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbat of a turbulent plane mixing layer DOBBS, VERLYNDA S. An application of heuristic searc problem of flight path generation i environment DOBES, W. S. The effects of enroute turbulence flight participation of turbulence	p 318 p 334 p 334 p 334 p 302 p 302 accide 5 p 305 titi-icing p 312 p 305 for \$ p 305 p 347 npariso p 347 p 347 p 347 p 347 p 347 p 348 p 347 p 348 p 347 p 348 p 347 p 348 p 347 p 347 p 348 p 347 p 355 reports	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 systems A89-25655 networks A89-25655 SAR motion A89-26721 ns between h hypersonic A89-26025 the structure A89-27692 inques to the itary hostile A89-27611 on air carrier
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabil Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure com computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbat of a turbulent plane mixing layer DOBBS, W. S. The effects of enroute turbulence flight operations [AIAA PAPER 89-0741]	p 318 p 334 p 334 p 334 p 302 p 302 accidio 5 p 305 p 305 for \$2 p 272 nce on p 348 h technin a mili p 355 reports p 303	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 ent Gander, A89-27602 SAR motion A89-25025 the structure A89-25025 the structure A89-27692 iiques to the itary hostile A89-25557
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 80099] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure com computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbat of a turbulent plane mixing layer DOBBS, VERLYNDA S. An application of heuristic searc problem of flight path generation i environment DOBBS, W. S. The effects of enroute turbulence flight operations [AIAA PAPER 89-0741] DOBGE, RICHARD N. Properties of aircraft tire materials	p 318 p 334 p 334 p 332 p 302 p 302 p 302 p 312 p 312 p 305 p 305 p 311 p 354 p 354 p 347 p 272 rec on p 272 rec on p 348 h technn a mil p 355 reports p 303	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 ent Gander, A89-27602 SAR motion A89-25025 the structure A89-25025 the structure A89-27692 siques to the itary hostile A89-27611 on air carrier A89-25557
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 800999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure con computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbat of a turbulent plane mixing layer DOBBS, VERLYNDA S. An application of heuristic searc problem of flight path generation i environment DOBBS, W. S. The effects of enroute turbulence flight operations [AIAA PAPER 89-0741] DODGE, RICHARD N. Properties of aircraft tire materials [SAE PAPER 881358]	p 318 p 334 p 334 p 302 p 302 p 302 p 302 p 305 p 305 p 305 p 305 p 305 p 307 p 311 p evral p 354 p 347 p 272 p 272 p 248 p 348 h techn n a mill p 353 p 303 p 313	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 ent Gander, A89-28625 networks A89-25655 A89-25025 the structure A89-27692 iiques to the itary hostile A89-27611 on air carrier A89-25577 A89-28177
tor hypersonic flight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments (AIAA PAPER 89-0738) DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1988 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure con computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbat of a turbulent plane mixing layer DOBBS, VERLYNDA S. An application of heuristic searc problem of flight path generation i environment DOBES, W. S. The effects of erroute turbulence flight operations [AIAA PAPER 89-0741] DOGES, RICHARD N. Properties of aircraft tire materials [SAE PAPER 881358] DOERFFER, P. Mach number dependence of flow	p 318 p 334 p 334 p 332 p 302 lity for fi p 302 accidut p 302 p 305 p 305 p 305 p 347 p 354 for § p 347 p 354 p 272 p 272 p 248 h techm a mil p 355 reports p 303 p 313 p 313 p 313 p 313 p 313 p 313	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 ent Gander, A89-2865 networks A89-25655 networks A89-27602 SAR motion A89-26721 ns between h hypersonic A89-27622 tithe structure A89-27622 iques to the itary hostile A89-27611 on air carrier A89-25557 A89-28177 ation induced
tor hypersonic tlight research DIBATTISTA, JOHN D. Controls and guidance: Aeronautic DICKINSON, JEFFREY L. Enroute convective turbulence dev on short segments [AIAA PAPER 89-0738] DIECKMANN, RICHARD R. Improved reliability and maintainabi Environmental Control Systems [SAE PAPER 880999] DIETENBERGER, MARK A. Analysis of Arrow Air DC-8-63 Newfoundland on 12 December 1983 [AIAA PAPER 89-0706] DIETRICH, DONALD A. Thermal analysis of engine inlet ar [AIAA PAPER 89-0759] DIETZ, W. E. Pattern-based fault diagnosis using DIFILIPPO, DAVID J. Evaluation of a Kalman filter compensation DILLEY, A. DOUGLAS Heat transfer and pressure con computation and wind tunnel for a aircraft [AIAA PAPER 89-0029] DIMOTAKIS, P. E. Effects of a downstream disturbat of a turbulent plane mixing layer DOBBS, VERLYNDA S. An application of heuristic searc problem of flight path generation i environment [AIAA PAPER 89-0741] DOBES, RICHARD N. Properties of aircraft tire materials [SAE PAPER 891358] DOERFFER, P. Mach number dependence of flow by normal shock-wave/turbule interaction at a circraft	p 318 p 334 p 334 p 332 p 302 lity for fi p 312 accide p 305 p 305 ti-icing p 311 p 354 for § p 347 p 355 reports p 348 p 347 p 355 reports p 303 p 313 p 313 y separant t bo	A89-27664 N89-18401 onsiderations A89-25555 ghter aircraft A89-27808 ent Gander, A89-27808 ent Gander, A89-2865 networks A89-2565 SAR motion A89-25025 the structure A89-27692 idques to the itary hostile A89-27691 on air carrier A89-25577 A89-28177 ation induced bundary-layer

DORNEY, DANIEL J.

A comparative study of iterative	e algorithms	for the Euler
equations of gasdynamics		
[AIAA PAPER 89-0114]	p 343	A89-25101
DOUGHERTY, F. CARROLL	-	

Transonic store separation using a three-dimensional chimera grid scheme

[AIAA PAPER 89-0637] p 296 A89-28442 DOUP, D.

Adiabatic Wankel type rotary engine [NASA-CR-182233] p 330 N89-17599

DOWNING, R. S. An experimental study and prediction of a two-phase

[AIAA PAPER 89-0074] p 343 A89-25065

DRESS, DAVID A.

Drag measurements on a modified prolate spheroid using a magnetic suspension and balance system [AIAA PAPER 89-0648] p 335 A89-25512

[AIAA PAPEH 89-0648] p 335 A89-2551 DRING, ROBERT P.

Measurement of airfoil heat transfer coefficients on a turbine stage p 351 N89-17311 DROEGEMEIER, KELVIN K.

- Numerical simulation of microburst downdrafts -Application to on-board and look ahead sensor technology [AIAA PAPER 89-0821] p 353 A89-25599
- DROLL, RAYMOND J.
- Supportability design requirements for army aircraft and equipment

[SAE PAPER 861447] p 356 A89-28217 DUBE, FRANCOIS

- Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 DUKE, EUGENE L.
- The development of an automated flight test management system for flight test planning and monitoring p 312 A89-27613
- DUKEK, W. G. Ball-on-cylinder testing for aviation fuel lubricity [SAE PAPER 881537] p 341 A89-28244
- DULIKRAVICH, GEORGE S. A comparative study of iterative algorithms for the Euler
- equations of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101 DUNN. M. G.
- Facility requirements for hypersonic propulsion system testing

[AIAA PAPER 89-0184] p 335 A89-25159 Influence of vane/blade spacing and injection on stage

heat-flux distributions p 325 A89-28342 DUPRIEZ, F.

- Numerical and experimental study of the crash behavior of helicopters and fixed-wing aircraft
- p 309 A89-24919 DURAO, D. F. G.
- Numerical study of single impinging jets through a crossflow
- [AIAA PAPER 89-0449] p 284 A89-25367 DURUP, PAUL C.
- Comparative tests of aircraft radial and bias ply tires [SAE PAPER 881359] p 313 A89-28178 DURVASULA. S.
- Aeroelastic flutter of low aspect ratio cantilever composite plate p 347 A89-26281 DUTTON, J. C.

An experimental investigation of the effects of a base cavity on the near-wake flowfield of a body at subsonic and transonic speeds

[AIAA PAPER 89-0210] p 277 A89-25184 DUTTON, J. CRAIG

An LDV investigation of a multiple normal shock wave/turbulent boundary layer interaction

- [AIAA PAPER 89-0355] p 282 A89-25300 DWYER, HARRY A.
- The influence of freestream vorticity on particle lift, drag, and heat transfer
- [AIAA PAPER 89-0555] p 345 A89-25445 DYSON, R. J. E.
- Military engine monitoring status at GE Aircraft Engines, Cincinnati, Ohio p 320 N89-16798 Commercial engine monitoring status at GE Aircraft
- Engines, Cincinnati, Ohio p 320 N89-16799 DZYGADLO, Z.
- Dynamics of longitudinal motion of an aeroplane after drop of loads p 333 A89-28396

E

EAMES, I. W.

Turbulent mixing in supersonic combustion systems [AIAA PAPER 89-0260] p 323 A89-25218 Comparison of the results of tests on A300 aircraft in the RAE 5 metre and the ONERA F1 wind tunnels p 300 N89-16849

EASTEP, F. E.

- Turbulence modeling in separated flow behind strong shocks p 294 A89-27746 EATON, JOHN K.
- Diverging boundary layers with zero streamwise pressure gradient
- [AIAA PAPER 89-0134] p 343 A89-25118 Unsteady, separated flow behind an oscillating, two-dimensional flap
- [AIAA PAPER 89-0288] p 280 A89-25245 EBERHARDT, D. SCOTT
- The effects of walls on a compressible mixing layer [AIAA PAPER 89-0372] p 283 A89-25315 EDWARDS, T. A.
- The effect of exhaust plume/afterbody interaction on installed scramjet performance
- [AIAA PAPER 89-0032] p 272 A89-25028 EDWARDS, THOMAS ALAN
- The effect of exhaust plume/afterbody interaction on instelled Segmint porformance
- installed Scramjet performance [NASA-TM-101033] p 330 N89-17600 EKATERINARIS, J. A.
- Compressible studies on dynamic stall [AIAA PAPER 89-0024] p 271 A89-25020
- ELBANNA, HESHAM M. Determination of aerodynamic sensitivity coefficients in
- the transonic and supersonic regimes [AIAA PAPER 89-0532] p 286 A89-25426
- ELDRED, T. Extended pitch axis effects on flow about a pitching
- airfoil [AIAA PAPER 89-0025] p 272 A89-25021
- ELESHAKY, MOHAMED E.
- Adaptive computations of multispecies mixing between scramjet nozzle flows and hypersonic freestream [AIAA PAPER 89-0009] p 322 A89-25005
- ELIAS, G. Source localization technique for impulsive multiple sources p 356 A89-27741
- ELLSWORTH, R. H. Boundary layer measurements on an airfoil at low Reynolds numbers in an accelerating flow from a nonzero
- base velocity [AIAA PAPER 89-0569] p 288 A89-25458 ELSENAAR, A.
- Reynolds number effects in transonic flow [AGARD-AG-303] p 300 N89-16760
- Expriments on the DFVLR-F4 wing body configuration in several European windtunnels p 337 N89-16808 ELZANKALY, MAHMOUD A.
- The comparative analysis and development of an 8000 psi rotary vane actuator
- [SAE PAPER 881435] p 349 A89-28210 ENDE, ROBERT
- The effects of aft-loaded airfoils on aircraft trim drag [AIAA PAPER 89-0836] p 312 A89-25605 ENGBLOM. JOHN J.
- Nonlinear dynamic responses of composite rotor blades
- [AD-A200145] p 315 N89-16774 ENGELLAND, SHAWN A.
- Simulation evaluation of transition and hover flying qualities of the E-7A STOVL aircraft [SAE PAPER 881430] p 333 A89-28205
- ENGELUND, WALTER C. Adaptive computations of multispecies mixing between
- scramjet nozzle flows and hypersonic freestream [AIAA PAPER 89-0009] p 322 A89-25005
- EPPEL, JOSEPH C.
- Flight measured downwash of the QSRA [NASA-TM-101050] p 316 N89-17593 EPPICH, HENRY M.
- A novel infrared thermography heat transfer measurement technique
- [AIAA PAPER 89-0601] p 345 A89-25478 EPSTEIN, A. H.
- Active suppression of aerodynamic instabilities in turbomachines p 295 A89-28341 ERICSSON, L. E.
- Lateral oscillations of sting-mounted models at high alpha
- [AIAA PAPER 89-0047] p 310 A89-25041 Wing rock generated by forebody vortices
- p 312 A89-27735 ERIKSSON, INGVAR
- An analysis method for bolted joints in primary composite aircraft structure p 317 N89-17691 ERNST, R. C.
- Thermal-energy management for air breathing hyper-velocity vehicles [AIAA PAPER 89-0183] p 310 A89-25158

ERZBERGER, HEINZ

Design of automation tools for management of descent traffic

FOLSOM, DALE W.

- [NASA-TM-101078] p 306 N89-17584 EVANGELISTA, RAQUEL
- Evaluation of an analysis method for low-speed airfoils by comparison with wind tunnel results
- [ÁIAA PAPER 89-0266] p 278 A89-25224 EWALD, B.
- Balance accuracy and repeatability as a limiting parameter in aircraft development force measurements in conventional and cryogenic wind tunnels
- p 338 N89-16873
- Turbulent mixing in supersonic combustion systems [AIAA PAPER 89-0260] p 323 A89-25218

F

FAHR, A.

FEARN, RICHARD L.

[AIAA PAPER 89-0448]

FELLERHOFF, J. RICK

FERNANDO, M. S. U. K.

two-dimensional airfoils

[AIAA PAPER 89-0296] FFOWCS WILLIAMS, J. E.

[DE89-004000]

FERBER, H. J.

knowledge

turbomachines FIEDLER, K.

FINSTAD, KAREN J.

FISHBACH, L. H.

FISHER, BRUCE D.

[AIAA 89-0806]

FLAKE, RICHARD A.

FLEETER, SANFORD

used in Air Force aircraft

[SAE PAPER 881411]

[AIAA PAPER 89-0289]

cascade aerodynamics

FLETCHER, W. D. M.

FOLSOM, DALE W.

[AD-A200801]

AIAA PAPER 89-0321]

systems in the UK armed forces

Fuel-additive system for test cells

FISHER. CELIA

technique

flow

AIAA PAPER 89-0756]

Navy/NASA Engine Program

thunderstorm research flights

[ASME PAPER 88-GT-314]

detection

FINAISH, F.

airfoils

associated with a jet in a crossflow

Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs p 350 N89-17257 FARHNER, L. E.

- Avionics display systems [SAE PAPER 881371] p 318 A89-28184 **FAVALORO, S. C.** An experimental and computational investigation of isothermal swirling flow in an axisymmetric dump
- combustor [AIAA PAPER 89-0620] p 323 A89-25491 FAVIN, STANLEY
 - Modular analysis of scramjet flowfields
 - p 325 A89-28337
- On the solution of nonequilibrium hypersonic inviscid steady flows [AIAA PAPER 89-0671] p 289 A89-25532

A numerical study of the contrarotating vortex pair

Advanced Fighter Technology Integration/Sandia

Automatic acquisition of domain and procedural

Moving surface boundary-layer control as applied to

Active suppression of aerodynamic instabilities in

Gas path modelling, diagnosis and sensor fault

Aerodynamic visualization for impulsively started

Use of the median volume droplet diameter in the

NNEPEQ - Chemical equilibrium version of the

Cockpit display of ground-based weather data during

Gas path condition monitoring using electrostatic

Overview on the evolution of aircraft battery systems

Oscillating aerodynamics and flutter of an aerodynamically detuned cascade in an incompressible

Experimental investigation of transonic oscillating

Engine usage condition and maintenance management

characterization of cloud droplet spectra

Inertial Terrain-Aided Navigation (AFTI/SITAN)

p 284 A89-25366

p 309 N89-17587

p 318 A89-27624

p 281 A89-25253

p 295 A89-28341

p 321 N89-16811

p 270 A89-24925

p 352 A89-25562

p 322 A89-24989

p 269 A89-28463

p 321 N89-16817

p 324 A89-28260

p 280 A89-25246

p 293 A89-26369

p 326 N89-16783

p 342 N89-17681

B-5

FORNEY, L. J.

FORNEY, L. J.
Droplet impaction on a supersonic wedge -
Consideration of similitude
[AIAA PAPER 89-0763] p 304 A89-25567
FORSYTH, T. J.
A signal filter with zero phase lag p 336 A89-27674
FOULADI, KAMRAN
A multigrid and upwind viscous flow solver on 3-D
embedded and overlapped grids
[AIAA PAPER 89-0464] p 285 A89-25379
FRANKLIN, JAMES A.
Simulation evaluation of transition and hover flying
qualities of the E-7A STOVL aircraft
[SAE PAPER 881430] p 333 A89-28205
FREELS, J. D.
Progress on a Taylor weak statement finite element
algorithm for high-speed aerodynamic flows
[AIAA PAPER 89-0654] p 289 A89-25517
FRETMUIN, F.
Aerodynamic visualization for impulsively started
Aerodynamic visualization for impulsively started airfolis p 270 A89-24925
Aerodynamic visualization for impulsively started airfoils p 270 A89-24925 FRITH, D. A.
Aerodynamic visualization for impulsively started airfolis p 270 A89-24925 FRITH, D. A. Reliable information from engine performance
Aerodynamic visualization for impulsively started airfoits p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring
Aerodynamic visualization for impulsively started airfoils p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215
Aerodynamic visualization for impulsively started airfoils p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FUELBER, H.
Aerodynamic visualization for impulsively started Aerodynamic visualization for impulsively started airfoils p 270 A89-24925 FRITH, D. A. Reliable information from engine Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FUELBER, H. GPS antennas for civil aviation p 308 A89-28296
Aerodynamic visualization for impulsively started airfoits p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FUELBER, H. GPS antennas for civil aviation p 308 A89-28296 FUJI, KOZO FUZE
Aerodynamic visualization for impulsively started airfoils p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FULBER, H. GPS antennas for civil aviation p 308 A89-28296 FUJII, KOZO Numerical study of the effect of tangential leading edge
Aerodynamic visualization for impulsively started airfoits p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FUELBER, H. GPS antennas for civil aviation p 308 A89-28296 FUJII, KOZO Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow
Aerodynamic visualization for impulsively started airfoits p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FUELBER, H. GPS antennas for civil aviation p 308 A89-28296 FUJII, KOZO Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow [Alter Paper R 89.0341] p 282 A89-25288
Aerodynamic visualization for impulsively started airfoils p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FUELBER, H. GPS antennas for civil aviation p 308 A89-28296 FUJI, KOZO Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow [AlA PAPER 89-0341] p 282 A89-25288 Navier-Stokes simulation of wind-tunnel flow using
Aerodynamic visualization for impulsively started p Aerodynamic visualization for impulsively started p 270 A89-24925 FRITH, D. A. Reliable information from engine performance Monitoring [SAE PAPER 881444] p 356 A89-28215 FUELBER, H. GPS antennas for civil aviation p 308 A89-28296 FUJII, KOZO Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow [AIAA PAPER 89-0341] p 282 A89-25288 Navier-Stokes simulation of wind-tunnel flow using U-ADI factorization algorithm p 291 A89-25864
Aerodynamic visualization for impulsively started airfoils p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FUELBER, H. GPS antennas for civil aviation go delta wing vortical flow [AIAA PAPER 89-0341] p 308 A89-28296 FUJII, KOZO Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow [AIAA PAPER 89-0341] p 282 A89-25288 Navier-Stokes simulation of wind-tunnel flow using LU-ADI factorization algorithm p 291 A89-25864
Aerodynamic visualization for impulsively started airfoits p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FUELBER, H. GPS antennas for civil aviation p 308 A89-28296 FUJII, KOZO Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow [AIAA PAPER 89-0341] p 282 A89-25288 Navier-Stokes simulation of wind-tunnel flow using LU-ADI factorization algorithm p 291 A89-25864 FUJIMARA, CLAY p 314 N89-16741
PIEL IND IT, P. Aerodynamic visualization for impulsively started p 270 A89-24925 FRITH, D. A. Reliable information from engine performance monitoring [SAE PAPER 881444] p 356 A89-28215 FULLBER, H. GPS antennas for civil aviation p 308 A89-28296 FULLI, KOZO Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow p 282 A89-25288 Navier-Stokes simulation of wind-tunnel flow using LU-ADI factorization algorithm p 291 A89-25864 FUIMARA, CLAY p 314 N89-16741

truncation error injection [AIAA PAPER 89-0468]	p 285	A89-25383

G

- GAPONOV. S. A. Evolution of perturbations near a surface in supersonic p 294 A89-27384
- GARBELL MAURICE A. Airport accident-potential and safety areas p 336 A89-28193 SAF PAPER 8813881
- GARCIA-ORTIZ, ASDRUBAL evidential reasoning to avionics Applying p 355 A89-27629 troubleshooting GARDNER. J. H.
- Computational studies of a localized supersonic shear laye
- [AIAA PAPER 89-0125] p 275 A89-25110 Effects of energy release on high-speed flows in an axisymmetric combustor
- p 283 A89-25326 [AIAA PAPER 89-0385] Acoustic-vortex interactions and low-frequency oscillations in axisymmetric combustors p 325 A89-28336

GARON, ANDRE

- Passage-averaged Navier-Stokes equations with finite element applications p 344 A89-25183 AIAA PAPER 89-0208
- GARRETT, FREDERICK E., JR. Fast half-loop maneuvers for a high alpha fighter aircraft
- using a singular perturbation feedback control law p 331 A89-25014 AIAA PAPER 89-00181 GARRIZ, J. A.
- Emerging technology for transonic wind-tunnel-wall interference assessment and corrections [SAE PAPER 881454] p 3 p 336 A89-28220
- GATLIN. BOYD Efficient application techniques of the EAGLE grid code
- to complex missile configurations p 353 A89-25305 [AIAA PAPER 89-0361]
- GAVALI, S. Grid refinement studies of turbine rotor-stator interaction
- p 281 A89-25274 (AIAA PAPER 89-03251 GÁVALI. SHARAD
- Numerical simulation of vortex unsteadiness on slender bodies of revolution at large incidence
- p 276 A89-25170 [AIAA PAPER 89-0195] Navier-Stokes simulation of wind-tunnel flow using p 291 A89-25864 LU-ADI factorization algorithm
- GEBERT, G. A. Modification of compressible turbulent boundary layer structures by streamlined devices
- p 277 A89-25186 [AIAA PAPER 89-0212] GEOFFROY, P.
- Numerical and experimental study of the crash behavior of helicopters and fixed-wing aircraft
- p 309 A89-24919
- **B-6**

- Helicopter tail rotor blade-vortex interaction noise p 356 N89-18167 [NASA-CR-183178] GEORGE. J. C.
- Superplastic formed aluminum-lithium aircraft structure p 316 N89-17591 [AD-A200245] GERA, JOSEPH
- Real-time comparison of X-29A flight data and simulation p 332 A89-27736 data GERARDI, J. J.
- Distributed ice accretion sensor for smart aircraft structures [AIAA PAPER 89-0772] p 311 A89-25571
- GERDES, RONALD M.
- Simulation evaluation of transition and hover flying qualities of the E-7A STOVL aircraft p 333 A89-28205 [SAE PAPER 881430]
- GERHARZ, J. J.
- Damage tolerance behavior of composite airframes fiber reinforce p 316 N89-17278 GEUT. HENK
- The law: The pilot and the air traffic controller Division p 357 A89-26665 of responsibilities GHAFFARI, FARHAD
- A patched-grid algorithm for complex configurations directed towards the F-18 aircraft
- p 310 A89-25106 [AIAA PAPER 89-0121] Navier-Stokes solutions about the F/A-18 forebody-LEX configuration
- AIAA PAPER 89-03381 p 281 A89-25285 GIELDA, THOMAS P.
- Efficient finite-volume parabolized Navier-Stokes solutions for three-dimensional, hypersonic, chemically reacting flowfields
- [AIAA PAPER 89-0103] p 274 A89-25090 GILBERT. BARRY
- Turbulence measurements in a radial upwash p 294 A89-27706
- GILES, MICHAEL B. Convergence acceleration through the use of time
- [AIAA PAPER 89-0096] p 274 A89-25085 GLENNY, D. E.
- Gas path analysis and engine performance monitoring p 327 N89-16802 in a Chinook helicopter
- GLOSS, BLAIR B. A solution to water vapor in the National Transonic Facility
- [AIAA PAPER 89-0152] p 334 A89-25135 GOBLE, BRIAN D.
- Viscous-inviscid interaction and local grid refinement via truncation error injection
- [AIAA PAPER 89-0468] p 285 A89-25383 GOKCEN, TAHIR
- Nonequilibrium effects for hypersonic transitional flows using continuum approach AIAA PAPER 89-0461] p 284 A89-25377
- GOLBITZ, W. C. Supersonic, transverse jet from a rotating ogive cylinder
- in a hypersonic flow p 294 A89-27728 GOLDBERG, JOSHUA
- Developments in expulsive separation ice protection blankets p 311 A89-25572
- [AIAA PAPER 89-0774] GOLDHAMMER, MARK I.
- CFD in design An airframe perspective [AIAA PAPER 89-0092] p 31 p 310 A89-25081
- GOO, ABRAHAM M. S. p 269 A89-26674 Condor for high altitudes
- GOODSELL, AGA M. TranAir and Euler computations of a generic fighter
- including comparisons with experimental data p 310 A89-25221 [AIAA PAPER 89-0263] GORADIA. S. H.
- Theoretical investigation for the effects of sweep, leading-edge geometry, and spanwise pressure gradients on transition and wave drag transonic, and supersonic speed with experimental correlations
- p 295 A89-28229 [SAF PAPER 881484] GORDON, S. NNEPEO - Chemical equilibrium version of the
- Navy/NASA Engine Program p 322 A89-24989 [ASME PAPER 88-GT-314]
- GOULD, G. Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine p 350 N89-17257
- GOUTINES, MARIUS Design methodology for advanced High Pressure (HP) p 330 N89-16840 compressor first stage GOWDY, VAN
- Measurement of dynamic reactions in passenger seat
- [SAE PAPER 881376] p 305 A89-28188

- GRACIASALCEDO, CARMEN M. Experimental verification of the thermodynamic properties for a jet-A fuel [NASA-TM-101475] p 342 N89-17017 GRAFTON, T. A. Measurements of gas turbine combustor and engine augmentor tube sooting characteristics p 328 N89-16821 [AD-A199768] GREBER, ISAAC Experimental and numerical investigation of an oblique shock wave/turbulent boundary layer interaction with continuous suction p 296 A89-28407 [AIAA PAPER 89-0357] GREENOUGH, JEFFREY A. The effects of walls on a compressible mixing layer p 283 A89-25315 AIAA PAPER 89-0372] GREITZER, E. M. Active suppression of aerodynamic instabilities in p 295 A89-28341 rbomachin **GRIFFIN, ALBERT B.** Field enhancement of UHF-VHF aircraft antennas p 349 N89-17069 AD.A2001801 GRIMM, DONALD K. An avionics diagnostics system for regional airlines and usiness aircraft applied in the Beech Starship 1 p 318 A89-28186 [SAE PAPER 881374] GŘIMM, R. A. Superplastic formed aluminum-lithium aircraft structure [AD-A200245] p 316 N89-17591 GROSS, KIMBERLY UHRICH Laser holographic interferometric measurements of the flow in a scramjet inlet at Mach 4 p 273 A89-25037 [AIAA PAPER 89-0043] GROSSMAN. B. Two-dimensional Euler computations on a triangular mesh using an upwind, finite-volume scheme p 354 A89-25385 [AIAA PAPER 89-0470] GUESS, M. K. Superplastic formed aluminum-lithium aircraft structure p 316 N89-17591 [AD-A200245] **GUFFOND. DIDIER P.** Infrared technique to measure the skin temperature on an electrothermal de-icer - Comparison with numerical simulations p 303 A89-25566 [AIAA PAPER 89-0760] GUMBERT, CLYDE Numerical solutions on a Pathfinder and other configurations using unstructured grids and a finite element enhu [AIAA PAPER 89-0362] p 282 A89-25306 GUPTA, R. N. Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies p 295 A89-28251 [AIAA PAPER 88-0460] GUPTA, U. K. Hierarchical representation and machine learning from faulty jet engine behavioral examples to detect real time p 355 A89-27622 abnormal conditions GURNETT, DONALD A. Merging of aircraft vortex trails - Similarities to magnetic p 356 A89-26630 field merging GURUPRASAD, K. Finite element analysis of composite rudder for DO 228 p 347 A89-26284 aircraft GURUSWAMY, GURU P. Numerical simulation of vortical flows on flexible wings p 286 A89-25431 [AIAA PAPER 89-0537] GUY, ROBERT W. CFD simulation of square cross-section, contoured nozzle flows - Comparison with data (AIAA PAPER 89-0045) p 273 A89-25039 GUYNES, BUDDY V. High-temperature containerless aircraft furnace experimentation in the microgravity environment aboard a KC-135 aircraft [AIAA PAPER 89-0402] p 345 A89-25337 Η HAENEL, D.
- An implicit flux-vector splitting scheme for the computation of viscous hypersonic flow p 279 A89-25231 [AIAA PAPER 89-0274]
- HAJEK, T. J. Coolant passage heat transfer with rotation
- p 351 N89-17314 HALL, R. M.
- Navier-Stokes solutions for vortical flows over a tangent-ogive cylinder [AIAA PAPER 89-0337] p 281 A89-25284
- Low-speed vortical flow over a 5-degree cone with tip deometry variations [SAE PAPER 881422]
 - p 295 A89-28203

FENSONAL AUTHOR INDE	<i>A</i>
HAMER, M. J.	
Installed thrust as a predictor o	f engine health for jet
engines HAN VINDA	p 327 N89-16806
Experimental research of flow se	paration, heat transfer
and ablation on flat plate-wedges i	n supersonic, turbulent
	p 292 A89-25938
A numerical investigation of the	e influence of surface
roughness on heat transfer in ice a	accretion
[AIAA PAPER 89-0737]	p 346 A89-25554
Cockpit display of bazardous we	ather information
[AIAA PAPER 89-0808]	p 335 A89-25591
Dynamic response of aircraft a	autopilot systems to
atmospheric disturbances	p 333 A89-27737
accretion	D 304 A89-27739
Modeling of surface roughness	effects on glaze ice
accretion	- 005 400 00454
HANSON, PALMER O.	p 305 A89-28451
Correction for deflections of the	vertical at the runup
site	p 307 A89-26725
Simulation evaluation of transiti	on and hover flying
qualities of the E-7A STOVL aircraft	t :
[SAE PAPER 881430]	p 333 A89-28205
Flow quality measurements for	or the Langley 8-foot
transonic pressure tunnel LFC expe	eriment
[AIAA PAPER 89-0150] HARRIS JOHN A JR	p 276 A89-25133
Relationships of nondestructive	evaluation needs and
component design	p 349 N89-17256
Three-dimensional compressib	le houndary laver
calculations to fourth order acc	uracy on wings and
fuselages	- 075 400 05445
HARRIS, THOMAS	p 2/5 A69-25115
Canadian forces aircraft conditi	on/health monitoring:
Policy, plans and experience HARTWICH, PETER-M.	p 326 N89-16784
Navier-Stokes solutions for vo	rtical flows over a
tangent-ogive cylinder	D 001 A00 05004
HARVEY, PETER R.	p 201 A09-20204
Creep fatigue life prediction for	engine hot section
materials (ISOTROPIC) filtin year pr	p 352 N89-17336
HASLAM, GEORGE E.	p
Evaluation of a Kalman filte	r for SAR motion
HASSAN, H. A.	p 347 A09-20721
A one equation turbulence mode	el for transonic airfoil
TIOWS	n 287 A89-25446
HASSAN, O.	p 201 100 20110
An adaptive implicit/explicit finite	element scheme for
[AIAA PAPER 89-0363]	p 344 A89-25307
HEFER, G.	•
DEVLR-F5 test wing experime aerodynamics	nt for computational p 290 A89-25857
HEGDE, U. G.	
Flowfield modifications of combus	tion rates in unstable
[AIAA PAPER 89-0105]	p 322 A89-25092
HEGLUND, WILLIAM S.	
[SAE PAPER 881001]	D 313 A89-27809
HENRY, J. R.	
CF-18/F404 transient performanc	e trending
HENRY, ROBERT C.	P 020 1100-10014
Infrared technique to measure the	skin temperature on
an electromermal de-icer - Compa simulations	nson with numerical
[AIAA PAPER 89-0760]	p 303 A89-25566
IDV surveys over a fighter model	at moderate to high
angles of attack	a moverate to high
[SAE PAPER 881448]	p 295 A89-28218

- HERNANDEZ. GLORIA Evaluation of leading- and trailing-edge flaps on flat and cambered delta wings at supersonic speeds AIAA PAPER 89-0027] p 272 A89-25023 HERSHEY, WILLIAM R.
- Ranging and Processing Satellite (RAPSAT) p 340 A89-26738
- HERSTINE. G. L. Considerations of control authority requirements in
- STOVL propulsion system sizing [SAE PAPER 881432] p 313 A89-28207

HESS. ANDREW J.

- An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 HESS, R. W.
 - Aircraft airframe cost estimating relationships: All mission types [AD-A200262] p 269 N89-16719
 - Aircraft airframe cost estimating relationships: Fighters [AD-A200263] p 270 N89-16720 Aircraft airframe cost estimating relationships; Bombers and transport
 - [AD-A2002641 p 270 N89-16721 Aircraft airframe cost estimating relationships: Attack aircraft
- [AD-A200265] p 270 N89-16722 HEUVELINK, GERARD B. M.
- An alternative method to solve a variational inequality applied to an air traffic control example
- p 354 A89-26196 HEWETT, MARLE D. The development of an automated flight test
- management system for flight test planning and monitorina p 312 A89-27613 HEYSSE, PAUL D.
- An avionics diagnostics system for regional airlines and business aircraft applied in the Beech Starship 1 [SAE PAPER 881374] p 318 A89-28186
- HICKMAN, G. A Distributed ice accretion sensor for smart aircraft
- structures [AIAA PAPER 89-0772] p 311 A89-25571 HIGGINS. M.
- Structural response of an advanced combustor liner; Test and analysis p 351 N89-17329
- HILBIG. R. The intelligent wing - Aerodynamic developments for
- future transport aircraft [AIAA PAPER 89-0534] p 269 A89-25428 HINGST, WARREN R.
- Experimental and numerical investigation of an oblique shock wave/turbulent boundary layer interaction with continuous suction [AIAA PAPER 89-0357]
- p 296 A89-28407 HINTON, DAVID A.
- Piloted-simulation evaluation of escape guidance for microburst wind shear encounters [NASA-TP-2886] p 321 N89-16820
- HINZ. MARK A. A model of pressure distributions on impeller blades for
- determining performance characteristics [AIAA PAPER 89-0840] p 346 A89-25609
- HIRT. FELIX New design of the nozzle section of a large subsonic
- wind tunnel [F+W-TF-1926] p 339 N89-17601
- HODABBAR. S. An antenna for the GPS installation at DFVLR
- p 309 A89-28298 HODGES, DEWEY H.
- Analysis of structures with rotating, flexible substructures applied to rotorcraft aeroelasticity p 312 A89-27695 HOERL, F.
- System-theoretical method for dynamic on-condition p 321 N89-16812 monitoring of gas turbines HOFF, F. G.
- Fiber optic torquemeter design and development p 348 A89-27661
- HOFFMANN, KLAUS A.
- Effect of dynamic changes in body configuration on hock structure [AIAA PAPER 89-0526] p 285 A89-25421
- HOGG, G. WILLIAM
- F100-PW-220 engine monitoring system p 320 N89-16795
- HOLDEN, M. S. Facility requirements for hypersonic propulsion system
- testina [AIAA PAPER 89-0184] p 335 A89-25159
- HOLLANDERS, H. Fast laminar near wake flow calculation by an implicit
- method solving the Navier-Stokes equations p 270 A89-24923
- HOLM. CHRIS L.
- Aerodynamic performance of wings of arbitrary planform in inviscid, incompressible, irrotational flow
- p 297 N89-16728 [AD-A2004361 HONIGFORD, E. R.
- Parallel operation of VSCF electrical power generators [SAE PAPER 881410] p 324 A89-28259 p 324 A89-28259 HOPKINS, A. STEWART
- Analysis of structures with rotating, flexible substructures p 312 A89-27695 applied to rotorcraft aeroelasticity HORNUNG, H. C.
- Reynolds number effects in transonic flow [AGARD-AG-303] p 300 N89-16760

HORSTMAN, C. C. An experimental study of shock wave/vortex interaction [AIAA PAPER 89-0082] p 273 A89-25072 HORSTMANN, K. H. Feasibility study on the design of a laminar flow [AIAA PAPER 89-0640] p 311 A89-25506 HOSEIN, TODD The vertical motion simulator p 339 N89-18384 HOUWINK, R. Requirements and capabilities in unsteady windtunnel

testing p 339 N89-16878

- HOVENAC, EDWARD A. Performance of the forward scattering spectrometer probe in NASA's Icing Research Tunnel p 346 A89-25570 [AIAA PAPER 89-0769]
- HSIAO, THOMAS
- Ranging and Processing Satellite (RAPSAT) p 340 A89-26738 HSU, C. A.
 - Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic
- [AIAA PAPER 89-0562] p 287 A89-25451 HSU. C.-H.
- Upwind Navier-Stokes solutions for leading-edge vortex flows
- [AIAA PAPER 89-0265] p 278 A89-25223 HSU. S. Y.
- Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic flows
- [AIAA PAPER 89-0562] p 287 A89-25451 HU. HONG
 - Full-potential integral solutions for steady and unsteady transonic airfoils with and without embedded Euler domains p 301 N89-17566
- HUANG, MINGKE

nacelle

Applications of an efficient algorithm to transonic conservative full-potential flow past 3-D wings p 291 A89-25930

- Applications of AF3 efficient iteration scheme to transonic nonconservative full-potential flow past airfoils
- p 292 A89-25940 HUDLICKA, EVA
- Integrating causal reasoning at different levels of abstraction p 355 A89-27609 HUFF, DENNIS L.
- Evaluation of three turbulence models for the prediction of steady and unsteady airloads [AIAA PAPER 89-0609] p 288 A89-25485
- Numerical analysis of flow through oscillating cascade sections
- [AIAA PAPER 89-0437] p 296 A89-28413 HUFFER, BRENT
- Electromagnetic emissions from a modular low voltage EIDI system
- [AIAA PAPER 89-0758] p 303 A89-25564 HUTH. H.
- Damage tolerance behavior of fiber reinforced composite airframes p 316 N89-17278 HUTTSELL, L. J.
- Modifications to transonic flow codes for unsteady perturbations around an experimental mean AIAA PAPER 89-0447] p 284 A89-25365
- HWAN, KIM DOO Some considerations on the liability of air traffic control
- agencies p 357 A89-26666 HWANG. HORNG-REN
- Direct solution of unsteady transonic flow equations in frequency domain [AIAA PAPER 89-0641]
- p 288 A89-25507

- IDE, ROBERT F.
- Performance of the forward scattering spectrometer probe in NASA's Icing Research Tunnel AIAA PAPER 89-0769] p 346 A89-25570
- IDEN. STEVEN M. Experimental cascaded doubly fed variable speed
- constant frequency generator system [SAE PAPER 881409] p 324 A89-28258
- High reliability aircraft generator system [SAE PAPER 881414] p 325 A89-28263 IWANSKI, KENNETH P.
- An experimental investigation of delta wing vortex flow vith and without external jet blowing
- [AIAA PAPER 89-0084] p 273 A89-25074 IYER. R. K.
- Diagonal implicit multigrid calculation of inlet flowfields p 294 A89-27716

IYER. VENKIT

Three-dimensional compressible boundary layer calculations to fourth order accuracy on wings and fuenterne p 275 A89-25115 [AIAA PAPER 89-0130]

JANG, HONG-MING

An interactive boundary-layer procedure for oscillating airfoils including transition effects p 271 A89-25016

AIAA PAPER 89-00201 JANKOVITZ. JACK

- Laboratory and flight evaluation of the Integrated Inertial p 307 A89-26708 Sensor Assembly (IISA) JANUS. J. MARK
- A simple time-accurate turbomachinery algorithm with numerical solutions of an uneven blade count configuration

p 344 A89-25181 [AIAĂ PAPER 89-02061 JARRAH, MOHAMMAD-AMEEN M.

Low speed wind tunnel investigation of the flow about delta wing, oscillating in pitch to very high angle of attack

p 281 A89-25252 [AIAA PAPER 89-0295] JENKINS, P. J.

- Information management systems for on-board p 319 N89-16786 monitoring systems JENKINS, RENALDO V.
- NASA SC(2)-0714 airfoil data corrected for sidewall boundary-layer effects in the Langley 0.3-meter transonic cryogenic tunnel [NASA-TP-2890]

p 301 N89-17568 JENKINS, RICHARD C.

- Modeling of subsonic flow through a compact offset inlet diffuser p 288 A89-25505 [AIAA PAPER 89-0639]
- JENSEN, ROBERT D.
- An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition
- input p 309 N89-17588 [AD-A200626] JESPERSEN, DENNIS C.
- The design and application of upwind schemes on unstructured meshes
- p 354 A89-25310 [AIAA PAPER 89-0366] JOHNSON, B. V.
- Coolant passage heat transfer with rotation p 351 N89-17314

JOHNSON, C. B.

Wind tunnel-sidewall-boundary-layer effects in transonic airfoil testing-some correctable, but some not p 338 N89-16864

JOHNSON, DALE L.

NASP natural environment definitions for design p 339 A89-25568 [AIAA PAPER 89-0764] JOHNSON, DENNIS A.

Prediction of separated transonic wing flows with a non-equilibrium algebraic model

p 287 A89-25447 [AIAA PAPER 89-0558]

JOHNSON, NEWTON

- Precision trajectory reconstruction p 307 A89-26726
- JOHNSON, RICHARD Transport airplane fuselage section longitudinal impact
- toet p 305 A89-28189 [SAE PAPER 881377]
- JOHNSON, RICHARD A. Comparative tests of aircraft radial and bias ply tires p 313 A89-28178 [SAE PAPER 881359]
- JOHNSON, WAYNE R. Wake model for helicopter rotors in high speed flight p 301 N89-17577 [NASA-CR-177507]
- JOHNSTON, JAMES P. Vortex generator jets - A means for passive and active control of boundary layer separation
- n 287 A89-25453 [AIAA PAPER 89-0564]
- JOHNSTON, ROBERT T.
- Propeller/wing interaction p 311 A89-25429 [AIAA PAPER 89-0535] JONES, GREGORY S.
- Flow quality measurements for the Langley 8-foot
- transonic pressure tunnel LFC experiment [AIAA PAPER 89-0150] p 27 p 276 A89-25133 JONES, J. J.
- Electric charge acquired by airplanes penetrating p 304 A89-26231 thunderstorms
- JONES, R. Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925

JONES, W. VERNON

Recent results in the NASA research balloon program p 269 A89-25199 [AIAA PAPER 89-0233]

JORDAN, ERIC H.

- Constitutive modelling of single crystal and directionally p 342 N89-17325 solidified superalloys JOSLYN, H. DAVID
- Measurement of airfoil heat transfer coefficients on a p 351 N89-17311 turbine stage JUNG OSCAR

National full-scale aerodynamic complex integrated

p 335 A89-27653 systems test data system

Κ

- KABA, HIDEKI Preliminary test results of NDA cryogenic wind tunnel
- and its system [SAE PAPER 881449] p 336 A89-28219 KAILASANATH. K.
- Computational studies of a localized supersonic shear lovor
- p 275 A89-25110 [AIAA PAPER 89-0125] Effects of energy release on high-speed flows in an axisymmetric combustor
- p 283 A89-25326 [AIAA PAPER 89-0385] Acoustic-vortex interactions and low-frequency
- oscillations in axisymmetric combustors p 325 A89-28336
- KALKHORAN, IRAJ MASBOOGHI An experimental investigation of the perpendicular vortex-airfoil interaction at transonic speeds
- p 301 N89-17569 KAMMEYER, MARK E.
- Microtuft flow visualization at Mach 10 and 14 in the NSWC hypervelocity wind tunnel No. 9 [AIAA PAPER 89-0041] p 334 A89-25035
- KÅMO. R.
- Adiabatic Wankel type rotary engine p 330 N89-17599 [NASA-CR-182233] KANDIL. OSAMA A.
- Unsteady Navier-Stokes computations past oscillating
- delta wing at high incidence [AIAA PAPER 89-0081] p 273 A89-25071 Navier-Stokes computations of separated vortical flows past prolate spheroid at incidence
- [AIAA PAPER 89-0553] p 286 A89-25443 Integral equation solution of the full potential equation for transonic flows
- p 287 A89-25452 [AIAA PAPER 89-0563] KAPPLER, G.
- System-theoretical method for dynamic on-condition p 321 N89-16812 monitoring of gas turbines KAZA, K. R. V.
- airfoil flutte Technique for the prediction p 348 A89-27744 characteristics in separated flow KAZA, KRISHNA RAO V.
- A computational procedure for automated flutter p 348 A89-28070 analysis
- KE. MÍN MLS, a machine learning system for engine fault p 355 A89-27623 diagnosis KE, MING
- MPC-75 feeder civil aircraft
- n 317 N89-17594 AD-A2009071 KEANINI, R.
- Low frequency pressure oscillations in a model ramjet combustor - The nature of frequency selection p 323 A89-25493 [AIAA PAPER 89-0623]
- **KEANINI, RUSSELL G.** Evidence of a strange attractor in ramjet combustion
- p 323 A89-25494 [AIAA PAPER 89-0624] KEENER, EARL R.
- Computational design aspects of a NASP nozzle/afterbody experiment p 284 A89-25364 [AIAA PAPER 89-0446]
- KEGARISE. R. J.
- Aluminum quality breakthrough for aircraft structural p 348 A89-27745 reliability **KEGELMAN, JEROME T.**
- Effects of leading-edge shape and vortex burst on the flowfield of a 70-degree-sweep delta-wing p 274 A89-25076 AIAA PAPER 89-0086]
- KEITH, THEO G., JR. Thermal analysis of engine inlet anti-icing systems p 311 A89-25565
- [AIAA PAPER 89-0759] p 311 A89-25565 Investigation of the flow in the diffuser section of the NASA Lewis Icing Research Tunnel p 336 A89-28455 AIAA 89-0755]
- **KEMMERLY, G. T.** Characteristics of the ground vortex formed by a jet
- moving over a fixed ground plane [AIAA PAPER 89-0650] p 288 A89-25514
- KEMP, W. B., JR. Emerging technology for transonic wind-tunnel-wall
 - interference assessment and corrections [SAE PAPER 881454] p 336 A89-28220

KENNAUGH, ANDREW Multiple solutions for aircraft sideslip behaviour at high angles of attack n 331 A89-25510 AIAA PAPER 89-06451 KENNON, STEPHEN R. Supersonic inlet calculations using an upwind finite-volume method on adaptive unstructured grids p 274 A89-25100 [AIAA PAPER 89-0113] KEPLER. C. E. Performance potential of air turbo-ramjet employing supersonic through-flow fan p 322 A89-25006 [AIAA PAPER 89-0010] KESHOCK E An experimental study and prediction of a two-phase pressure drop in microgravity p 343 A89-25065 AIAA PAPER 89-00741 KESSLER, EDWIN On design and projected use of Doppler radar and low-level windshear alert systems in aircraft terminal operations AIAA PAPER 89-07041 n 302 A89-25545 KHAN, FARUKH A. Tip vortex/airfoil interaction for a canard//wing configuration at low Reynolds numbers p 286 A89-25430 TAIAA PAPER 89-05361 KHODADOUST, A. Effect of simulated glaze ice on a rectangular wing [AIAA PAPER 89-0750] p 303 A89-25560 KIECH. E. L. Pattern-based fault diagnosis using neural networks p 354 A89-27602 KIM, MEUNG J. Application of continuous vorticity panels three-dimensional lifting flows with partial separation panels in p 275 A89-25104 [AIAA PAPER 89-0117] KING P. S. Combined tangential-normal injection into a supersonic flow TAIAA PAPER 89-0622 p 288 A89-25492 KINSEY, DON W. Turbulence modeling in separated flow behind strong p 294 A89-27746 chocks KJELGAARD, S. O. Low-speed vortical flow over a 5-degree cone with tip geometry variations p 295 A89-28203 SAE PAPER 8814221 KLEIN, ARMIN Relation between diffusor losses and the inlet flow p 322 A89-24916 conditions of turbojet combustors KLINE. B. R. Fiber optic torquemeter design and development p 348 A89-27661 KLIVANS, DEAN Superplastic formed aluminum-lithium aircraft structure p 316 N89-17591 [AD-A200245] KNIGHT, C. J. Computations of 3D viscous flows in rotating turbomachinery blades p 281 A89-25273 [AIAA PAPER 89-0323] KNIGHT, CHARLES J. Evaluation of an OH grid formulation for viscous cascade flows [AIAA PAPER 89-0207] p 277 A89-25182 KNOWLES. K. Subcritical swirling flows in convergent, annular p 323 A89-27694 nozzles KOBLISH. T. Airblast atomization at conditions of low air velocity p 344 A89-25191 [AIAA PAPER 89-0217] KOENIG, G. Material defects in a PM-nickel-base superalloy p 341 A89-25919 KOERNER, WOLFGANG LIRAS - A proposal for an airport traffic safety system p 308 A89-28293 KOGA, DENNIS J. Unsteady, separated flow behind an oscillating, two-dimensional flap p 280 A89-25245 [AIAA PAPER 89-0288] KOMERATH, N. M. Measurement of transient vortex-surface interaction phenomena p 289 A89-25603 [AIAA PAPER 89-0833] KOMERATH, NARAYANAN Numerical simulation of the growth of instabilities in supersonic free shear layers p 283 A89-25319 [AIAA PAPER 89-0376] KOOCHESFAHANI, M. M. Effects of a downstream disturbance on the structure of a turbulent plane mixing layer p 348 A89-27692 KOOI. J. W. Accuracy requirements for high-speed test with engine simulation on transport aircraft models in the NLR-HST p 338 N89-16870

KORDULLA, W.

Comparison of two different Navier-Stokes methods for the simulation of 3-D transonic flows with separation [AIAA PAPER 89-0559] p 287 A89-25448 KORDULA, WILHELM

Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany, Sept. 30-Oct. 2, 1987 p 290 A89-25856 KOREN, BARRY

Euler flow solutions for transonic shock wave-boundary layer interaction p 295 A89-28074 KOSS, D.

An experimental evaluation of a low-Reynolds number high-lift airfoil with vanishingty small pitching moment [AIAA PAPER 89-0538] p 286 A89-25432 KOUL, A, K.

Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine discs p 350 N89-17257

- KREATSOULAS, JOHN C. A novel infrared thermography heat transfer measurement technique [AIAA PAPER 89-0601] p 345 A89-25478
- KREBS, N. E. Local buckling and crippling of thin-walled composite structures under axial compression p 341 A89-27733 KRENZ, GUENTER

KRENZ, GUENTER Accuracy problems in wind tunnets during transport aircraft development p 338 N89-16877

KRISHNAKUMAR, K. Inertial energy distribution error control for optimal wind

shear penetration [AIAA PAPER 89-0016] p 331 A89-25012

KRISHNAN, VENKATARAMA Causal probability model for transoceanic track separations with applications to automatic dependent surveillance p 308 A89-26735

KROLL, N. Analysis of three-dimensional aerospace configurations using the Euler equations

[AIAA PAPER 89-0268] p 279 A89-25226 KROUTIL, J. C.

Confined normal-shock/turbulent-boundary-layer interaction followed by an adverse pressure gradient [AIAA PAPER 89-0354] p 282 A89-25299

KRUISWYK, R. W. An experimental investigation of the effects of a base cavity on the near-wake flowfield of a body at subsonic and transonic speeds

[AIAA PAPER 89-0210] p 277 A89-25184 KRUPAR, MARTIN J.

Laser velocimeter measurements of the flowfield generated by an advanced counterrotating propeller [AIAA PAPER 89-0434] p 293 A89-26373

- KUAN, JYH-HORNG Transonic store separation using a three-dimensional
- chimera grid scheme [AIAA PAPER 89-0637] p 296 A89-28442 KUBO, SHIN Numerical simulation of hypersonic flow around a space plane at high angles of attack using implicit TVD
- plane at high angles of attack using implicit TVD Navier-Stokes code [AIAA PAPER 89-0273] p 279 A89-25230 KUHLMAN, JOHN M. Computational design of low aspect ratio wing-winglets
- for transonic wind-tunnel testing [AIAA PAPER 89-0644] p 311 A89-25509
- KUMAR, A. A numerical study of hypersonic propulsion/airframe
- integration problem [AIAA PAPER 89-0030] p 272 A89-25026
- Effect of nose bluntness on flow field over slender bodies in hypersonic flows
- [AIAA PAPER 89-0270] p 279 A89-25228 KUMAR, ANAND Numerical solution of flow fields around Delta wings
- using Euler equations method [NAL-TM-FM-8701] p 299 N89-16757
- KUNZ, DONALD L. Analysis of structures with rotating, flexible substructures applied to rotorcraft aeroelasticity p 312 A89-27695
- KUNZ, J. H. On board life monitoring system Tornado (OLMOS) p 319 N89-16785
- KURIBAYASHI, NOBUMITSU Preliminary test results of NDA cryogenic wind tunnel and its system
- [SAE PAPER 881449] p 336 A89-28219 KURIYAMA, MASAMICHI
- The current status of the flight test of the ASKA [SAE PAPER 881433] p 314 A89-28208 KUROISHI, K.
- Superplasticity of HIPped PM superalloys made from attrited prealloy powder p 341 A89-25915

L

LABRUJERE. TH. E.

Accuracy of various wall-correction methods for 3D subsonic wind-tunnel testing p 338 N89-16863 LAFFERTY, JOHN F.

Microtult flow visualization at Mach 10 and 14 in the NSWC hypervelocity wind tunnel No. 9 [AIAA PAPER 89-0041] p 334 A89-25035

- LAFLAMME, J. C. G.
- The effects of a compressor rebuild on gas turbine engine performance p 327 N89-16803 LAFORGE, L. G.
- Advanced flight control for the Fokker 100 [SAE PAPER 881373] p 333 A89-28185 LAGRAFF, J. E.
- Measurement and modelling of turbulent spot growth on a gas turbine blade
- [AIAA PAPER 89-0328] p 281 A89-25276 LAGRANDEUR, ROSS
- Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784 LAHODNY, H.
- Material defects in a PM-nickel-base superalloy p 341 A89-25919

LAI, H.

- Comparison of 3D computation and experiment for non-axisymmetric nozzles
- [AIAA PAPER 89-0007] p 325 A89-28403 LAINE, B. B-1B CITS engine monitoring p 319 N89-16788
- LAMONT, PETER J.
- Multiple solutions for aircraft sideslip behaviour at high angles of attack [AIAA PAPER 89-0645] p 331 A89-25510
- LAN, C. E.
- Direct solution of unsteady transonic flow equations in frequency domain [AIAA PAPER 89-0641] p 288 A89-25507
- LANE, F. D. The effect of a ground-based inversion layer on an
- impacting microburst [AIAA PAPER 89-0810] p 352 A89-25593
- LARDIERE, BENJAMIN, JR. Developments in expulsive separation ice protection blankets
- [AIAA PAPER 89-0774] p 311 A89-25572
- LAUER, R. F., JR. Wind tunnel predicted air vehicle performance: A review of lessons learned p 337 N89-16852
- LAWSON, R. PAUL
- The measurement of temperature from an aircraft in cloud p 353 N89-17978 LEBLANC, ALAIN
- Canadian forces aircraft condition/health monitoring: Policy, plans and experience p 326 N89-16784
- LEE, DAESUNG Evaluation of an OH grid formulation for viscous cascade
- flows [AIAA PAPER 89-0207] p 277 A89-25182
- LEE, H. P. Considerations of control authority requirements in STOVL propulsion system sizing
- [SAE PAPER 881432] p 313 A89-28207 LEE. K. P.
- Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies
- [ÅIAA PAPER 88-0460] p 295 A89-28251 LEE. KI D.
- A comparative study of iterative algorithms for the Euler
- equations of gasdynamics [AIAA PAPER 89-0114] p 343 A89-25101
- LEE, M. H. A self-adaptive computational method applied to transonic turbulent projectile aerodynamics
- [AIAA PAPER 89-0837] p 290 A89-25606 LEFEBVRE, A.
- Airblast atomization at conditions of low air velocity [AIAA PAPER 89-0217] p 344 A89-25191 LEISHMAN, J. GORDON
- A state-space model of unsteady aerodynamics in a compressible flow for flutter analyses
- [AIAA PAPER 89-0022] p 271 A89-25018 LELE, SANJIVA K. Direct numerical simulation of compressible free shear
- Direct numerical simulation of compressible free shear flows
- [AIAA PAPER 89-0374] p 283 A89-25317 LEONARD, WAYNE M., JR.
- Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study
- [AD-A200665] p 270 N89-17564 LESSARD, VICTOR R.
- A multigrid and upwind viscous flow solver on 3-D embedded and overlapped grids [AIAA PAPER 89-0464] p 285 A89-25379

An H(infinity) method for the design of linear me-invariant multivariable sampled-data control time-invariant p 354 A89-26187 systems LEVIONNOIS, ALBERT Maintenance aid system for wide body aircraft p 327 N89-16805 LEWIS, CLARK H. Prediction of supersonic/hypersonic viscous flows over RVs and decoys p 272 A89-25024 [AIAA PAPER 89-0028] Large-angle-of-attack viscous hypersonic flows over complex lifting configurations p 279 A89-25227 [AIAA PAPER 89-0269] Nonequilibrium viscous hypersonic flows over ablating Teflon surfaces [AIAA PAPER 89-0314] p 293 A89-26368 LEYLAND, D. C. p 299 N89-16743 Jaguar/Tornado intake design p 315 N89-16745 Intakes for high angle of attack Intake drag p 299 N89-16747 LEYNAERT, JACKY Transport aircraft intake design p 315 N89-16749 Wind tunnel air intake test techniques p 299 N89-16751 LI. HANJIE Applications of AF3 efficient iteration scheme to transonic nonconservative full-potential flow past airfoils p 292 A89-25940 LI, JI-BAO Experimental and analytical study on exit radial temperature profile of experimental 2D combustor [AIAA PAPER 89-0493] p 340 A89-25403 LIDSTONE, GARY L. A model for 3-D sonic/supersonic transverse fuel njection into a supersonic air stream [AIAA PAPER 89-0460] p 345 A89-25376 LIJEWSKI, LAWRENCE E. Transonic Euler solutions on mutually interfering finned bodies [AIAA PAPER 89-0264] p 278 A89-25222 Efficient application techniques of the EAGLE grid code to complex missile configurations [AIAA PAPER 89-0361] p 353 A89-25305 LIM, JOON WON Aeroelastic optimization of a helicopter rotor p316 N89-16778 LINDEBERG. TONY Numerical simulation of viscous transonic flow over the DFVLR F5 wing p 291 A89-25863 LIOU, S. G. Measurement of transient vortex-surface interaction phenomena [AIAA PAPER 89-0833] p 289 A89-25603 LIU. C. H. Upwind Navier-Stokes solutions for leading-edge vortex flows [AIAA PAPER 89-0265] p 278 A89-25223 Navier-Stokes computations of separated vortical flows past prolate spheroid at incidence [AIAA PAPER 89-0553] p 286 A89-25443 LIU, JONG-SHANG Unsteady Euler cascade analysis [AIAA PAPER 89-0322] p 295 A89-28406 LIU, RICHARD Y. L. Vibration and aeroelastic tailoring of advanced composite plate-like lifting surfaces p 351 N89-17263 LIU. YIXIN Testing on two dimensional vertical models in a conventional wind tunnel p 292 A89-25939 LIZZA. CARL An application of heuristic search techniques to the problem of flight path generation in a military hostile p 355 A89-27611 environment LOEFFLER, ALBERT L., JR. Modeling of subsonic flow through a compact offset inlet diffuser [AIAA PAPER 89-0639] p 288 A89-25505 LOHNER, R. Two-dimensional Euler computations on a triangular mesh using an upwind, finite-volume scheme

- [AIAA PAPER 89-0470] p 354 A89-25385 LOHNER, RAINALD
- Numerical solutions on a Pathfinder and other configurations using unstructured grids and a finite element solver
- [AIAA PAPER 89-0362] p 282 A89-25306 Adaptive H-refinement on 3-D unstructured grids for transient problems
- [AIAA PAPER 89-0365] p 283 A89-25309 LOHSE KLAUS
 - A GPS receiver antenna with integrated down-mixer p 309 A89-28299

LEVINE, WILLIAM S.

LOPEZ, MERCEDES C.

PERSONAL AUTHOR INDEX

MCCROSKEY, W. J.	
A critical assessment of wind tunnel 0012 airfoil	results for the NACA p 300 N89-16847
MCDONELL, V. G.	
Evolution of particle-laden jet flows experimental study	p 348 A89-27693
MCFARLAND, RICHARD H.	vott
[AIAA PAPER 89-0809]	p 304 A89-25592
MCGINLEY, C. B.	ne of a Boeing 737
airplane	ge of a booling 707
[AIAA PAPER 89-0209]	p 295 A89-28404
Influence of wing geometry on leadi	ng-edge vortices and
vortex-induced aerodynamics at supe	p 274 A89-25075
MCGREW, JEAN A.	
Results of the AIA/ATA/FAA Dy Program	namic Seat Testing
[SAE PAPER 881375]	p 304 A89-28187
Numerical study of single imping	ing jets through a
Crossflow	n 284 A89-25367
MCGUIRK, JAMES J.	p 204 100-2000
Shock capturing using a pressur	n 345 A89-25450
MCKINZIE, D. J.	
Control of laminar separation ove excitation	r ainolis by acoustic
[AIAA PAPER 89-0565]	p 288 A89-25454
MCLEAN, J. DOUGLAS Spanload optimization for stre	ngth designed lifting
Surfaces	n 214 AB0-28252
MCMAHON, H. M.	p 314 A03-20232
Measurement of transient vortex-	surface interaction
[AIAA PAPER 89-0833]	p 289 A89-25603
MCMAHON, ROBERT D. A free-trailing vane flow direction	indicator employing
a linear output Hall effect transduce	- 926 A90 27675
MCMASTER, D. L.	p 330 A09-27075
Supersonic, transverse jet from a r	otating ogive cylinder
MECHERLE, G. S.	p 204 7.00 27.20
Laser communication test system	D 349 N89-17215
MEIFFREN, J. L.	
State-of-the-art in non-destructive engine parts	p 350 N89-17261
MELSON, W. EDWARD	r oprodynamic testing
of large-scale wing sections in a s	imulated natural rain
environment	n 337 A89-28457
MELTON, JOHN E.	
TranAir and Euler computations	of a generic fighter
[AIAA PAPER 89-0263]	p 310 A89-25221
MELVIN, W. W. Overview of optimal trajectori	ies for flight in a
windshear	n 206 A80 08464
MENDEZ, BRUCE	p 300 A03-20404
The national aero-space plane	p 317 N89-18387
A set of strongly coupled, up	owind algorithms for
computing flows in chemical noneq [AIAA PAPER 89-0199]	ulibrium p 277 A89-25174
Viscous swirling nozzle flow	
[AIAA PAPER 89-0280] MERRINGTON, G. L.	p 279 A89-25237
Identification of dynamic character	istics for fault isolation
purposes in a gas turbine measurements	p 328 N89-16813
METWALLY, O. M.	shock wave/vortov
interaction	SHOCK WAVE/ VOICEA
[AIAA PAPER 89-0082]	p 273 A89-25072
MEILUEN, U. C.	P 210 100 20010
Single and multiple jet impinger	nent heat transfer on
Single and multiple jet impinger rotating disks	nent heat transfer on
Single and multiple jet impinger rotating disks [AIAA PAPER 89-0174] Influence of clearance leakage o	nent heat transfer on p 344 A89-25150 n turbine heat transfer
Single and multiple jet impinger rotating disks [AIAA PAPER 89-0174] Influence of clearance leakage o at and near blade tips - Summary ([AIAA PAPER 89-0327]	p 244 A89-25150 n turbine heat transfer on n turbine heat transfer of recent results p 344 A89-25275
Single and multiple jet impinger rotating disks [AIAA PAPER 89-0174] Influence of clearance leakage o at and near blade tips - Summary of [AIAA PAPER 89-0327] METZGER, DAVID W.	nent heat transfer on p 344 A89-25150 n turbine heat transfer of recent results p 344 A89-25275
Single and multiple jet impinger rotating disks [AIAA PAPER 89-0174] Influence of clearance leakage o at and near blade tips - Summary o [AIAA PAPER 89-0327] METZGER, DAVID W. Field enhancement of UHF-VHF [AD-A200180]	p 344 A89-25150 n turbine heat transfer of recent results p 344 A89-25275 aircraft antennas p 349 N89-17069
Single and multiple jet impinger rotating disks [AIAA PAPER 89-0174] Influence of clearance leakage o at and near blade tips - Summary of [AIAA PAPER 89-0327] METZGER, DAVID W. Field enhancement of UHF-VHF [AD-A200180] MEYER, THOMAS G.	nent heat transfer on p 344 A89-25150 n turbine heat transfer of recent results p 344 A89-25275 aircraft antennas p 349 N89-17069
Single and multiple jet impinger rotating disks [AIAA PAPER 89-0174] Influence of clearance leakage o at and near blade tips - Summary of [AIAA PAPER 89-0327] METZGER, DAVID W. Field enhancement of UHF-VHF [AD-A200180] MEYER, THOMAS G. High temperature constitutive modeling of coated single crystal s	nent heat transfer on p 344 A89-25150 n turbine heat transfer of recent results p 344 A89-25275 aircraft antennas p 349 N89-17069 and crack initiation uperalloys

LOPEZ, MERCEDES C. Fore-and-aft stiffness and dampi x 11.5-14.5, Type VIII, bias-ply ar	ng characte nd radial-be	eristics of 30 Ited aircraft
tires	o 313	A89-28176

[SAL FALLIN CONCOUNT			
LORDI, J. A.			
Facility requirements	for hypersonic	propuls	ion system

testing p 335 A89-25159 [AIAA PAPER 89-0184] LOWREY JAMES A., III

VERDICT - A plan for gravity compensation of inertial p 307 A89-26724 navigation systems LOWSON MARTIN V.

- Visualization measurements of vortex flows p 276 A89-25166 AIAA PAPER 89-01911
- LOZOWSKI, EDWARD P. Use of the median volume droplet diameter in the characterization of cloud droplet spectra
- p 352 A89-25562 [AIAA PAPER 89-0756] LU, ZHILIANG A prediction of the stalling of the multielement airfoils
- p 292 A89-25932 LUCKRING, JAMES M.
- A patched-grid algorithm for complex configurations directed towards the F-18 aircraft
- p 310 A89-25106 [AIAA PAPER 89-0121] Navier-Stokes solutions about the F/A-18 forebody-LEX configuration
- [AIAA PAPER 89-0338] p 281 A89-25285 LUDTKE, WILLIAM P.
- Notes on a theoretical parachute opening force analysis applied to a general trajectory p 302 N89-17582
- AD-42010501 LUERS. JAMES K.
- Analysis of Arrow Air DC-8-63 accident Gander, Newfoundland on 12 December 1985 p 305 A89-28448 [AIAA PAPER 89-0706]
- LUNDERSTAEDT, R. Gas path modelling, diagnosis and sensor fault p 321 N89-16811 detection
- LUTTGES, MARVIN W. Dragonfly unsteady aerodynamics The role of the wing phase relations in controlling the produced flows p 289 A89-25602 [AIAA PAPER 89-0832]
- LUZHETSKII. V. K. Problems of ensuring civil-aircraft fire safety p 304 A89-27249
- LYNCH, F. T. Wind tunnel-sidewall-boundary-layer effects in transonic airfoil testing-some correctable, but some not
- p 338 N89-16864 LYONS, WALTER A. National lightning detection - A real-time service to
- aerospace p 352 A89-25578 [AIAA PAPER 89-0787]
- LYSENKO, V. I. Evolution of perturbations near a surface in supersonic
- p 294 A89-27384 flow

M

- MAARSINGH, R. A.
- Accuracy of various wall-correction methods for 3D p 338 N89-16863 subsonic wind-tunnel testing MACCORMACK, ROBERT W.
- Nonequilibrium effects for hypersonic transitional flows using continuum approach p 284 A89-25377 [AIAA PAPER 89-0461]
- MACKINTOSH, G. B.
- Installed thrust as a predictor of engine health for jet p 327 N89-16806 engines MACLEOD. J. D.
- The effects of a compressor rebuild on gas turbine ngine performance p 327 N89-16803 engine performance MADAVAN, N. K.
- Grid refinement studies of turbine rotor-stator interaction p 281 A89-25274
- [AIAA PAPER 89-0325] MADSON, MICHAEL D.
- TranAir and Euler computations of a generic fighter including comparisons with experimental data p 310 A89-25221 [AIAA PAPER 89-0263]
- MAIDA, JAMES L. A Kalman filter for an integrated Doppler/GPS navigation
- p 308 A89-26740 system MAKKONEN, LASSE
- Use of the median volume droplet diameter in the characterization of cloud droplet spectra p 352 A89-25562 [AIAA PAPER 89-0756]
- MALDONADO, MIGUEL A. Experimental cascaded doubly fed variable speed
- constant frequency generator system [SAE PAPER 881409] p 324 A89-28258

MANDEL. ERIC

- Severe weather Impact on aviation and FAA programs in response p 352 A89-25583
- [AIAA PAPER 89-0794] MANNING, S. L
- Thermal barrier coating life prediction model p 351 N89-17333 development MANSOUR, NAGI N.
- The effect of Mach number on the stability of a plane supersonic wave p 280 A89-25242 [AIAA PAPER 89-0285]
- MARCHENKO, V. M.
- Modal control in systems with aftereffect p 354 A89-26038 MARKUNAS. ALBERT L.
- A dynamic model for vapor-cycle cooling systems p 313 A89-27809 [SAE PAPER 881001]
- MARMIGNON, C.
- Fast laminar near wake flow calculation by an implicit method solving the Navier-Stokes equations p 270 A89-24923 MARTIN, GARDNER R.
- Superplastic formed aluminum-lithium aircraft structure p 316 N89-17591 [AD-A200245] MARTIN, JAMES L
- Simulation evaluation of transition and hover flying qualities of the E-7A STOVL aircraft p 333 A89-28205 [SAE PAPER 881430]
- MARTIN, JAMES P. Aviation security: A system's perspective
- p 306 N89-16766 [DE89-002020] MARTINEZ CABEZA, JOSE A.
- Materials for interiors A brief review of their current p 342 A89-28433 status MASHKIVSKII, I. E.
- Research pressed to improve flight information contribution to aircraft accident investigations p 318 A89-27247
- MASKEW, BRIAN Development of a panel method for modeling configurations with unsteady component motions, phase
- p 315 N89-16775 [AD-A200255] MASTERS, CHARLES O.
- Electro-impulse de-icing systems Issues and concerns for certification p 314 A89-28456
- [AIAA 89-0761] MASUI, KAZUYA The current status of the flight test of the ASKA
- p 314 A89-28208 [SAE PAPER 881433] MAUGHMER, MARK D.
- Design and experimental results for a high-altitude p 312 A89-27740 long-endurance airfoil MAUTNER, T. S.
- Preliminary results in the development of a method to correct propeller inflow for improved unsteady force calculations TAIAA PAPER 89-0436] p 293 A89-26374
- MAY, MARVIN VERDICT - A plan for gravity compensation of inertial
- p 307 A89-26724 navigation systems MAYNARD, EVERETT

National full-scale aerodynamic complex integrated p 335 A89-27653 systems test data system MAZAREANU, S.

- Fault management in aircraft power plant controls p 327 N89-16809
- MAZUR, KIM M. Mechanization, design and methodological lessons learned from a dynamic cockpit mock-up evaluation p 319 A89-28213 [SAE PAPER 881438]
- MAZUR, VLADISLAV Lightning initiation on aircraft in thunderstorms
- p 353 A89-26214 MCARTHUR, J. CRAIG
- Laser holographic interferometric measurements of the flow in a scramjet inlet at Mach 4
- p 273 A89-25037 [AIAA PAPER 89-0043] MCAULIFFE, P. S.
- Superplastic formed aluminum-lithium aircraft structure p 316 N89-17591 [AD-A200245] MCBRIDE, BONNIE J.
- Experimental verification of the thermodynamic properties for a jet-A fuel
- p 342 N89-17017 NASA-TM-1014751 MCCONNAUGHEY, PAUL K.
- Comparison of LDV measurements and Navier-Stokes solutions in a two-dimensional 180-degree turn-around duct
- [AIAA PAPER 89-0275] p 279 A89-25232 MCCRARY, E. B.
- Do pilots let aircraft operations schedules influence nroute turbulence avoidance procedures?
- p 303 A89-25558 [AIAA PAPER 89-0743]

MEYERS, JAMES F.		
angles of attack	at moo	lerate to high
[SAE PAPER 881448] MICHAUD NORMAN H	p 295	A89-28218
Utilization of wind tunnel instrume verifications	ntation p 335	with software A89-27654
MIELE, A. Overview of optimal trajectori	os for	flight in a
windshear		mgni ni a
[AIAA 89-0812] MILLER, T. J.	p 306	A89-28464
An experimental and computat isothermal swirling flow in an combustor	axisymr	vestigation of netric dump
[AIAA PAPER 89-0620] MINCER, EARL	p 323	A89-25491
Aircraft automation with an elec [SAE PAPER 881415]	p 318	brary system A89-28199
A one equation turbulence mode	l for tra	nsonic airfoil
[AIAA PAPER 89-0557]	p 287	A89-25446
Aircraft design education at Ne University	orth Ca	rolina State
[AIAA PAPER 89-0649]	p 357	A89-25513
MITTY, TODD J. Oscillatory flow field simulation in	n a blo	w-down wind
tunnel and the passive shock wave/b concept	oundary	layer control
[AIAA PAPEH 89-0214] MODI, V. J.	p 278	A89-25188
Moving surface boundary-layer co two-dimensional airfoils	ontrol a	s applied to
[AIAA PAPER 89-0296]	p 281	A89-25253
Accuracy requirements for high-sp	eed tes	t with engine
simulation on transport aircraft mode	p 338 p	NLR-HST N89-16870
Aeroelastic flutter of low aspe	ect ratio	cantilever
MOHLEJI, SATISH C.	p 347	A89-26281
Air traffic control automation conce management system utilization MOIN. PARVIZ	pts to o p 307	ptimize flight A89-26733
On the structure of two- and	d three	-dimensional
[AIAA PAPER 89-0287]	p 280	A89-25244
Moving surface boundary-layer c	ontrol a	s applied to
[AIAA PAPER 89-0296]	p 281	A89-25253
Design of an all boron/epoxy doub	ler reinf	prcement for
the F-111C wing pivot fitting - Structu	ural aspo p 313	ects A89-27925
MOLVIK, GREGORY A. A set of strongly coupled, upv	vind ald	orithms for
computing flows in chemical nonequi [AIAA PAPER 89-0199]	librium p 277	A89-25174
MONGIA, H. C. Correlations of high density fuel eff	fects	
[AIAA PAPER 89-0216] 3-D combustor performance validat	p 340 tion with	A89-25190 high density
fuels [AIAA PAPER 89-0219]	D 340	A89-25193
Evolution of particle-laden jet flows	s - A the	oretical and
Aerothermal modeling program. P	hase 2,	element B:
How interaction experiment MONSON, DARYL J.	p 351	N89-17304
Comparison of LDV measurements solutions in a two-dimensional 180-	s and N degree	avier-Stokes turn-around
[AIAA PAPER 89-0275] MOOK. D. T.	p 279	A89-25232
Application of continuous vo	orticity	panels in
[AIAA PAPER 89-0117] MOON, JOHN	p 275	A89-25104
The wind tunnels of the national full- complex	-scale a p 339	orodynamics N89-18388
Aerodynamic prediction rationale	e for a	analyses of
[AIAA PAPER 89-0525]	p 285	A89-25420
Supersonic throughflow fans	p 330	N89-16837
MUCHHEAD, PAUL E. Structural response of an advance	ed com	bustor liner:
MORAN, MARK S.	p 351	1489-17329
Supersonic low-density flow over a [AIAA PAPER 89-0530]	p 286	A89-25424

An adaptive implicit/explicit finit	te element	scheme for
compressible viscous high speed t	flow	
[AIAA PAPER 89-0363]	p 344	A89-25307
ORGAN, KEN	-	
A three-dimensional upwind finite	e element	point implicit
unstructured grid Euler solver		
[AIAA PAPER 89-0658]	p 289	A89-25521
ORRIS, ANGELA	•	
-		

MORGAN, K.

High reliability aircraft generator system [SAE PAPER 881414] p 325 A89-28263 MORRIS, M. J.

Confined normal-shock/turbulent-boundary-layer Interaction followed by an adverse pressure gradient [AIAA PAPER 89-0354] p 282 A89-25299 MORRISON, JOSEPH H.

Heat transfer and pressure comparisons between computation and wind tunnel for a research hypersonic aircraft [AIAA PAPER 89-0029]

- p 272 A89-25025 MOSELEY, DOUGLAS D. Performance testing of an electrically actuated aircraft braking system
- [SAE PAPER 881399] p 313 A89-28194 MÖSS, J. N.

Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies

p 295 A89-28251 [AIAA PAPER 88-0460] MÒSS, JAMES N. Three-dimensional flow simulation about the AFE vehicle

in the transitional regime [AIAA PAPER 89-0245] p 278 A89-25207

- MÒSS, RICHARD W.
- Mechanization, design and methodological lessons learned from a dynamic cockpit mock-up evaluation p 319 A89-28213 [SAE PAPER 881438]
- MOSTAFA. A. A. Evolution of particle-laden jet flows - A theoretical and experimental study p 348 A89-27693
- MUELLER. 8. Comparison of two different Navier-Stokes methods for the simulation of 3-D transonic flows with separation [AIAA PAPER 89-0559] p 287 A89-25448

MUELLER, BERNHARD Numerical simulation of viscous transonic flow over the DFVLR F5 wing p 291 A89-25863

- MUELLER, R. Expriments on the DFVLR-F4 wing body configuration in several European windtunnels p 337 N89-16848 MUELLER, T. J.
- Boundary layer measurements on an airfoil at low Reynolds numbers in an accelerating flow from a nonzero
- base velocity [AIAA PAPER 89-0569] p 288 A89-25458 MUELLER, THOMAS J.
- Tip vortex/airfoil interaction for a canard//wing configuration at low Reynolds numbers [AIAA PAPER 89-0536] p 286 A89-25430
- MUR. D. E. CF-18 engine performance monitoring
- p 326 N89-16787 MURPHY, N. A. D.
- Analytical wing weight prediction/estimation using computer based design techniques p 316 N89-17589 MURPHY, RONALD D. Amber for long endurance p 269 A89-26673 p 269 A89-26674
- Condor for high altitudes MURTHY, A. V. Sidewall boundary-layer removal effects on wall
- adaptation in the Langley 0.3-meter transonic cryogenic tunnel [AIAA PAPER 89-0148] p 334 A89-25131
- MURTHY, DURBHA V. A computational procedure for automated flutter
- analysis MURTHY, S. N. B. p 348 A89-28070
- Effect of heavy rain on aviation engines [AIAA 89-0799] p 326 A89-28462
- Aerothermal modeling program. Phase 2, element B: Flow interaction experiment p 351 N89-17304 MYERS, DENNIS A.
 - F100-PW-220 engine monitoring system
 - p 320 N89-16795

Ν

- NAGAMATSU, H. T.
- Hypersonic scramjet inlet flow investigations, M1 = 16-26 [AIAA PAPER 89-0003] p 270 A89-25002
- NAGAMATSU, HENRY T. Oscillatory flow field simulation in a blow-down wind
- tunnel and the passive shock wave/boundary layer control concen [AIAA PAPER 89-0214]
 - p 278 A89-25188

NAGARAJ, N.
Computational design aspects of a NASP
nozzle/afterbody experiment
[AIAA PAPEH 89-0446] p 284 A89-25364
NAGEL, A. L.
Stability of 3D wing boundary layer on a SST
T-100 Multipurpose Small Power Unit - Technology for
the next generation auxiliary power units
[SAE PAPER 881501] p 349 A89-28267
NARAYAN, J. R.
A numerical study of hypersonic propulsion/airframe
integration problem
[AIAA PAPER 89-0030] p 272 A89-25026
NARAYANA, H. V. L.
Vibration and flutter analysis of composite wing panels
p 346 A89-26273
NATHMAN, JAMES K.
Inermal analysis of engine inlet anti-icing systems
[AIAA FAFER 09-0/09] p 311 A89-25565
Design of automation tools for management of descent
traffic
[NASA-TM-101078] 0.306 N89-17584
NEJAD. A. S
An experimental and computational investigation of
isothermal swirling flow in an axisymmetric dump
combustor
[AIAA PAPER 89-0620] p 323 A89-25491
NELSON, CURTIS F.
Unsteady, separated flow behind an oscillating,
two-dimensional flap
[AIAA PAPER 89-0288] p 280 A89-25245
NELSON, E.
Comparison of 3D computation and experiment for
Inon-axisymmetric nozzles
[DIDD PAPER 05-0007] p 325 A89-28403
A flow visualization and corodynamic factor date
evaluation of spanwise blowing on full and helf span dolta
wings
[AIAA PAPER 89-0192] D 276 A89-25167
The separated flow field on a stender wing undergoing
transient pitching motions
[AIAA PAPER 89-0194] p 276 A89-25169
NELSON, RICHARD S.
Creep fatigue life prediction for engine hot section
materials (ISOTROPIC) fifth year progress review
p 352 N89-17336
NELSON, ROBERT C.
An experimental investigation of delta wing vortex flow
with and without external jet blowing
[AIAA PAPER 89-0084] p 273 A89-25074
NERI, LAWRENCE M.
Effects of aircraft size on cabin floor dynamic pulses
[SAE FAPEH 8813/9] p 305 A89-28191
Field opportunit of UNE MUSE starts
FIERD ERRARCEMENT OF UME-VHF AIRCRAFT Antennas
[DU-D200100] D 349 N69-17069
Measurements of das turbing combustor and analysis
augmentor tube sooting characteristics
[AD-A199768] p 328 N89-16821
NEWBERG, CARL E.
Thermal conductivity and microstructure stability of heat
treated AMZIRC copper-based alloys
p 341 A89-26361
NEWBOLD, W. D.
A self-adaptive computational method applied to
trapponio turbulant projectile coredunamice

- [AIAA PAPER 89-0837] p 290 A89-25606 NEWMAN, F. A.
- The design and development of transonic multistage compressors p 329 N89-16834
- NEWMAN, P. A. Emerging technology for transonic wind-tunnel-wall interference assessment and corrections
- p 336 A89-28220 [SAE PAPER 881454] NEWTON, DENNIS W.
- Weather accident prevention using the tools that we have
- [AIAA PAPER 89-0707] p 302 A89-25547 NG, JAMES
- Electromagnetic emissions from a modular low voltage EIDI system
- [AIAA PAPER 89-0758] p 303 A89-25564 NG. T. T.
 - A flow visualization and aerodynamic force data evaluation of spanwise blowing on full and half span delta wings [AIAA PAPER 89-0192]
 - p 276 A89-25167

NG, T. TERRY

NG, T. TERRY

An experimental investigation of delta wing vortex flow with and without external jet blowing [AIAA PAPER 89-0084] p 273 A89-25074

- NG. WING-FAI An improved upwind finite volume relaxation method for
- high speed viscous flows p 286 A89-25441 TATAA PAPER 89-05491
- NI. RON-HO R. Prediction of 3D multi-stage turbine flow field using a
- multiple-grid Euler solver [AIAA PAPER 89-0203] p 277 A89-25178 NIKJOOY, M.
- Aerothermal modeling program. Phase 2, element B: Flow interaction experiment p 351 N89-17304 NISHI, MICHIHIRO
- Vortex generator jets A means for passive and active control of boundary layer separation 1AIAA PAPER 89-0564] p 287 A89-25453
- NISSLEY, DAVID M. High temperature constitutive and crack initiation
- modeling of coated single crystal superalloys p 342 N89-17334
- NIXON, D. Modifications to transonic flow codes for unsteady perturbations around an experimental mean p 284 A89-25365 [AIAA PAPER 89-0447]
- NOBRE. A. Fault management in aircraft power plant controls p 327 N89-16809
- NORDMAN, JOSEPH H. Remotely Piloted Vehicle (RPV) two versus three level
- maintenance support concept study p 270 N89-17564 [AD-A200665] NOWAK, B.
- Material defects in a PM-nickel-base superalloy p 341 A89-25919
- NUMBERS, KEITH E. p 298 N89-16740 Tactical fighter inlets NYBERG, GREGORY A.
- Oscillatory flow field simulation in a blow-down wind tunnel and the passive shock wave/boundary layer control concept [AIAA PAPER 89-0214] p 278 A89-25188
- 0
- O'LEARY, C. O.
- Measurements of the oscillatory lateral derivatives of a high incidence research model (HIRM 1) at speeds up p 332 A89-26688 to M = 0.8 O'MARA, T. M.
- Determination of longitudinal aerodynamic derivatives using flight data from an icing research aircraft p 333 A89-28454 [AIAA 89-0754]
- OBAYASHI, SHIGERU Navier-Stokes simulation of wind-tunnel flow using
- p 291 A89-25864 LU-ADI factorization algorithm OCHOA, OZDEN O.
- Nonlinear dynamic responses of composite rotor blades p 315 N89-16774
- [AD-A2001451 OCONNOR, C. M.
- Military engine condition monitoring systems: The UK p 320 N89-16797 experience OKADA, NORIAKI
- The current status of the flight test of the ASKA p 314 A89-28208 [SAE PAPER 881433]
- OMAR. M. EMMETT Pressure and heat transfer investigation of a modified
- NASP baseline configuration at M = 6 p 339 A89-25208 [AIAA PAPER 89-0246]
- ONOFRI, M. On the solution of nonequilibrium hypersonic inviscid steady flows
- [AIAA PAPER 89-0671] p 289 A89-25532 ORAN. E. S.
- Computational studies of a localized supersonic shear
- [AIAA PAPER 89-0125] p 275 A89-25110 Effects of energy release on high-speed flows in an axisymmetric combustor
- [AIAA PAPER 89-0385] p 283 A89-25326 Acoustic-vortex interactions and low-frequency
- oscillations in axisymmetric combustors p 325 A89-28336 ORTIZ, M.
- prediction model Thermal barrier coating life p 351 N89-17333 development OSTRANDER MARK J.
- CFD simulation of square cross-section, contoured nozzle flows - Comparison with data p 273 A89-25039 TAIAA PAPER 89-00451

OWEN. C. R. Aluminum quality breakthrough for aircraft structural n 348 A89-27745

[AIAA PAPER 89-0123]

- OYIBO, GABRIEL A.
- Some implications of warping restraint on the behavior p 312 A89-27747 of composite anisotropic beams

P

- PAAS, J. E.
- Commercial engine monitoring status at GE Aircraft p 320 N89-16799 Engines, Cincinnati, Ohio PAGE, GARY J.
- Shock capturing using a pressure-correction method [AIAA PAPER 89-0561] p 345 A89-25450 PAGLIUSO, SALVATORE
- Joining of carbon fiber composite with fasteners p 343 N89-17701
- PALLISTER, K. C.
 - Development of testing techniques in a large transonic wind tunnel to achieve a required drag accuracy and flow standards for modern civil transports
- p 337 N89-16857 PALMER, GRANT
- An efficient, explicit finite-rate algorithm to compute flows in chemical nonequilibrium
- [AIAA PAPER 89-0522] p 285 A89-25418 PALUMBO, BENITO
- Some new ideas in radar antenna technology p 347 A89-26542
- PANTON, RONALD L.
- The effects of a contoured apex on vortex breakdow p 276 A89-25168 [AIAA PAPER 89-0193] PAPAMOSCHOU, DIMITRI
- Structure of the compressible turbulent shear layer p 275 A89-25111 [AIAA PAPER 89-0126]
- PARIKH, P. G. Stability of 3D wing boundary layer on a SST
- configuration [AIAA PAPER 89-0036] p 272 A89-25031 PARIKH, PARESH
- Numerical solutions on a Pathfinder and other configurations using unstructured grids and a finite element solve
- [AIAA PAPER 89-0362] p 282 A89-25306 PARKER. CRAIG B.
- Weather data dissemination to aircraft p 304 A89-25592 [AIAA PAPER 89-0809]
- PARLETTE, EDWARD B.
- Heat transfer and pressure comparisons between computation and wind tunnel for a research hypersonic aircraft [AIAA PAPER 89-0029] p 272 A89-25025
- PARTIPILO, V. A. Single and multiple jet impingement heat transfer on
- rotating disks [AIAA PAPER 89-0174] p 344 A89-25150
- PATKI, A. V.
- Structural reliability in aerospace design p 340 A89-27175
- PAULEY, LAURA L. On the structure of two- and three-dimensional separation
- p 280 A89-25244 [AIAA PAPER 89-0287] PAULEY, WAYNE R. Diverging boundary layers with zero streamwise pressure aradient
- p 343 A89-25118 AIAA PAPER 89-01341
- PAYNE, FRED R. vortex-ring model for microburst unsteady simulation
- [AIAA PAPER 89-0811] p 353 A89-25594 PEARSON, H. R.
- Superplastic formed aluminum-lithium aircraft structure p 316 N89-17591 [AD-A200245] PEIRO, JOAQUIN
- A three-dimensional upwind finite element point implicit unstructured grid Euler solver
- p 289 A89-25521 TAIAA PAPER 89-06581 PELLETIER, DOMINIQUE
- Passage-averaged Navier-Stokes equations with finite lement applications p 344 A89-25183 [AIAA PAPER 89-0208]
- Finite element simulation of 3D turbulent free shear p 294 A89-26946 flows PENCIKOWSKI, PAUL
- Reconfigurable cockpit development
- [SAE PAPER 881472] p 319 A89-28224 PERAIRE, J.
- An adaptive implicit/explicit finite element scheme for compressible viscous high speed flow p 344 A89-25307 [AIAA PAPER 89-0363]

PERSONAL AL	JTHOR INDEX	
PERAIRE, JAIME A three-dimensional upwind finite ele	ement point implicit	
unstructured grid Euler solver [AIAA PAPER 89-0658] PERALA, RODNEY A.	p 289 A89-25521	
Lightning triggered by the preser vehicles	nce of aerospace p353 A89-26215	
PERDZOCK, JOHN Laboratory and flight evaluation of th Sensor Assembly (IISA)	e Integrated Inertial p 307 A89-26708	
PERKINS, J. N. Aircraft design education at Not	rth Carolina State	
[AIAA PAPER 89-0649] PERRY, F. J.	p 357 A89-25513	
The contribution of planform area to of the BERP rotor	p 314 A89-28350	
National lightning detection - A re- aerospace	al-time service to	
PETITNIOT, JL.	f the crach behavior	
of helicopters and fixed-wing aircraft	p 309 A89-24919	
PFENNINGER, WERNER Optimization of natural laminar flusection lift-to-drag ratios in the lower	ow airfoils for high r Reynolds number	
range [AIAA PAPER 89-0539] PHN 1 IPS JAMES D	p 296 A89-28428	
Modal control of an oblique wing ai [NASA-TP-2898]	rcraft p 333 N89-16845	
Particular flight mechanics specifical tunnel test results	tions related to wind p 339 N89-16879	
PICKETT, GORDON F. CFD applications - Propulsion persy [AIAA PAPER 89-0093]	pective p 343 A89-25082	
PIKE, J. A. Prop-fan airfoil icing characteristics [AIAA PAPER 89-0753]	p 303 A89-25561	
PIRZADEH, SHAHYAR Numerical solutions on a Path configurations using unstructured grids	hfinder and other s and a finite element	
solver [AIAA PAPER 89-0362]	p 282 A89-25306	
Adaptive computations of multispec scramjet nozzle flows and hypersonic	cies mixing between c freestream	
An Euler analysis of leading-edge forebody-strake at supersonic speeds	vortex flows on a s	
[AIAA PAPER 89-0343] PODBOY, GARY G.	p 293 A89-26371	
generated by an advanced counterro [AIAA PAPER 89-0434]	p 293 A89-26373	
High-temperature containerless experimentation in the microgravity	aircraft furnace environment aboard	
a KC-135 aircraft [AIAA PAPER 89-0402] POPE, G. T.	p 345 A89-25337	
Laser communication test system [AD-A199612]	p 349 N89-17215	
Unsteady separation wave in a s layer	p 293 A89-26011	
POTAPCZUK, M. Modeling of surface roughness (accretion	effects on glaze ice	
[AIAA 89-0734] POTAPCZUK, MARK G.	p 305 A89-28451	
An overview of the current NASA icing research	program on aircraft	
[SAE PAPER 001300] An experimental investigation of m accretion and resulting performance [AIAA 89-0752]	p 305 AS9-20192 ulti-element airfoil ice degradation p 297 A89-28453	
POWELL, DAVID J. Applications of an AI design she advanced engineering products	ell ENGINEOUS to p 355 A89-27618	
PROVOST, M. J. COMPASS (Trademark): A gener monitoring system	alized ground-based	1
PUJOL, C. Precision improvement of tran	sport aircraft drag	I
measurements PULLIAM, THOMAS H.	p 300 N89-16858	
	p 275 A89-25108	

Q

QUACKENBUSH, TODD R. Vortex dynamics for	or rotorcraft	interactional
aerodynamics [AD-A200128]	p 297	N89-16726
QUEMARD, C. Comparison of the result	ts of tests on A3	00 aircraft in
	p 300	N89-16849
The turbulent free jet is	ssuing from a s	harp-edged
emptical slot [AIAA PAPER 89-0664]	p 345	A89-25526
F	3	
Unbalanced and nonline	ar loads in aircr	aft electrical
[SAE PAPER 881413] RADESPIEL, R.	p 325	A89-28262
An investigation of cell cel schemes for the Navier-Sto	ntered and cell ve kes equations	rtex multigrid
[AIAA PAPER 89-0548] Feasibility study on the	p345 design of a l	A89-25440 aminar flow
nacelle [AIAA PAPER 89-0640]	- р 311	A89-25506
RAI, M. M. Grid refinement studie	s of turbine	rotor-stator
interaction [AIAA PAPER 89-0325]	p 281	A89-25274
RAJAGOPAL, P. Vibration and flutter analy	sis of composite	wing panels
RAMACHANDRAN, K.	p 346	A89-26273
The free-wake prediction using a vortex embedding m	of rotor hover p ethod	performance
(AIAA PAPER 89-0638) RAMAMURTHY, M. R.	p 296	A89-28443
RAMAN. SOWMYAN	p 346 p 346	wing panels A89-26273
Flight mission sce knowledge-based system	nario generat p 355	ion with A89-27614
RAMANI, T. S. Vibration and flutter analys	sis of composite	wing panels
-	p 346	A89-26273
RAMSEY, M. A. Superplastic formed alumi [AD-A200245]	num-lithium aircra	aft structure
RANAUDO, R. J. Determination of longitudi	nal aerodynamic	derivatives
using flight data from an icin [AIAA 89-0754]	g research aircra p 333	ft A89-28454
RANAUDO, RICHARD J. An overview of the curren	t NASA program	on aircraft
[SAE PAPER 881386]	p 305	A89-28192
RANGAIAH, V. P. Aeroelastic flutter of lo	w aspect ratio	cantilever
composite plate RAY, E. J.	p 347	A89-26281
adaptation in the Langley 0.3	removal effects 3-meter transonio	s on wall c cryogenic
[AIAA PAPER 89-0148]	p 334	A89-25131
Local buckling and cripplin structures under axial compre	ng of thin-walled	composite
REDEKER, G. Feasibility study on the	design of a la	minar flow
nacelle [AIAA PAPER 89-0640]	D 311	A89-25506
Expriments on the DFVLR in several European windtunr	F4 wing body co nels p 337	nfiguration N89-16848
REEHORST, A. L. Determination of longitudir	nal aerodynamic	derivatives
using flight data from an icing [AIAA 89-0754]	research aircrafi p 333	t A89-28454
REEHORST, ANDREW L. An overview of the current	t NASA program	on aircraft
icing research [SAE PAPER 881386]	p 305	A89-28192
Local buckling and cripplin	g of thin-walled	composite
structures under axial compre REU, TAEKYU	ission p 341	A89-27733
A patched-grid algorithm f directed towards the F-18 aird	or complex conf craft	igurations
EUBUSH, DAVID E.	p 310	A89-25106
NASP baseline configuration a	investigation of at M = 6	a modified
LAIAA PAPER 89-02461	D 339 /	A89-25208

REUTER, D. M.		
ramjets	oustion rates in unstable	
[AIAA PAPER 89-0105] REYNOLDS, W. C.	p 322 A89-25092	
The compressible mixing layer - simulation	Linear theory and direct	
[AIAA PAPER 89-0371]	p 283 A89-25314	
On the structure of two-	and three-dimensional	
separation [AIAA PAPER 89-0287]	p 280 A89-25244	
RHODE, D. L. Combustor air flow prediction	n canability comparing	
several turbulence models	p 349 A89-28345	
Zonal modelling of flows throu	ugh multiple inlets and	
[AIAA PAPER 89-0005]	p 271 A89-25003	
RICHARDSON, PAMELA F. Heat transfer and pressure	comparisons between	
computation and wind tunnel for aircraft	a research hypersonic	
[AIAA PAPER 89-0029]	p 272 A89-25025	
System-theoretical method for	dynamic on-condition	
RIDDLE, DENNIS W.	p 321 N89-16812	
Flight measured downwash of th [NASA-TM-101050]	he QSRA p 316 N89-17593	
RILEY, JAMES J. The effects of walls on a con	noressible mixing laver	
[AIAA PAPER 89-0372]	p 283 A89-25315	
A highly reliable DC power	source for avionic	
subsystems [SAE PAPER 881408]	p 324 A89-28257	
RIZK, N. K. Correlations of high density fuel	effects	
[AIAA PAPER 89-0216] 3-D combustor performance valid	p 340 A89-25190	
	action with high density	
RIZK, YEHIA M.	p 340 A89-25193	
Numerical simulation of high-in F-18 fuselage forebody	cidence flow over the	
[AIAA PAPER 89-0339] BIZZI, ARTHUR	p 282 A89-25286	
Numerical simulation of viscous t	transonic flow over the	
ROBERTS, L	p 291 A89-25863	
jets	control by Coanda wall	
[AIAA PAPER 89-0149] ROBERTS, LEONARD	p 334 A89-25132	
Numerical study of the effect of ta blowing on delta wing vortical flow	angential leading edge	I
[AIAA PAPER 89-0341]	p 282 A89-25288	
Pneumatic link secondary powe	r systems for military	
aircraft [SAE PAPER 881499]	p 325 A89-28265	
RODMAN, L. C. Modifications to transonic flow	V codes for unsteady	
perturbations around an experiment	tal mean	5
ROGERS, STEVEN P.	for the allot (active	
interface	y for the pilot/venicle	ŝ
[SAE PAPER 881440] ROH, J.	p 319 A89-28214	
Extended pitch axis effects on t airfoil	flow about a pitching	5
[AIAA PAPER 89-0025]	p 272 A89-25021	
Scissor wing - An alternative to v	ariable sweep	
IOMANOFF, H. P.	p 310 A89-25009	-
mission types	ng relationships: All	S
[AD-A200262] Aircraft airframe cost estimating r	p 269 N89-16719 elationships: Fighters	
[AD-A200263] Aircraft airframe cost estimation re	p 270 N89-16720	S
and transports	- 070 Non 1070-	
Aircraft airframe cost estimating	p 270 N89-16721 relationships: Attack	s
aircraft [AD-A200265]	p 270 N89-16722	
OME, JAMES H. Causal probability model for	transoceanic track	~
separations with applications to au	AUBOOODING (FBCK	S
<u>europillanco</u>	tomatic dependent	
SURVEILLANCE CONEY, E. C.	itomatic dependent p 308 A89-26735	

Wind tunnel predicted air vehicle performance: A review of lessons learned p 337 N89-16852

c

Effects of leading-edge shape and vortex burst on the flowfield of a 70-degree-sweep delta-wing [AIAA PAPER 89-0086] p 274 A89-25076 ROSE, DIETER Typical joints in a wing structure p 317 N89-17693 ROSE, O. J. An Euler analysis of leading-edge vortex flows on a forebody-strake at supersonic speeds [AIAA PAPER 89-0343] p 293 A89-26371 ROSSOW, C. C. Analysis of three-dimensional aerospace configurations using the Euler equations [AIAA PAPER 89-0268] p 279 A89-25226 ROTH, KARLIN R. A numerical study of the contrarotating vortex pair associated with a jet in a crossflow [AIAA PAPER 89-0448] p 284 A89-25366 ROTHER, MANFRED Typical joints in a wing structure p 317 N89-17693 ROWTHORN, E. N. Measurements of the oscillatory lateral derivatives of a high incidence research model (HIRM 1) at speeds up to M = 0.8p 332 A89-26688 RUBBERT, PAUL E. CFD in design - An airframe perspective [AIAA PAPER 89-0092] p 31 p 310 A89-25081 RUDD, R. E. Fiber optic torquemeter design and development p 348 A89-27661 RUDNITSKI, D. M. CF-18 engine performance monitoring p 326 N89-16787 RUDOLPH, TERENCE H. Lightning triggered by the presence of aerospace vehicles p 353 A89-26215 RUE, A. K. Laser communication test system [AD-A199612] p 349 N89-17215 RUED. K. Influence of clearance leakage on turbine heat transfer at and near blade tips - Summary of recent results [AIAA PAPER 89-0327] p 344 A89p 344 A89-25275 RUFFIN, STEPHEN M. Computational design nozzle/afterbody experiment [AIAA PAPER 89-0446] aspects of a NASP p 284 A89-25364 RUSSELL, H. The Honeywell/DND helicopter integrated navigation system (HINS) p 308 A89-26741 p 308 A89-26741 RUSSO, CAROL J. Applications of an AI design shell ENGINEOUS to advanced engineering products p 355 A89-27618 RUTLEDGE, WALTER H. Effect of dynamic changes in body configuration on shock structure [AIAA PAPER 89-0526] p 285 A89-25421 S SAHARON, DANIEL Dragonfly unsteady aerodynamics - The role of the wing phase relations in controlling the produced flows [AIAA PAPER 89-0832] p 289 A89-25602 SAJBEN, M. normal-shock/turbulent-boundary-layer Confined

ROOS, FREDERICK W.

interaction followed by an adverse pressure gradient [AIAA PAPER 89-0354] p 282 A89-25299 SALAS, M. D. A one equation turbulence model for transonic airfoil flows [AIAA PAPER 89-0557] p 287 A89-25446 SAMUELSEN, G. S. Evolution of particle-laden jet flows - A theoretical and experimental study p 348 A89-27693 p 348 A89-27693 AND, WAYNE R. TDWR display experiences [AIAA PAPER 89-0807] p 346 A89-25590 ANDHAM. N. D. The compressible mixing layer - Linear theory and direct simulation [AIAA PAPER 89-0371] p 283 A89-25314 ANGIOVANNI, J. J. Estimates of oxides of nitrogen formed in an inlet air stream for high Mach number flight conditions [AIAA PAPER 89-0197] p 277 A89-25172 ÁNKAR, L. N. Evaluation of three turbulence models for the prediction of steady and unsteady airloads

[AIAA PAPER 89-0609] p 288 A89-25485 Technique for the prediction of airfoil flutter characteristics in separated flow p 348 A89-27744

SANKAR, LAKSHMI N.

SANKAR, LAKSHMI N. Numerical simulation of the growth of instabilities in supersonic free shear layers

- [AIAA PAPER 89-0376] p 283 A89-25319 SAPSARD, M. J. Recent UK trials in engine health monitoring: Feedback
- and feedforward p 326 N89-16790 SCHELLING, HELMUT
- Typical joints in a wing structure p 317 N89-17693 SCHERR, S.
- Analysis of three-dimensional aerospace configurations using the Euler equations [AIAA PAPER 89-0268] p 279 A89-25226
- SCHERZINGER, B. The Honeywell/DND helicopter integrated navigation
- system (HINS) p 308 A89-26741 SCHETZ, J. A.
- Combined tangential-normal injection into a supersonic flow 288 A89-25492
- [AIAA PAPER 89-0622] p 288 A89-2549 SCHETZ, JOSEPH A. Modular analysis of scramjet flowfields
- p 325 A89-28337
- SCHIFF, LEWIS B. Numerical simulation of vortex unsteadiness on slender bodies of revolution at large incidence
- [AIAA PAPER 89-0195] p 276 A89-25170 Numerical simulation of high-incidence flow over the
- F-18 fuselage forebody [AIAA PAPER 89-0339] p 282 A89-25286
- SCHMATZ, M. A. Three-dimensional viscous flow simulations using an implicit relaxation scheme p 291 A89-25865
- SCHMIDT, E. Inverse methods for blade design, controlled diffusion blading for supercritical compressor flow
- p 329 N89-16832 SCHMITT, V. Expriments on the DFVLR-F4 wing body configuration
- in several European windtunnels p 337 N89-16848 Some difficulties in the wind tunnel prediction of modern civil aircraft buffeting: Proposed remedies p 301 N89-16869
- SCHMITZ, D. M.
- Intake swirl and simplified methods for dynamic pressure distortion assessment p 299 N89-16742 SCHNEIDER, ALAN M.
- A Kalman filter for an integrated Doppler/GPS navigation system p 308 A89-26740 SCHNIEDER. H.
- High-lift aerodynamics for transport aircraft by interactive experimental and theoretical tool development [AIAA PAPER 89-0267] p 278 A89-25225
- SCHOENE, J. Analysis of three-dimensional aerospace configurations
- Interpretended and a second and a second and a second and a second a second
- SCHOFIELD, CHRISTOPHER Canadian forces aircraft condition/health monitoring: Policy plans and experience p 326 N89-16784
- Policy, plans and experience p 326 N89-16784 SCHREIBER, H. A.
- Shock losses in transonic and supersonic compressor cascades p 329 N89-16829 Axial velocity density ratio influence on exit flow angle in transonic/supersonic cascades p 329 N89-16830
- SCHUH, JEROME A. National lightning detection - A real-time service to
- aerospace [AIAA PAPER 89-0787] p 352 A89-25578 SCHULZ, U.
- On board life monitoring system Tornado (OLMOS) p 319 N89-16785
- SCHWAMBORN, D.
- Simulation of the DFVLR-F5 wing experiment using a block structured explicit Navier-Stokes method p 291 A89-25866
- SCHWANE, R.
- An implicit flux-vector splitting scheme for the computation of viscous hypersonic flow [AIAA PAPER 89-0274] p 279 A89-25231
- SCOTT, J. N. A numerical investigation of the influence of surface
- roughness on heat transfer in ice accretion [AIAA PAPER 89-0737] p 346 A89-25554 SCOTT. W. R.
- Long term possibilities for nondestructive evaluation for US Navy aircraft p 350 N89-17259
- SEDDON, J. Introduction to intake aerodynamics p 298 N89-16739 Transonic cowl design p 315 N89-16746
- Transonic cowl design p 315 N89-16746 SEEGMILLER, H. LEE Comparison of LDV measurements and Navier-Stokes
- solutions in a two-dimensional 180-degree turn-around duct
- [AIAA PAPER 89-0275] p 279 A89-25232

- SEIFERT, A.
- An experimental evaluation of a low-Reynolds number high-lift airfoil with vanishingly small pitching moment [AIAA PAPER 89-0538] p 286 A89-25432 SELBERG. BRUCE P.
- Scissor wing An alternative to variable sweep [AIAA PAPER 89-0013] p 310 A89-25009
- SELLERS, WILLIAM L., III LDV surveys over a fighter model at moderate to high angles of attack
- [SAE PAPER 881448] p 295 A89-28218 SERGHIDES, V. C.
- Design synthesis for canard-delta combat aircraft, volumes 1 and 2 p 316 N89-17590 SETTLES. G. S.
- An experimental study of shock wave/vortex interaction [AIAA PAPER 89-00821 p 273 A89-25072
- [AIAA PAPER 89-0082] p 273 A89-25072 SHALYGIN, ARKADII S.
- Determination of the numerical integration step during the analog-digital modeling of dynamic systems p 354 A89-27405
- SHANAHAN, DENNIS F. Kinematics of U.S. Army helicopter crashes - 1979-85
- p 306 A89-28486 SHANAHAN, MAUREEN O.
- Kinematics of U.S. Army helicopter crashes 1979-85 p 306 A89-28486
- SHANE, S. JOSEPH Discussion of transport passenger seat performance characteristics
- [SAE PAPER 881378] p 305 A89-28190 SHANG, J. S.
- Supersonic, transverse jet from a rotating ogive cylinder in a hypersonic flow p 294 A89-27728 SHEER, R. E., JR.
- Hypersonic scramjet inlet flow investigations, M1 = 16.26
- [AIAA PAPER 89-0003] p 270 A89-25002 SHEFFLER, K. D.
- Thermal barrier coating life prediction model development p 351 N89-17333 SHEPSHELOVICH, M.
- An experimental evaluation of a low-Reynolds number high-lift airfoil with vanishingly small pitching moment [AIAA PAPER 89-0538] p 286 A89-25432 SHEU. M. J.
- Investigation of internal singularity methods for multielement airfoils p 294 A89-27748 SHIMADA. TORU
- A numerical simulation of flows about two-dimensional bodies of parachute-like configuration [ISAS-629] p 302 N89-17580
- SHIRAZI, SIAMACK A. Simple turbulence models for supersonic and hypersonic flows - Bodies at incidence and compression corners (AIAA PAPER 89-0669) p 289 A89-25530
- SHIVELY, CURTIS A. Ranging and Processing Satellite (RAPSAT) p 340 A89-26738
- SHOOK, WILLIAM H.
- Results of the AIA/ATA/FAA Dynamic Seat Testing Program [SAE PAPER 881375] p 304 A89-28187
- SHURNEY, ROBERT
- High-temperature containerless aircraft furnace experimentation in the microgravity environment aboard a KC-135 aircraft [AIAA PAPER 89-0402] p 345 A89-25337
- [AIAA PAPER 89-0402] p 345 A89-25337 SIBILSKI, K.
- Dynamics of longitudinal motion of an aeroplane after drop of loads p 333 A89-28396 SICLARI, M. J.
- Three-dimensional hybrid finite volume solutions to the Euler equations for supersonic/hypersonic aircraft [AIAA PAPER 89-0281] p 280 A89-25238
- SILVA, BETTY W. Utilization of wind tunnel instrumentation with software verifications p 335 A89-27654
- SIMEONIDES, G. Infrared thermography in blowdown and intermittent
- hypersonic facilities [AIAA PAPER 89-0042] p 334 A89-25036 SIMPSON, ROGER L.
- The design and development of a dynamic plunge-pitch-roll model mount
- [AIAA PAPER 89-0048] p 334 A89-25042 SINGH. D. J.
- Effect of nose bluntness on flow field over slender bodies in hypersonic flows
- [AIAA PAPER 89-0270] p 279 A89-25228 SINGH, SAHJENDRA N.
- Control of nearly singular decoupling systems and nonlinear aircraft maneuver p 332 A89-25692

PERSONAL AUTHOR INDEX

The realization of microwave landing system benefits

SINHA, AGAM N.

p 307 A89-26734 SKELLY, THOMAS W. Recoverable test vehicle, an innovative approach to a low cost composite airframe for aerospace application p 311 A89-25320 AIAA PAPER 89-03781 SLAVIANSKII, OLEG E. Determination of the numerical integration step during the analog-digital modeling of dynamic systems p 354 A89-27405 SMITH, J. Accuracy of various wall-correction methods for 3D p 338 N89-16863 subsonic wind-tunnel testing SMITH, ORVEL E. Analysis of extreme wind shear p 352 A89-25549 [AIAA PAPER 89-0710] NASP natural environment definitions for design p 339 A89-25568 [AIAA PAPER 89-0764] SMITH, ROBERT E. NASP natural environment definitions for design [AIAA PAPER 89-0764] p 339 A89-25568 SMITH, TIMOTHY S. Measurements of a supersonic turbulent boundary layer with mass addition p 344 A89-25119 [AIAA PAPER 89-0135] SMOTHERMAN, MARC N. A microprocessor-based proportional-integral controller for hydraulically actuated mechanisms p 335 A89-27655 SNELL. M. B. Test specimens for bearing and by-pass stress interaction in carbon fibre reinforced plastic laminates p 342 N89-17696 SOBIECZKY, H. DFVLR-F5 test wing experiment for computational p 290 A89-25857 aerodynamics DFVLR-F5 test wing configuration The boundary value p 290 A89-25858 problem SOCKOL, PETER M. Unsteady Euler cascade analysis p 295 A89-28406 [AIAA PAPER 89-0322] SOETRISNO, MOELJO The effects of walls on a compressible mixing layer p 283 A89-25315 AIAA PAPER 89-03721 SOLTIS. STEVE Transport airplane fuselage section longitudinal impact [SAE PAPER 881377] p 305 A89-28189 SOMERS DAN M. Design and experimental results for a high-altitude, p 312 A89-27740 long-endurance airfoil SOMMERFIELD, D. Scramjet analysis with chemical reaction using three-dimensional approximate factorization p 323 A89-25533 [AIAA PAPER 89-0672] SONG, DONG JOO Prediction of supersonic/hypersonic viscous flows over RVs and decoys p 272 A89-25024 [AIAA PAPER 89-0028] Nonequilibrium viscous hypersonic flows over ablating Teflon surfaces p 293 A89-26368 [AIAA PAPER 89-0314] SORENSON, REESE L. Numerical simulation of high-incidence flow over the E-18 fuselage forebody p 282 A89-25286 [AIAA PAPER 89-0339] SPEGELE, JOHN J. An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition input n 309 N89-17588 [AD-A200626] SPIKER, V. ALAN Computer-generated map display for the pilot/vehicle interface p 319 A89-28214 [SAE PAPER 881440] SPILLMAN, W. B., JR. Fiber optic torquemeter design and development p 348 A89-27661 SPRING, W. CHARLES, III Microtuft flow visualization at Mach 10 and 14 in the NSWC hypervelocity wind tunnel No. 9 p 334 A89-25035 [AIAA PAPER 89-0041] Laser holographic interferometric measurements of the flow in a scramjet inlet at Mach 4 [AIAA PAPER 89-0043] p 273 A89-25037 SPRINKLE, CHARLES H., JR. Impact of severe weather on aviation - An NWS

- perspective [AIAA PAPER 89-0795] p 304 A89-25584
- SPRUNG, CLAUDE Service life calculator for the M53 turbofan engine p 326 N89-16796

B-14

SRINIVASAN, SHIVAKUMAR	
CFD simulation of square cros	ss-section, contoured
[AIAA PAPER 89-0045]	p 273 A89-25039
STAEHLE, JAMES C.	, -···
Use of color displays in the A320	cockpit
STAINBACK. P. CALVIN	p 319 A69-26200
Flow quality measurements for	the Langley 8-foot
transonic pressure tunnel LFC expe	riment
STALFORD, HAROLD I	p 276 A89-25133
Fast half-loop maneuvers for a high	h alpha fighter aircraft
using a singular perturbation feedba	ck control law
[AIAA PAPER 89-0018]	p 331 A89-25014
Thermodynamics and wave proc	esses in high Mach
number propulsive ducts	
[AIAA PAPER 89-0261]	p 278 A89-25219
Study of the vortical wake patter	rns of an oscillating
airfoil	, and an accounting
[AIAA PAPER 89-0554]	p 287 A89-25444
STANEWSKY, E. Bevrolds number effects in transc	nic flow
[AGARD-AG-303]	p 300 N89-16760
STARKEN, HANS	•
Loss development in transonic co	mpressor cascades
Incidence angle rules in supersoni	p 328 N89-16826
indication angle falos in supersoni	p 328 N89-16827
Exit angle rules in supersonic case	ades
STEINKE, R. J.	p 329 N89-16828
The design and development of	transonic multistage
compressors	p 329 N89-16834
Extended pitch axis effects on file	ow about a pitching
airfoil	on about a pitching
[AIAA PAPER 89-0025]	p 272 A89-25021
Flight measured downwash of the	OSBA
[NASA-TM-101050]	p 316 N89-17593
STEWART, DONALD B., JR.	
[SAF PAPER 881500]	auxiliary power unit
STEWART, V. R.	p 020 7100 20200
Characteristics of the ground von	tex formed by a jet
[AIAA PAPER 89-0650]	p 288 A89-25514
STICKLE, JOSEPH W.	
Cockpit display of ground-based v	veather data during
[AIAA 89-0806]	p 269 A89-28463
STIGALL, P. D.	•
Aircratt vertical profile impl directed-graph methods	ementation using
STORTZ, MICHAEL W.	p 332 A85-23083
Simulation evaluation of transition	n and hover flying
ISAE PAPER 8814301	n 333 A89-28205
STOWERS, S. T.	p 000 7.00 20200
Combustor air flow prediction o	apability comparing
STURDY, JAMES L.	p 349 A09-20345
Dynamic response of aircraft au	topilot systems to
atmospheric disturbances SUBBA RAO, M.	p 333 A89-27737
Finite element analysis of composite	e rudder for DO 228
aircraft	p 347 A89-26284
Impact of device level faults in	a digital avionic
processor	a algitar attorno
[NASA-CR-184783]	p 356 N89-18046
Aerothermal modeling program. Pl	hase 2. element B:
Flow interaction experiment	p 351 N89-17304
SULLIVAN, JAMES F. The effects of inclement weather of	airling appretions
[AIAA PAPER 89-0797]	p 304 A89-25585
SULLIVAN, JOHN P.	- -
Fropelier/wing interaction	D 311 A89-25429
SULLIVAN, P. P.	P 011 100-20428
Stability of 3D wing boundary	layer on a SST
[AIAA PAPER 89-00361	p 272 A89-25031
SURBER, LEWIS E.	
Tactical fighter inlets	
Inlat anging competibility	p 298 N89-16740
Inlet-engine compatibility Intake-airframe integration	p 298 N89-16740 p 314 N89-16741 p 315 N89-16744
Inlet-engine compatibility Intake-airframe integration SWANSON, GUSTAV A.	p 298 N89-16740 p 314 N89-16741 p 315 N89-16744

modeling of	COated	single	crystal	superanoys	
				p 342	N89-17334

SWANSON, R. C. An investigation of cell centered and cell vertex multigrid schemes for the Navier-Stokes equations [AIAA PAPER 89-0548] p 345 A89-25440 SWIFT, STEVEN T. Development of a laboratory method for studying water coalescence of aviation fuel [SAE PAPER 881534] p 341 A89-28243 SWITHENBANK, J. Turbulent mixing in supersonic combustion systems [AIAA PAPER 89-0260] p 323 A89-25218 SWITZER, GEORGE F. Heat transfer and pressure comparisons between computation and wind tunnel for a research hypersonic [AIAA PAPER 89-0029] p 272 A89-25025 SYED. SAADAT A. CFD applications - Propulsion perspective [AIAA PAPER 89-0093] p 343 A89-25082 SZEMA, K. Y. F-14 flow field simulation [AIAA PAPER 89-0642] p 296 A89-28444 SZODRUCH, J. High-lift aerodynamics for transport aircraft by interactive experimental and theoretical tool development [AIAA PAPER 89-0267] p 278 A89-25225 The intelligent wing - Aerodynamic developments for future transport aircraft [AIAA PAPER 89-0534] p 269 A89-25428 Т TAI, TSZE C. Supersonic low-density flow over airfoils

TAKEDA, Y. Superplasticity of HIPped PM superalloys made from attrited prealloy powder p 341 A89-25915

p 286 A89-25424

[AIAA PAPER 89-0530]

TANG, WANG Precision trajectory reconstruction

p 307 A89-26726

Numerical simulation of the growth of instabilities in supersonic free shear layers [AIAA PAPER 89-0376] p 283 A89-25319

TARTT, DAVID M.

The development of an automated flight test management system for flight test planning and monitoring p 312 A89-27613 TAVELLA, DOMINGO A.

Numerical study of the effect of tangential leading edge blowing on delta wing vortical flow

- [AIAA PAPER 89-0341] p 282 A89-25288 TAYLOR, ARTHUR C., III
- An improved upwind finite volume relaxation method for high speed viscous flows [AIAA PAPER 89-0549] p 286 A89-25441

[AĨAA PAPER 89-0549] p 286 A89-25441 TAYLOR, R. G.

Need for common AGARD approach and actions p 350 N89-17260

TCHON, K. F. Flow visualization investigation of dynamic stall on a pitching airfoil

[AIAA PAPER 89-0842] p 290 A89-25611 TENISON, GARY V.

Development of a new subsonic icing wind tunnel [AIAA 89-0773] p 337 A89-28458

TESTER, R. M.

System considerations for integrated machinery health monitoring p 327 N89-16804 THAKUR, SIDDHARTH S.

A numerical study of the contrarotating vortex pair associated with a jet in a crossflow [AIAA PAPER 89-0448] p 284 A89-25366

[AIAA PAPER 89-0448] p 284 A89-25366 THAREJA, RAJIV R.

A three-dimensional upwind finite element point implicit unstructured grid Euler solver [AIAA PAPER 89-0658] p 289 A89-25521

THEIMER, P.

The advantage of a thrust rating concept used on the RB199 engine p 327 N89-16800 THOMAS, JAMES L

A patched-grid algorithm for complex configurations directed towards the F-18 aircraft

[AIAA PAPER 89-0121] p 310 A89-25106 Navier-Stokes solutions about the F/A-18 forebody-LEX

configuration [AIAA PAPER 89-0338] p 281 A89-25285 THOMAS, LORRAINE

An investigation of the physical and chemical factors affecting the perfomance of fuels in the JFTOT [SAE PAPER 881533] p 341 A89-28242

THOMAS, R. H. Combined tangential-normal injection into a supersonic flow [AIAA PAPER 89-0622] p 288 A89-25492 THOMAS, SCOTT R. CFD simulation of square cross-section, contoured nozzle flows - Comparison with data [AIAA PAPER 89-0045] p 273 A89-25039 THOMPSON, JOE F. Efficient application techniques of the EAGLE grid code to complex missile configurations [AIAA PAPER 89-0361] p 353 A89-25305 THOMPSON, R. G. T-100 Multipurpose Small Power Unit - Technology for e next generation auxiliary power units [SAE PAPER 881501] p 349 A89-28267 THOMPSON, ROBERT L. Structural response of an advanced combustor liner: Test and analysis p 351 N89-17329 THOMPSON, S. A. The separated flow field on a slender wing undergoing transient pitching motions [AIAA PAPER 89-0194] p 276 A89-25169 TINGER, HERBERT L. Departure resistance and spin characteristics of the F-15 S/MTD [AIAA PAPER 89-0012] p 331 A89-25008 TINGSKOG, TORBJORN A new technique for the production of gas atomized p 340 A89-25902 powder TIWARI, S. N. Effect of nose bluntness on flow field over slender bodies in hypersonic flows [AIAA PAPER 89-0270] p 279 A89-25228 Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies [AIAA PAPER 88-0460] p 295 A89-28251 TOBINAGA, YOSHINARI The current status of the flight test of the ASKA [SAE PAPER 881433] p 314 A89-28208 TOBY, A. STEVEN An exploratory study of corner bleed on a fin generated three-dimensional shock wave turbulent boundary layer interaction [AIAA PAPER 89-0356] p 282 A89-25301 TODD. E. S. Three-dimensional inelastic analysis methods for hot p 351 N89-17316 section components TONG. M. Structural response of an advanced combustor liner: Test and analysis p 351 N89-17329 TRAMMELL, ARCHIE Enroute turbulence avoidance procedures [AIAA PAPER 89-0739] p 303 A89-25556 TROUVE. A. Low frequency pressure oscillations in a model ramjet combustor - The nature of frequency selection [AIAA PAPER 89-0623] p 323 A p 323 A89-25493 TROVER, WILLIAM F. Software control of a high speed, modular signal conditioner and PCM encoder system p 318 A89-27670 TRUMAN, C. RANDALL Simple turbulence models for supersonic and hypersonic flows - Bodies at incidence and compression corners [AIAA PAPER 89-0669] p 289 A89-25530 p 289 A89-25530 TSUKAMOTO, SHIGEKI Development of new redundant flight safety system using inertial sensors ISAS-6341 p 306 N89-17585 TUNCER, ISMAIL H. Theoretical and numerical studies of oscillating airfoils [AIAA PAPER 89-0021] p 271 A89-25017 TUNG. C. The free-wake prediction of rotor hover performance using a vortex embedding method [AIAA PAPER 89-0638] p 296 A89-28443 TURNBERG, J. E. Prop-fan structural results from PTA tests [SAE PAPER 881418] p 324 p 324 A89-28202 TURNOCK, STEPHEN R. Investigation of surface water behavior during glaze ice p 304 A89-27739 accretion

TURZANSKI, R. IFM applications to cavity flowfield predictions [AIAA PAPER 89-0477] p 285 A89-25390

[AIAA PAPER 89-0477] p 285 A89-25390 TUSCHE, S.

DFVLR-F5 test wing experiment for computational aerodynamics p 290 A89-25857 TUZOV, VLADIMIR P.

Electrical equipment of aircraft p 346 A89-26171 TWETE, M. A.

Laser communication test system [AD-A199612] p 349 N89-17215

U

Superplasticity of HIPped PM superalloys made from attrited prealloy powder p 341 A89-25915

V

- VAERMAN, J. Short term developments in non-destructive evaluation applicable to turbine engine parts p 350 N89-17258 VAI ORANL M.
- On the solution of nonequilibrium hypersonic inviscid steady flows
- [AIAA PAPER 89-0671] p 289 A89-25532 VAN DER STICHELE, S. Infrared thermography in blowdown and intermittent
- hypersonic facilities [AIAA PAPER 89-0042] p 334 A89-25036
- VAN GENT, A. H. Advanced flight control for the Fokker 100 [SAE PAPER 881373] p 333 A89-28185
- VAN LIERDE, P. Infrared thermography in blowdown and intermittent hypersonic facilities [AIAA PAPER 89-0042] p 334 A89-25036
- VANKA, S. P. An experimental and computational investigation of isothermal swirling flow in an axisymmetric dump
- combustor [AIAA PAPER 89-0620] p 323 A89-25491 VANWANDERHAM, M. C.
- Relationships of nondestructive evaluation needs and component design p 349 N89-17256 VAQUEZ, PHILIPPE
- Trend monitoring of a turboprop engine at low and mean power p 321 N89-16801
- VASSBERG, JOHN An acceleration method for solving the Euler equations on an unstructured mesh by applying multigrid on an auxiliary structured mesh [AIAA PAPER 89-0116] p 275 A89-25103
- VATSA, V. N.
- Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867
- Effect of sidewall boundary layer on a wing in a wind tunnel p 294 A89-27742
- VATSA, VEER N. Prediction of separated transonic wing flows with a non-equilibrium algebraic model
- [AIAA PAPER 89-0558] p 287 A89-25447
- VEMURU, CHANDRA S. Evaluation of an analysis method for low-speed airfoils by comparison with wind tunnel results
- [AIAA PAPER 89-0266] p 278 A89-25224 Optimization of natural laminar flow airfoils for high section lift-to-drag ratios in the lower Reynolds number range
- [AIAA PAPER 89-0539] p 296 A89-28428 VENKATAKRISHNAN, V.
- Application of direct solvers to unstructured meshes for the Euler and Navier-Stokes equations using upwind
- schemes [AIAA PAPER 89-0364] p 283 A89-25308 VENKATAPATHY, ETHIRAJ Computational design aspects of a NASP nozzle/afterbody experiment [AIAA PAPER 99-0466] p 284 A89-25364
- [AIAA PAPER 89-0446] p 284 A89-25364 VESS, R. J. Aircraft design education at North Carolina State
- University [AIAA PAPER 89-0649] p 357 A89-25513
- VIETS, KAREN J. Ranging and Processing Satellite (RAPSAT)
- p 340 A89-26738
- Phase-only filters with improved signal to noise ratio p 356 A89-28382
- VISBAL, M. R. Study of the vortical wake patterns of an oscillating airfoil
- [AIAA PAPER 89-0554] p 287 A89-25444 VISSER, K. D. A flow visualization and aerodynamic force data evaluation of spanwise blowing on full and half span delta
- wings [AIAA PAPER 89-0192] p 276 A89-25167
- VOGLER, WILLIAM A. Fore-and-aft stiffness and damping characteristics of 30 x 11.5-14.5, Type VIII, bias-ply and radial-belted aircraft tires
- [SAE PAPER 881357] p 313 A89-28176

- Numerical and experimental study of the crash behavior
- of helicopters and fixed-wing aircraft p 309 A89-24919
- VOLAND, RANDALL T. CFD simulation of square cross-section, contoured nozzle flows - Comparison with data
- [AIAA PAPER 89-0045] p 273 A89-25039 VOLLMERS, H.
- Comparison of two different Navier-Stokes methods for the simulation of 3-D transonic flows with separation (AIAA PAPER 89-0559) p 287 A89-25448
- VOLPE, G. Streamlines and streamribbons in aerodynamics
- [AIAA PAPER 89-0140] p 276 A89-25123 VON VILLIEZ, HANSJUERGEN
 - The integration of European flight-safety systems p 308 A89-28292

W

WADE, BARRY

- Transport airplane fuselage section longitudinal impact test
- [SAE PAPER 881377] p 305 A89-28189 WAGNER, J. H.
- Coolant passage heat transfer with rotation p 351 N89-17314
- WAI, J. C. Scramjet analysis with chemical reaction using three-dimensional approximate factorization [AIAA PAPER 89-0672] p 323 A89-25533
- WAINAUSKI, H. S. Prop-fan airfoil icing characteristics [AIAA PAPER 89-0753] p 303 A89-255
- [AIAA PAPER 89-0753] p 303 A89-25561 WALKER, J. M. Extended pitch axis effects on flow about a pitching
- airfoil [AIAA PAPER 89-0025] p 272 A89-25021
- WALKER, KEVIN P. Constitutive modelling of single crystal and directionally solidified superalloys p 342 N89-17325
- solidified superalloys p 342 N89-17325 WALKER, WALTER W. Thermal conductivity and microstructure stability of heat
- treated AMZIRC copper-based alloys p 341 A89-26361
- WALTERS, ROBERT W. A patched-grid algorithm for complex configurations
- directed towards the F-18 aircraft [AIAA PAPER 89-0121] p 310 A89-25106 An improved upwind finite volume relaxation method for high speed viscous flows
- (AIAA PAPER 89-0549) p 286 A89-25441 WAN. TUNG
- An unsteady vortex-ring model for microburst simulation
- [AIAA PAPER 89-0811] p 353 A89-25594 WANG, C. M.
- Theoretical and numerical studies of oscillating airfoils [AIAA PAPER 89-0021] p 271 A89-25017 WANG. H.
- Overview of optimal trajectories for flight in a windshear
- [AIAA 89-0812] p 306 A89-2846 WANG, P. K. C.
- Feedback control of vibrations in an extendible cantilever sweptback wing p 332 A89-26193 WANG, T.
- Overview of optimal trajectories for flight in a windshear
- [AIAA 89-0812] p 306 A89-28464 WANKE, CRAIG
- Cockpit display of hazardous weather information [AIAA PAPER 89-0808] p 335 A89-25591 WARD. S.
- Wind tunnel wall boundary layer control by Coanda wall jets
- [AIAA PAPER 89-0149] p 334 A89-25132 WARREN, R. E.
- Supersonic sudden-expansion flow with fluid injection -An experimental and computational study [AIAA PAPER 89-0389] p 284 A89-25328
- WATSON, R. D. Flow measurement on the fuselage of a Boeing 737
- airplane [AIAA PAPER 89-0209] p 295 A89-28404
- WATTS, MICHAEL E. Tip aerodynamics and acoustics test: A report and data survey
- [NASA-RP-1179] p 302 N89-17579 WEBSTER, JAMES L., SR.
- Results of the AIA/ATA/FAA Dynamic Seat Testing Program [SAE PAPER 881375] p 304 A89-28187
- [SAE PAPER 881375] p 304 A89-28187

PERSONAL AUTHOR INDEX

WEDAN, B. W. Navier-Stokes calculations for DFVLR F5-wing in wind tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 Effect of sidewall boundary layer on a wing in a wind n 294 A89-27742 tunne WEDAN, BRUCE W. Prediction of separated transonic wing flows with a non-equilibrium algebraic model p 287 A89-25447 [AIAA PAPER 89-0558] WEEKS, JACK High-temperature containerless aircraft furnace experimentation in the microgravity environment aboard a KC-135 aircraft p 345 A89-25337 AIAA PAPER 89-04021 WENDT. J. F. Infrared thermography in blowdown and intermittent hypersonic facilities [AIAA PAPER 89-0042] p 334 A89-25036 WENNERSTROM, A. J. Design of critical compressor stages p 330 N89-16835 p 330 N89-16836 Supersonic com pressors WESSELMANN, GARY F. Flow-field characteristics and normal-force correlations for delta wings from Mach 2.4 to 4.6 p 272 A89-25022 [AIAA PAPER 89-0026] Influence of wing geometry on leading-edge vortices and vortex-induced aerodynamics at supersonic speeds AIAA PAPER 89-0085] p 274 A89-25075 WEST-VUKOVICH, G. The Honeywell/DND helicopter integrated navigation p 308 A89-26741 evetern (HINS) WESTON, ROBERT P. A patched-grid algorithm for complex configurations directed towards the F-18 aircraft p 310 A89-25106 [AIAA PAPER 89-0121] WHITAKER, D. L. Two-dimensional Euler computations on a triangular mesh using an upwind, finite-volume scheme p 354 A89-25385 [AIAA PAPER 89-0470] WHITFIELD, DAVID L. A simple time-accurate turbomachinery algorithm with numerical solutions of an uneven blade count configuration [AIAA PAPER 89-0206] p 344 A89-25181 WICHMANN, G. Analysis of three-dimensional aerospace configurations using the Euler equations p 279 A89-25226 [AIAA PAPER 89-0268] WIDNALL, WILLIAM S. Evaluation of a Kalman filter for SAR motion p 347 A89-26721 compensation WILLIAMS, J. E. Aerodynamic prediction rationale for analyses of hypersonic configurations p 285 A89-25420 TAIAA PAPER 89-05251 WINGROVE, R. C. Analysis of windshear from airline flight data p 332 A89-27734 WINKELMANN, ALLEN E. The effects of aspect ratio on the stall of a finite wing [AIAA PAPER 89-0570] p 296 A89-28434 WITKOWSKI, DAVID P. ropeller/wing interaction [AIAA PAPER 89-0535] p 311 A89-25429 WITTENBURG, TIM M. Photo-based three dimensional graphics models for multi-sensor simulation p 348 A89-27787 WITTLIFF, C. E. Facility requirements for hypersonic propulsion system testina p 335 A89-25159 [AIAA PAPER 89-0184] WITWER, ROBERT J. Use of color displays in the A320 cockpit [SAE PAPER 881416] p 319 p 319 A89-28200 WONG, TIN-CHEE Navier-Stokes computations of separated vortical flows past prolate spheroid at incidence [AIAA PAPER 89-0553] p 286 A89-25443 WOOD, M. N. The accurate measurement of drag in the 8 ft x 8 ft p 337 N89-16855 tunnel WOOD, N. J. Wind tunnel wall boundary layer control by Coanda wall iets p 334 A89-25132 AIAA PAPER 89-01491 WOOD, RICHARD M. Evaluation of leading- and trailing-edge flaps on flat and cambered delta wings at supersonic speeds p 272 A89-25023 [AIAA PAPER 89-0027]

Influence of wing geometry on leading-edge vortices and vortex-induced aerodynamics at supersonic speeds [AIAA PAPER 89-0085] p 274 A89-25075

UENISHI, N.
PERSONAL AUTHOR INDEX

WOODSON, SHAWN H.

An interactive three-dimensional boundary-layer method for transonic flow over swept wings

[AIAA PAPER 89-0112] p 274 A89-25099 WU, JAMES C.

Theoretical and numerical studies of oscillating airfoils [AIAA PAPER 89-0021] p 271 A89-25017 WU. JIUNN-CHI

Evaluation of three turbulence models for the prediction of steady and unsteady airloads

[AIAA PAPER 89-0609] p 288 A89-25485 Technique for the prediction of airfoil flutter

- characteristics in separated flow p 348 A89-27744 WUNSCHEL, ALFRED J., JR.
- Cockpit display of ground-based weather data during thunderstorm research flights

[AIAA 89-0806] p 269 A89-28463 WYGNANSKI, I.

An experimental evaluation of a low-Reynolds number high-lift airfoil with vanishingly small pitching moment [AIAA PAPER 89-0538] p 286 A89-25432

X

XIANG, YANSUN

A numerical method for calculating the low-speed aerodynamic characteristics of the strake-wing configurations p 292 A89-25941 XU, RUJJUAN

Longitudinal stability analysis for deformable aircraft p 332 A89-25934

Y

YAGER, THOMAS J. A summary of recent aircraft/ground vehicle friction measurement tests

- [SAE PAPER 881403] p 336 A89-28196 YAMAGUCHI, KEIKO Modeling of surface roughness effects on glaze ice
- Accretion [AIAA 89-0734] p 305 A89-28451 YAMAGUCHI, YUTAKA Preliminary test results of NDA cryogenic wind tunnel and its system [SAE PAPER 881449] p 336 A89-28219
- [SAE PAPER 881449] p 336 A89-28219 YAMAMOTO, YUKIMITSU
- Numerical simulation of hypersonic flow around a space plane at high angles of attack using implicit TVD Navier-Stokes code
- [AIAA PAPER 89-0273] p 279 A89-25230 YAMATO, HIROYUKI
- The current status of the flight test of the ASKA [SAE PAPER 881433] p 314 A89-28208
- YANG, J. Y. Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic
- flows [AIAA PAPER 89-0562] p 287 A89-25451 YANG, JIANN-SHIOU
- An H(infinity) method for the design of linear time-invariant multivariable sampled-data control systems p 354 A89-26187 YANG, Z. Y. Turbulent mixing in supersonic combustion systems

[AIAA PAPER 89-0260] p 323 A89-25218 YANTA, WILLIAM J. Laser holographic interferometric measurements of the

flow in a scramjet inlet at Mach 4 [AIAA PAPER 89-0043] D 273 A89-25037

- [AIAA PAPER 89-0043] p 273 A89-25037 Measurements of a supersonic turbulent boundary layer with mass addition
- [AIAA PAPER 89-0135] p 344 A89-25119 YATES, E. CARSON, JR. Integral equation solution of the full potential equation
- for transonic flows
 [AIAA PAPER 89-0563] p 287 A89-25452
- YEATON, ROBERT B. Fore-and-aft stiffness and damping characteristics of 30 x 11.5-14.5, Type VIII, bias-ply and radial-belted aircraft
- tires [SAE PAPER 881357] p 313 A89-28176
- YEH, DAVID T. Numerical study of the effect of tangential leading edge
- blowing on delta wing vortical flow [AIAA PAPER 89-0341] p 282 A89-25288
- YEH, N. A. Automatic generation of component modes for rotordynamic substructures p 343 A89-24995 YEOMAN, KENNETH E.
- Selection of the critical icing/flight case for an unprotected airfoil [AIAA PAPER 89-0757] p 303 A89-25563

YOKOMIZO, T.		
Manda and an	An an example of a local state of the second s	

Moving surface boundary-layer	control as	applied to
two-dimensional airfoils		
[AIAA PAPER 89-0296]	p 281	A89-25253
YOSHIDA, SHIZUYUKI		

- Preliminary test results of NDA cryogenic wind tunnel and its system [SAE PAPER 881449] p 336 A89-28219
- YOUNG, J. W., III The effect of a ground-based inversion layer on an impacting microburst [AIAA PAPER 89-0810] p 352 A89-25593
- [AIAA PĂPER 89-0810] p 352 A89-25593 YOUNG, M. F.
- Measurements of gas turbine combustor and engine augmentor tube sooting characteristics [AD-A199768] p 328 N89-16821
- YOUNG, T. R., JR. Computational studies of a localized supersonic shear laver
- [AIAA PAPER 89-0125] p 275 A89-25110 YU, K.
- Low frequency pressure oscillations in a model ramjet combustor - The nature of frequency selection [AIAA PAPER 89-0623] p 323 A89-25493
- YU, K. C. A transonic computational method for an aft-mounted
- nacelle/pylon configuration with propeller power effect [AIAA PAPER 89-0560] p 311 A89-25449 YU, KENNETH
- Evidence of a strange attractor in ramjet combustion [AIAA PAPER 89-0624] p 323 A89-25494

Z

ZAMAN, K. B. M. Q.

- Control of laminar separation over airfoils by acoustic excitation
- [AIAA PAPER 89-0565] p 288 A89-25454 ZELL, PETER T.
- A free-trailing vane flow direction indicator employing a linear output Hall effect transducer
- p 336 A89-27675
- A prediction of the stalling of the multielement airfoils p 292 A89-25932 ZHANG, JIANBAI
- A numerical method for unsteady transonic flow about tapered wings p 291 A89-25929 ZHUK, V. I.
- Unsteady separation wave in a supersonic boundary layer p 293 A89-26011 ZIEVE, PETER
- Electromagnetic emissions from a modular low voltage EIDI system
- [AIAA PAPER 89-0758] p 303 A89-25564 ZINN, B. T.
- Flowfield modifications of combustion rates in unstable ramjets [AIAA PAPER 89-0105] p 322 A89-25092
- ZOBY, E. V. Viscous shock-layer solutions for the low-density
- hypersonic flow past long slender bodies [AIAA PAPER 88-0460] p 295 A89-28251
- ZWAAN, R. J. Requirements and capabilities in unsteady windtunnel testing p 339 N89-16878
- ZWEIFEL, TERRY Sensor consideration in the design of a windshear
- detection and guidance system [SAE PAPER 881417] p 319 A89-28201 ZYWIEL, J.
- The Honeywell/DND helicopter integrated navigation system (HINS) p 308 A89-26741

CORPORATE SOURCE INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 240)

June 1989

SOURCE

Typical Corporate Source Index Listing



Listings in this index are arranged alphabetically by corporate source. The title of the document is used to provide a brief description of the subject matter. The page number and the accession 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.

Α

Adiabatics, Inc., Columbus, IN.		
Adiabatic Wankel type rotary eng	ne	
[NASA-CR-182233]	p 330	N89-17599
Advisory Group for Aerospace Res	earch ar	nd
Development, Neuliy-Sur-Seine (I	rance).	
Heynolds number effects in trans	DRIC TIOW	
[AGARD-AG-303]	p 300	N89-16760
Aeritalia S.p.A., Naples (Italy).		
Joining of carbon fiber composite	WITH TASI	eners
Aerolet TechSystems Co. Secreme	μ 343	1469-17701
CED simulation of square erer	nio, CA.	
nozzle flows - Comparison with date	5-500101	i, contoureu
IAIAA PAPER 89-00451	n 273	A89-25039
Aeronautical Research Labs M	shourne	(Australia)
Gas path analysis and engine ne	formanc	e monitoring
in a Chinook helicopter	p 327	N89-16802
Identification of dynamic characteri	stics for f	aultisolation
purposes in a gas turbine	usina	closed-loop
measurements	p 328	N89-16813
Air Force Systems Command, Wrigi	nt-Patter	son AFB.
OH.		
MPC-75 feeder civil aircraft		
[AD-A200907]	p 317	N89-17594
Air Force Weapons Lab., Kirtland A	FB, NM.	
Field enhancement of UHF-VHF a	ircraft ar	itennas
[AD-A200180]	p 349	N89-17069
Air Force Wright Aeronautical Labs.	, Wright	-Patterson
AFB, OH.		
l'actical fighter inlets	p 298	N89-16740
Inlet-engine compatibility	p 314	N89-16741
Intake-airframe integration	p 315	N89-16744
Design of critical compressor stag	es	
	p 330	N89-16835
Supersonic compressors	p 330	N89-16836
Air France, Paris.		
The CFM 56-5 on the A-320 at Ai	France	
	p 320	N89-16793

Aircraft Research Association Ltd., Bedford (England). Development of testing techniques in a large transonic wind tunnel to achieve a required drag accuracy and flow standards for modern civil transports p 337 N89-16857

Amdahl Corp., Sunnyvale, CA.

Numerical simulation of vortex unsteadiness on slender bodies of revolution at large incidence

[AIAA PAPER 89-0195] p 276 A89-25170 Grid refinement studies of turbine rotor-stator interaction

[AIAA PAPER 89-0325] p 281 A89-25274

Navier-Stokes simulation of wind-tunnel flow using p 291 A89-25864 LU-ADI factorization algorithm

Analytical Methods, inc., Redmond, WA. Thermal analysis of engine inlet anti-icing systems

[AIAA PAPER 89-0759] p 311 A89-25565 Development of a panel method for modeling configurations with unsteady component motions, phase

[AD-A200255] p 315 N89-16775 Analytical Services and Materials, Inc., Hampton, VA. Heat transfer and pressure comparisons between computation and wind tunnel for a research hypersonic aircraf

[AIAA PAPER 89-0029] p 272 A89-25025 A numerical study of hypersonic propulsion/airframe integration problem

[AIAA PAPER 89-0030] p 272 A89-25026 CFD simulation of square cross-section, contoured nozzle flows - Comparison with data [AIAA PAPER 89-0045]

p 273 A89-25039 Evaluation of an analysis method for low-speed airfoils by comparison with wind tunnel results

[AIAA PAPER 89-0266] p 278 A89-25224 Application of direct solvers to unstructured meshes for the Euler and Navier-Stokes equations using upwind scheme

[AIAA PAPER 89-0364] p 283 A89-25308 Optimization of natural laminar flow airfoils for high section lift-to-drag ratios in the lower Reynolds number range

[AIAA PAPER 89-0539] p 296 A89-28428 Arizona Univ., Tucson.

Viscous-inviscid interaction and local grid refinement via truncation error injection

[AIAA PAPER 89-0468] p 285 A89-25383 Army Aviation Research and Development Command, Hampton, VA.

LDV surveys over a fighter model at moderate to high angles of attack

[SAE PAPER 881448] p 295 A89-28218

Army Aviation Systems Command, Cleveland, OH. Experimental verification of the thermodynamic properties for a jet-A fuel

[NASA-TM-101475] p 342 N89-17017 Army Aviation Systems Command, Moffett Field, CA. An interactive boundary-layer procedure for oscillating airfoils including transition effects

[AIAA PAPER 89-0020] p 271 A89-25016 Flow visualization studies of the Mach number effects

on the dynamic stall of an oscillating airfoil [AIAA PAPER 89-0023] p 271 A89-25019 Design and development of a compressible dynamic stall facility

[AIAA PAPER 89-0647] p 335 A89-25511 The free-wake prediction of rotor hover performance

using a vortex embedding method [AIAA PAPER 89-0638] p 296 A89-28443

A critical assessment of wind tunnel results for the NACA 0012 airfoil p 300 N89-16847 Army Missile Command, Redstone Arsenal, AL.

Remotely Piloted Vehicle (RPV) two versus three level maintenance support concept study

[AD-A200665] p 270 N89-17564 Army Propulsion Lab., Cleveland, OH.

Performance of the forward scattering spectrometer probe in NASA's Icing Research Tunnel [AIAA PAPER 89-0769] p 346 A89-25570 Arnold Engineering Development Center, Arnold Air Force Station, TN.

Flow-field characteristics and normal-force correlations for delta wings from Mach 2.4 to 4.6

p 272 A89-25022 [AIAA PAPER 89-0026] Influence of wing geometry on leading-edge vortices and vortex-induced aerodynamics at supersonic speeds

p 274 A89-25075 [AIAA PAPER 89-0085] Avco Lycoming Div., Stratford, CT. Unsteady Euler cascade analysis

[AIAA PAPER 89-0322] p 295 / Avions Marcel Dassault, Saint-Cloud (France). p 295 A89-28406

Bolted scarf joints in carbon composite materials. Comparison between assemblies with an interference fit and those with play n 343 N89-17702

B

Battelle Columbus Labs., OH.

Fuel-additive system for test cells

- [AD-A200801] p 342 N89-17681 Boeing Advanced Systems Co., Seattle, WA. Pressure and heat transfer investigation of a modified
 - NASP baseline configuration at M = 6
- [AIAA PAPER 89-0246] p 339 A89-25208 A model for 3-D sonic/supersonic transverse fuel injection into a supersonic air stream
- [AIAA PAPER 89-0460] p 345 A89-25376 Boeing Commercial Airplane Co., Seattle, WA.
- Stability of 3D wing boundary layer on a SST configuration [AIAA PAPER 89-0036] p 272 A89-25031
- Boit, Beranek, and Newman, Inc., Cambridge, MA. Integrating causal reasoning at different levels of bstraction p 355 A89-27609
- abstraction British Aerospace Aircraft Group, Preston (England). p 299 N89-16743 Jaguar/Tornado intake design Intakes for high angle of attack p 315 N89-16745
- Intake drag p 299 N89-16747 British Aerospace Public Ltd. Co., Preston (England).
- Accurate drag estimation using a single component drag odel technique p 337 N89-16856 model technique
- Bundesanstalt fuer Flugsicherung, Frankfurt am Main (Germany, F.R.). Activities report in air traffic control

- [ETN-89-93513] p 309 N89-17586 Bureau Veritas, Paris (France).
- Trend monitoring of a turboprop engine at low and mean power p 321 N89-16801

С

- California Univ., Irvine.
- Evolution of particle-laden jet flows A theoretical and experimental study p 348 A89-27693 Cambridge Univ. (England).

Analysis of 3D viscous flows in transonic compressors p 329 N89-16831

- Canadian Forces Base Trenton, Astra (Ontario).
- CF-18/F404 transient performance trending

p 328 N89-16814

- Case Western Reserve Univ., Cleveland, OH. Experimental and numerical investigation of an oblique shock wave/turbulent boundary layer interaction with continuous suction
- [AIAA PAPER 89-0357] p 296 A89-28407 Centre Aeroporte de Toulouse (France).
- Study of the aerodynamic situation along the C 160 aircraft in parachuting configuration p 299 N89-16756 [DAT-88-06]
- Computer Sciences Corp., Huntsville, AL. Analysis of extreme wind shear
- [AIAA PAPER 89-0710] p 352 A89-25549 Computing Devices Co., Ottawa (Ontario).
- Installed thrust as a predictor of engine health for jet engines p 327 N89-16806

Continuum Dynamics, Inc., Princeton, NJ.

Problems in understanding aircraft icing dynamics [AIAA PAPER 89-0735] p 302 A89-25553

dynamics for rotorcraft interactional Vortex aerodynar p 297 N89-16726

[AD-A200128] Cornell Univ., Ithaca, NY.

- Helicopter tail rotor blade-vortex interaction noise p 356 N89-18167 [NASA-CR-183178]
- Cranfield Inst. of Tech., Bedford (England). The design, construction and test of a postbuckled, carbon fibre reinforced plastic wing box
- p 315 N89-16773 Analytical wing weight prediction/estimation using computer based design techniques p 316 N89-17589 Design synthesis for canard-delta combat aircraft, p 316 N89-17590 volumes 1 and 2

D

- Dayton Univ., OH.
- A numerical investigation of the influence of surface roughness on heat transfer in ice accretion

p 346 A89-25554 [AIAA PAPER 89-0737] Defense Science Board, Washington, DC. Report of the Defense Science Board task force on the

National Aerospace Plane (NASP) p 317 N89-17595 [AD-A201124]

Deita Air Lines, Inc., Atlanta, GA. Overview of optimal trajectories for flight in a

- windshear p 306 A89-28464 [AIAA 89-0812]
- Deutsche Forschungs- und Versuchsanstalt fuer Luftund Raumfahrt, Brunswick (Germany, F.R.).
- An investigation of cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 345 A89-25440
- [AIAA PAPER 89-0548] Expriments on the DFVLR-F4 wing body configuration in several European windtunnels p 337 N89-16848 Deutsche Forschunge- und Versuchsanstalt fuer Luft-
- und Raumfahrt, Porz (Germany, F.R.).
 - Loss development in transonic compressor cascades p 328 N89-16826 Incidence angle rules in supersonic c ascade
 - p 328 N89-16827 Exit angle rules in supersonic cascad
 - p 329 N89-16828 Shock losses in transonic and supersonic compresso
- p 329 N89-16829 cascades Axial velocity density ratio influence on exit flow angle p 329 N89-16830 in transonic/supersonic cascades
- Dornier-Werke G.m.b.H., Friedrichshafen (Germany, F.R.). p 317 N89-17693
- Typical joints in a wing structure Douglas Aircraft Co., Inc., Long Beach, CA. An interactive boundary-layer procedure for oscillating
- airfoils including transition effects [AIAA PAPER 89-0020] p 271 A89-25016

E

- Eidetics International, Inc., Torrance, CA.
- An experimental investigation of delta wing vortex flow with and without external jet blowing p 273 A89-25074
- [AIAA PAPER 89-0084] p 273 A89-25074 A flow visualization and aerodynamic force data evaluation of spanwise blowing on full and half span delta
- p 276 A89-25167 [AIAA PAPER 89-0192] Eidgenoessisches Flugzeugwerk, Emmen
- (Switzerland).
- New design of the nozzle section of a large subsonic wind tunnel
- p 339 N89-17601 [F+W-TF-1926] Eloret Corp., Sunnyvale, CA. aspects of a NASP Computational design
- nozzle/afterbody experiment p 284 A89-25364 [AIAA PAPER 89-0446]
- Engineering Science Software, Inc., Smithfield, Ri. Constitutive modelling of single crystal and directionally p 342 N89-17325 solidified superallovs
- ESDU International Ltd., London (England). Estimation of drag arising from asymmetry in thrust or
- airframe configuration p 297 N89-16730 [ESDU-88006]
- Rolling moment derivative Lxi, for plain ailerons at subsonic speeds p 297 N89-16731
- [ESDU-88013] Derivation of primary air-data parameters for hypersonic flight
- p 298 N89-16732 [ESDU-88025] Yawing moment coefficient for plain ailerons at subonic sneeds
- p 298 N89-16734 [ESDU-88029] Boundaries of linear characteristics of cambered and twisted wings at subcritical Mach numbers p 298 N89-16735 [ESDU-88030]

Iongitudinal forces on Lift and propeller/nacelle/wing/flap systems p 298 N89-16736 ESDU-880311

F

- Florida Univ., Gainesville.
- A numerical study of the contrarotating vortex pair associated with a jet in a crossflow [AIAA PAPER 89-0448] p 284 A89-25366
- Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt
- (Germany, F.R.). Damage tolerance behavior of fiber reinforced p 316 N89-17278 composite airframes

G

- GasTOPS Ltd., Ottawa (Ontario). CF-18 engine performance monitoring
- n 326 N89-16787 GEC Avionics Ltd., Rochester (England). System considerations for integrated machinery health
- p 327 N89-16804 monitoring General Dynamics Corp., Fort Worth, TX.
- Viscous-inviscid interaction and local grid refinement via truncation error injection
- p 285 A89-25383 [AIAA PAPER 89-0468] General Electric Co., Cincinnati, OH.
- Thermal analysis of engine inlet anti-icing system AIAA PAPER 89-0759] p 311 A89-25565 Military engine monitoring status at GE Aircraft Engines, [AIAA PAPER 89-0759] p 320 N89-16798 Cincinnati, Ohio Commercial engine monitoring status at GE Aircraft p 320 N89-16799
- Engines, Cincinnati, Ohio General Motors Corp., Indianapolis, IN.
- Evolution of particle-laden jet flows A theoretical and p 348 A89-27693 experimental study Aerothermal modeling program. Phase 2, element B: Flow interaction experiment p 3 George Washington Univ., Hampton, VA. p 351 N89-17304
- Diverging boundary layers with zero streamwise pressure adion
- [AIAA PAPER 89-0134] p 343 A89-25118 George Washington Univ., Washington, DC.
- Numerical solutions on a Pathfinder and other configurations using unstructured grids and a finite element solve
- p 282 A89-25306 [AIAA PAPER 89-0362] Determination of longitudinal aerodynamic derivatives using flight data from an icing research aircraft p 333 A89-28454 [AIAA 89-0754]
- Georgia Inst. of Tech., Atlanta. Fast half-loop maneuvers for a high alpha fighter aircraft
- using a singular perturbation feedback control law [AIAA PAPER 89-0018] p 331 A89 p 331 A89-25014
- Evaluation of three turbulence models for the prediction of steady and unsteady airloads p 288 A89-25485
- [AIAA PAPER 89-0609] Analysis of structures with rotating, flexible substructures p 312 A89-27695 applied to rotorcraft aeroelasticity of airfoil flutter Technique for the prediction p 348 A89-27744 characteristics in separated flow
- German Air Force Air Armament Directorate, Cologne (Germany, F.R.).
 - On board life monitoring system Tornado (OLMOS) p 319 N89-16785
- Gordon (Sanford), Cleveland, OH.
- NNEPEQ Chemical equilibrium version of the Navy/NASA Engine Program p 322 A89-24989 [ASME PAPER 88-GT-314]

Η

- High Technology Corp., Hampton, VA.
- Flow measurement on the fuselage of a Boeing 737 airolane p 295 A89-28404
- [AIAA PAPER 89-0209] Hochschule der Bundeswehr, Hamburg (Germany, F.R.).
- Gas path modelling, diagnosis and sensor fault p 321 N89-16811 detection
- Hughes Aircraft Co., El Segundo, CA. Laser communication test system
- p 349 N89-17215 [AD-A199612]

I

Illinois Univ., Urbana-Champaign

Impact of device level faults in a digital avionic processor p 356 N89-18046 [NASA-CR-184783]

Imperial Coll. of Science and Technology, London (England).

- Vortex/boundary layer interactions
- p 273 A89-25073 [AIAA PAPER 89-0083] Institut de Mecanique des Fluides de Lille (France). Particular flight mechanics specifications related to wind
- p 339 N89-16879 tunnel test results Iowa Univ., Iowa City. Merging of aircraft vortex trails - Similarities to magnetic
- p 356 A89-26630 field merging

J

Johnson Aeronautics, Palo Alto, CA. Wake model for helicopter rotors in high speed flight p 301 N89-17577 [NASA-CR-177507]

- Lockheed Aeronautical Systems Co., Burbank, CA. Conceptual design of a STOVL fighter/attack aircraft p 313 A89-28206 SAF PAPER 8814311 Lockheed Missiles and Space Co., Huntsville, AL.
- Computation of turbulent incompressible wing-body unction flow
 - [AIAA PAPER 89-0279] p 310 A89-25236

Μ

Maryland Univ., College Park.

- Aeroelastic optimization of a helicopter rotor p 316 N89-16778
 - sachusetts inst. of Tech., Cambridge.
 - Cockpit display of hazardous weather information [AIAA PAPER 89-0808] p 335 A89-2 p 335 A89-25591 Dynamic response of aircraft autopilot systems to p 333 A89-27737 atmospheric disturbances
 - Investigation of surface water behavior during glaze ice ccretion p 304 A89-27739 accretion Active suppression of aerodynamic instabilities in
 - p 295 A89-28341 turbomachine Modeling of surface roughness effects on glaze ice
 - accretion p 305 A89-28451
- AIAA 89-07341 McDonneli-Douglas Helicopter Co., Mesa, AZ.
- Application of a Comprehensive Analytical Model of Rotor Aerodynamics and Dynamics (CAMRAD) to the McDonnell Douglas AH-64A helicopter [NASA-CR-177455] p.301 N89-17578

Accuracy requirements for high-speed test with engine

Accuracy problems in wind tunnels during transport

Intake swirl and simplified methods for dynamic pressure

Recent UK trials in engine health monitoring: Feedback

A simple time-accurate turbomachinery algorithm with

Engine life consumption monitoring program for RB199

The advantage of a thrust rating concept used on the

Numerical solution of flow fields around Delta wings

Recent results in the NASA research balloon program

Controls and guidance: Aeronautics

Ν

numerical solutions of an uneven blade count

Motoren- und Turbinen-Union Muenchen G.m.b.H.

integrated in the on-board life monitoring system

National Aeronautical Lab., Bangalore (India).

National Aeronautics and Space Administration,

using Euler equations method

[NAL-TM-FM-8701]

Washington, DC.

[AIAA PAPER 89-0233]

p 338 N89-16870

p 338 N89-16877

p 299 N89-16742

p 352 N89-17700

p 313 A89-28177

p 326 N89-16790

p 344 A89-25181

p 320 N89-16789

p 327 N89-16800

p 299 N89-16757

simulation on transport aircraft models in the NLR-HST

sserschmitt-Boelkow-Blohm G.m.b.H., Bremen

Messerschmitt-Boeikow-Blohm G.m.b.H., Munich

Mechanism of single shear fastened joints

Properties of aircraft tire materials

Ministry of Defence, London (England).

Mississippi State Univ., Mississippi State.

(Germany, F.R.).

aircraft development

distortion assessment

Michigan Univ., Ann Arbor.

SAE PAPER 8813581

[AIAA PAPER 89-0206]

and feedforward

configuration

(Germany, F.R.).

RB199 engine

(Germany, F.R.).

CORPORATE SOURCE

National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

An interactive boundary-layer procedure for oscillating airfoils including transition effects [AIAA PAPER 89-0020] p 271 A89-25016

Flow visualization studies of the Mach number effects on the dynamic stall of an oscillating airfoil

p 271 [AIAA PAPER 89-0023] 489.25019 Compressible studies on dynamic stall

[AIAA PAPER 89-0024] p 271 A89-25020 The effect of exhaust plume/afterbody interaction on

installed scramjet performance [AIAA PAPER 89-0032] p 272 A89-25028 An experimental study of shock wave/vortex interaction

[AIAA PAPER 89-0082] p 273 A89-25072 Low Reynolds number numerical solutions of chaotic flow

p 275 A89-25108 [AIAA PAPER 89-0123] Numerical simulation of vortex unsteadiness on slender

bodies of revolution at large incidence [AIAA PAPER 89-0195] p p 276 A89-25170 A set of strongly coupled, upwind algorithms for

computing flows in chemical nonequilibrium [AIAA PAPER 89-0199] p 277 AIAA PAPER 89-0199) p 277 A89-25174 TranAir and Euler computations of a generic fighter including comparisons with experimental data

p 310 A89-25221 AIAA PAPER 89-02631 Comparison of LDV measurements and Navier-Stokes solutions in a two-dimensional 180-degree turn-around duct

[AIAA PAPER 89-0275] p 279 A89-25232 The effect of Mach number on the stability of a plane unoreonic wave

[AIAA PAPER 89-0285] p 280 A89-25242 Grid refinement studies of turbine rotor-stator interaction

p 281 A89-25274 [AIAA PAPER 89-0325] Numerical simulation of high-incidence flow over the F-18 fuselage forebody

[AIAA PAPER 89-0339] p 282 A89-25286 Application of direct solvers to unstructured meshes for the Euler and Navier-Stokes equations using upwind

schemes [AIAA PAPER 89-0364] p 283 A89-25308 The design and application of upwind schemes on unstructured meshes

[AIAA PAPER 89-0366] p 354 A89-25310 Direct numerical simulation of compressible free shear flows

[AIAA PAPER 89-0374] p 283 A89-25317 aspects NASP Computational design of а

nozzle/afterbody experiment [AIAA PAPER 89-0446] p 284 A89-25364 A numerical study of the contrarotating vortex pair

associated with a jet in a crossflow [AIAA PAPER 89-0448] p 284 A89-25366 An efficient, explicit finite-rate algorithm to compute flows chamical nonequilibrium

in onormout nonequilibrium		
[AIAA PAPER 89-0522]	p 285	A89-25418
Numerical simulation of vortical flo	ws on fl	exible wings
[AIAA PAPER 89-0537]	p 286	A89-25431
Prediction of separated transonie	c wing 1	ilows with a
non-equilibrium algebraic model		
[AIAA PAPER 89-0558]	p 287	A89-25447
Design and development of a compr	essible	dynamic stall
facility		
[AIAA PAPER 89-0647]	p 335	A89-25511
Navier-Stokes simulation of transc	onic win	g flow fields
using a zonal grid approach	p 290	A89-25862
Navier-Stokes simulation of wind	l-tunnel	flow using
LU-ADI factorization algorithm	p 291	A89-25864
National full-scale aerodynamic	comple	x integrated
systems test data system	p 335	A89-27653
Utilization of wind tunnel instrumer	ntation v	vith software
verifications	p 335	A89-27654
A signal filter with zero phase lag	p 336	A89-27674
A free-trailing vane flow direction	indicato	or employing
a linear output Hall effect transducer		
-	p 336	A89-27675
Analysis of structures with rotating 1	flexible s	ubstructures

applied to rotorcraft aeroelasticity p 312 A89-27695 Analysis of windshear from airline flight data

p 332 A89-27734 Real-time comparison of X-29A flight data and simulation p 332 A89-27736 data

Simulation evaluation of transition and hover flying gualities of the E-7A STOVL aircraft p 333 A89-28205 [SAE PAPER 881430]

The free-wake prediction of rotor hover performance using a vortex embedding method [AIAA PAPER 89-0638] p 296 A89-28443

Modal control of an oblique wing aircraft [NASA-TP-2898] p 333 N89-16845

Tip aerodynamics and acoustics test: A report and data ei inven

p 302 N89-17579 [NASA-RP-1179] Design of automation tools for management of descent traffic

p 306 N89-17584 [NASA-TM-101078] Flight measured downwash of the QSBA p 316 N89-17593 [NASA-TM-101050] The effect of exhaust plume/afterbody interaction on lad Caramiat porfor

nie wie e e e e e e e e e e e e e e e e e		
[NASA-TM-101033]	p 330	N89-17600
V/STOL aircraft and the pro	blem of	jet-induced
suckdown	p 317	N89-18380
The vertical motion simulator	p 339	N89-18384
The national aero-space plane	p 317	N89-18387
The wind tunnels of the national fu	ull-scale a	erodynamics
complex	p 339	N89-18388

National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

The development of an automated flight test management system for flight test planning and p 312 A89-27613 monitoring The design and use of a temperature-compensated

hot-film anemometer system for boundary-layer flow transition detection on supersonic aircraft p 318 A89-27668

National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

Adaptive computations of multispecies mixing between scramjet nozzle flows and hypersonic freestream p 322 A89-25005 [AIAA PAPER 89-0009]

Flow-field characteristics and normal-force correlations for delta wings from Mach 2.4 to 4.6 [AIAA PAPER 89-0026] p 272 A89-25022

Evaluation of leading- and trailing-edge flaps on flat and cambered delta wings at supersonic speeds

p 272 A89-25023 [AIAA PAPER 89-0027] Heat transfer and pressure comparisons between computation and wind tunnel for a research hypersonic aircraft

[AIAA PAPER 89-0029] p 272 A89-25025 A numerical study of hypersonic propulsion/airframe integration problem

[AIAA PAPER 89-0030] p 272 A89-25026 CED simulation of square cross-section, contoured nozzle flows - Comparison with data

p 273 A89-25039 [AIAA PAPER 89-0045] Influence of wing geometry on leading-edge vortices and vortex-induced aerodynamics at supersonic speeds

p 274 A89-25075 [AIAA PAPER 89-0085] An interactive three-dimensional boundary-layer method for transonic flow over swept wings

[AIAA PAPER 89-0112] p 274 A89-25099 Unsteady Euler airfoil solutions using unstructured dvnamic meshes

[AIAA PAPER 89-0115] p 275 A89-25102 A patched-grid algorithm for complex configurations directed towards the F-18 aircraft

p 310 A89-25106 [AIAA PAPER 89-0121] Three-dimensional compressible boundary layer

calculations to fourth order accuracy on wings and fuselages [AIAA PAPER 89-0130] p 275 A89-25115

Diverging boundary layers with zero streamwise pressure aradient

[AIAA PAPER 89-0134] p 343 A89-25118 Sidewall boundary-layer removal effects on wall adaptation in the Langley 0.3-meter transonic cryogenic tunnel

[AIAA PAPER 89-0148] p 334 A89-25131 Flow quality measurements for the Langley 8-foot

transonic pressure tunnel LFC experiment [AIAA PAPER 89-0150] p 276 A89-25133 A solution to water vapor in the National Transonic

Facility [AIAA PAPER 89-0152] p 334 A89-25135

Three-dimensional flow simulation about the AFE vehicle in the transitional regime [AIAA PAPER 89-0245] p 278 A89-25207

Pressure and heat transfer investigation of a modified NASP baseline configuration at M = 6

p 339 A89-25208 [AIAA PAPER 89-0246] Upwind Navier-Stokes solutions for leading-edge vortex flows

[AIAA PAPER 89-0265] p 278 A89-25223 Effect of nose bluntness on flow field over slender bodies in hypersonic flows

[AIAA PAPER 89-0270] p 279 A89-25228 Navier-Stokes solutions for vortical flows over a tangent-ogive cylinder

[AIAA PAPER 89-0337] p 281 A89-25284 Navier-Stokes solutions about the F/A-18 forebody-LEX configuration

p 281 A89-25285 [AIAA PAPER 89-0338]

NASA. Langley Research Center, Hampton, Va.

Numerical solutions on a Pathfinder and other configurations using unstructured grids and a finite element entro

[AIAA PAPER 89-0362] p 282 A89-25306 An investigation of cell centered and cell vertex multigrid chemes for the Navier-Stokes equations

p 345 A89-25440 [AIAA PAPER 89-0548] Navier-Stokes computations of separated vortical flows

past prolate spheroid at incidence [AIAA PAPER 89-0553] p 286 A89-25443

A one equation turbulence model for transonic airfoil [AIAA PAPER 89-0557] p 287 A89-25446

Prediction of separated transonic wing flows with a non-equilibrium algebraic model

p 287 A89-25447 [AIAA PAPER 89-0558] Integral equation solution of the full potential equation

for transonic flows [AIAA PAPER 89-0563] p 287 A89-25452

Drag measurements on a modified prolate spheroid using a magnetic suspension and balance system p 335 A89-25512 [AIAA PAPER 89-0648]

Characteristics of the ground vortex formed by a jet moving over a fixed ground plane [AIAA PAPER 89-0650]

n 288 A89-25514 Navier-Stokes calculations for DFVLR F5-wing in wind

tunnel using Runge-Kutta time-stepping scheme p 291 A89-25867 An Euler analysis of leading-edge vortex flows on a

forebody-strake at supersonic speeds [AIAA PAPER 89-0343] p 293 A89-26371

Miniaturized compact water-cooled pitot-pressure probe for flow-field surveys in hypersonic wind tunnels p 348 A89-27659

Miniature PCM compatible wideband spectral analyzer

p 318 A89-27664 for hypersonic flight research Unsteady transonic algorithm improvements for realistic

aircraft applications p 312 A89-27738

Design and experimental results for a high-altitude, p 312 A89-27740 long-endurance airfoil

on a wing in a wind Effect of sidewall boundary layer p 294 A89-27742 tunnel

Fore-and-aft stiffness and damping characteristics of 30 x 11.5-14.5, Type VIII, bias-ply and radial-belted aircraft tires

p 313 A89-28176 [SAE PAPER 881357] A summary of recent aircraft/ground vehicle friction

measurement tests [SAE PAPER 881403] p 336 A89-28196

Low-speed vortical flow over a 5-degree cone with tip geometry variations

[SAE PAPER 881422] p 295 A89-28203 LDV surveys over a fighter model at moderate to high

angles of attack [SAE PAPER 881448] p 295 A89-28218

Emerging technology for transonic wind-tunnel-wall interference assessment and corrections

p 336 A89-28220 [SAE PAPER 881454] Results from NASA Langley experimental studies of

multiaxis thrust vectoring nozzles [SAE PAPER 881481] p 324 A89-28228 Theoretical investigation for the effects of sweep,

leading-edge geometry, and spanwise pressure gradients on transition and wave drag transonic, and supersonic speed with experimental correlations [SAE PAPER 881484] p 295 A89-28229

Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies

[AIAA PAPER 88-0460] p 295 A89-28251 Flow measurement on the fuselage of a Boeing 737

airplane [AIAA PAPER 89-0209] p 295 A89-28404

Determination of longitudinal aerodynamic derivatives using flight data from an icing research aircraft p 333 A89-28454 [AIAA 89-0754]

The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment

[AIAA 89-0762] p 337 A89-28457 Cockpit display of ground-based weather data during thunderstorm research flights

p 269 A89-28463 [AIAA 89-08061 Piloted-simulation evaluation of escape guidance for

microburst wind shear encounters (NASA-TP-2886) p 321 N89-16820

Wind tunnel-sidewall-boundary-layer effects in transonic airfoil testing-some correctable, but some not p 338 N89-16864

NASA SC(2)-0714 airfoil data corrected for sidewall boundary-layer effects in the Langley 0.3-meter transonic cryogenic tunnel p 301 N89-17568 [NASA-TP-2890]

C-3

NASA. Lewis Research Center, Cleveland, Ohio.

National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NNEPEQ - Chemical equilibrium version of the Navy/NASA Engine Program ASME PAPER 88-GT-3141 p 322 A89-24989

- Control of laminar separation over airfoils by acoustic excitation
- [AIAA PAPER 89-0565] p 288 A89-25454 Evaluation of three turbulence models for the prediction of steady and unsteady airloads
- p 288 A89-25485 [AIAA PAPER 89-0609] Performance of the forward scattering spectrometer probe in NASA's Icing Research Tunnel
- p 346 A89-25570 [AIAA PAPER 89-0769] Experimental investigation of transonic oscillating
- cascade aerodynamics p 293 A89-26369 [AIAA PAPER 89-0321]
- Laser velocimeter measurements of the flowfield generated by an advanced counterrotating propeller [AIAA PAPER 89-0434] p 293 A89-26373
- A computational procedure for automated flutter p 348 A89-28070 analysis An overview of the current NASA program on aircraft
- icing research [SAE PAPER 881386] p 305 A89-28192
- Composite mechanics for engine structures p 341 A89-28344
- Comparison of 3D computation and experiment for non-axisymmetric nozzles
- [AIAA PAPER 89-0007] p 325 A89-28403 Unsteady Euler cascade analysis
- [AIAA PAPER 89-0322] p 295 A89-28406 Experimental and numerical investigation of an oblique shock wave/turbulent boundary layer interaction with continuous suction
- [AIAA PAPER 89-0357] p 296 A89-28407 Numerical analysis of flow through oscillating cascade
- sections p 296 A89-28413 [AIAA PAPER 89-0437]
- Modeling of surface roughness effects on glaze ice accretion
- [AIAA 89-0734] p 305 A89-28451 An experimental investigation of multi-element airfoil ice
- accretion and resulting performance degradation p 297 A89-28453 [AIAA 89-0752] Determination of longitudinal aerodynamic derivatives
- using flight data from an icing research aircraft [AIAA 89-0754] p 333 A89-28454
- Investigation of the flow in the diffuser section of the NASA Lewis Icing Research Tunnel p 336 A89-28455
- [AIAA 89-0755] CFD application to subsonic inlet airframe integration p 299 N89-16753
- CFD application to supersonic/hypersonic inlet airframe integration p 299 N89-16754 The design and development of transonic multistage p 329 N89-16834 compressors
- p 330 N89-16837 Supersonic throughflow fans the Experimental verification of thermodynamic properties for a jet-A fuel
- p 342 N89-17017 [NASA-TM-101475] Turbine Engine Hot Section Technology, 1987 NASA-CP-2493] p 351 N89-17298
- [NASA-CP-2493] Structural response of an advanced combustor liner
- Test and analysis p 351 N89-17329 National Aeronautics and Space Administration.
- Marshall Space Flight Center, Huntsville, AL Comparison of LDV measurements and Navier-Stokes
- solutions in a two-dimensional 180-degree turn-around duct p 279 A89-25232 [AIAA PAPER 89-0275]
- High-temperature containerless aircraft furnace experimentation in the microgravity environment aboard a KC-135 aircraft
- [AIAA PAPER 89-0402] p 345 A89-25337 NASP natural environment definitions for design p 339 A89-25568
- [AIAA PAPER 89-0764] National Aeronautics and Space Administration.
- Wallops Flight Facility, Wallops Island, VA. The development of a capability for aerodynamic testing of large-scale wing sections in a simulated natural rain environment
- p 337 A89-28457 [AIAA 89-0762] National Aerospace Lab., Amsterdam (Netherlands). Accuracy of various wall-correction methods for 3D subsonic wind-tunnel testing p 338 N89-16863 Requirements and capabilities in unsteady windtunned p 339 N89-16878
- testing National Central Univ., Chung-Li (Taiwan).
- Technique for the prediction of airfoil flutter characteristics in separated flow p 348 A89-27744 National Defence Headquarters, Ottawa (Ontarlo). Canadian forces aircraft condition/health monitoring:
- p 326 N89-16784 Policy, plans and experience
- C-4

- National Research Council of Canada, Ottawa (Ontario).
- The effects of a compressor rebuild on gas turbine p 327 engine performance N89-16803 Importance of sensitivity and reliability of NDI techniques on damage tolerance based life prediction of turbine p 350 N89-17257 discs
- National Severe Storms Lab., Norman, OK. Lightning initiation on aircraft in thunderstorms
 - p 353 A89-26214

National Transportation Safety Board, Washington, DC.

- Aircraft accident/incident summary report, Travis Air Force Base, California, 8 April 1987
- [PB88-910414] p 306 N89-16768 Naval Air Development Center, Warminster, PA.
- Long term possibilities for nondestructive evaluation for US Navy aircraft p 350 N89-17259 Naval Air Systems Command, Washington, DC.
- An overview of US Navy engine monitoring system programs and user experience p 326 N89-16782 Wind tunnel predicted air vehicle performance: A review
- p 337 N89-16852 of lessons learned Naval Coastal Systems Center, Panama City, FL. An experimental investigation of delta wing vortex flow
- with and without external jet blowing p 273 A89-25074 [AIAA PAPER 89-0084]
- Naval Postgraduate School, Monterey, CA. Aerodynamic performance of wings of arbitrary planform
- in inviscid, incompressible, irrotational flow p 297 N89-16728 [AD-A200436]
- Measurements of gas turbine combustor and engine augmentor tube sooting characteristics p 328 N89-16821
- [AD-A1997681 An evaluation of automating Carrier Air Traffic Control Center (CATCC) status boards utilizing voice recognition input
- [AD-A200626] p 309 N89-17588 Naval Research Lab., Washington, DC.
- Two-dimensional Euler computations on a triangular mesh using an upwind, finite-volume scheme p 354 A89-25385 [AIAA PAPER 89-0470]
- Naval Surface Warfare Center, Silver Spring, MD. Laser holographic interferometric measurements of the flow in a scramjet inlet at Mach 4
- [AIAA PAPER 89-0043] p 273 A89-25037 Naval Surface Weapons Center, Silver Spring, MD.
- Notes on a theoretical parachute opening force analysis applied to a general trajectory
- p 302 N89-17582 FAD-A2010501 North Carolina State Univ., Raleigh.
- Laser holographic interferometric measurements of the flow in a scramjet inlet at Mach 4
- [AIAA PAPER 89-0043] p 273 A89-25037 An interactive three-dimensional boundary-layer method for transonic flow over swept wings
- [AIAA PAPER 89-0112] p 274 A89-25099 A one equation turbulence model for transonic airfoil flows
- [AIAA PAPER 89-0557] p 287 A89-25446 Notre Dame Univ., IN.
- An experimental investigation of delta wing vortex flow with and without external jet blowing
- p 273 A89-25074 [AIAA PAPER 89-0084] A flow visualization and aerodynamic force data evaluation of spanwise blowing on full and half span delta winas
- [AIAA PAPER 89-0192] p 276 A89-25167 The separated flow field on a slender wing undergoing
- transient pitching motions p 276 A89-25169 [AIAA PAPER 89-0194]

0

- Office National d'Etudes et de Recherches Aeronautiques, Paris (France).
 - Comparison of the results of tests on A300 aircraft in the RAE 5 metre and the ONERA F1 wind tunnels p 300 N89-16849
 - Some difficulties in the wind tunnel prediction of modern
- civil aircraft buffeting: Proposed remedies p 301 N89-16869
- Office National d'Etudes et de Recherches Aerospatiales, Modane (France).
 - Precision improvement of transport aircraft drag p 300 N89-16858 measurements
- Office National d'Etudes et de Recherches
- Aerospatiales, Paris (France). p 315 N89-16749 Transport aircraft intake design
 - Wind tunnel air intake test techniques p 299 N89-16751
- Ohio State Univ., Columbus.
- Effect of simulated glaze ice on a rectangular wing p 303 A89-25560 [AIAA PAPER 89-0750]

Old Dominion Univ., Norfolk, VA.

- Adaptive computations of multispecies mixing between et nozzle flows and hypersonic freestrea p 322 A89-25005 [AIAA PAPER 89-0009]
- Unsteady Navier-Stokes computations past oscillating delta wing at high incidence
- [AIAA PAPER 89-0081] p 273 A89-25071 Effect of nose bluntness on flow field over slender bodies
- in hypersonic flows
- [AIAA PAPER 89-0270] p 279 A89-25228 A multigrid and upwind viscous flow solver on 3-D embedded and overlapped grids
- [AIAA PAPER 89-0464] p 285 A89-25379
- Navier-Stokes computations of separated vortical flows past prolate spheroid at incidence
- AIAA PAPER 89-05531 p 286 A89-25443 Integral equation solution of the full potential equation
- for transonic flows [AIAA PAPER 89-0563] p 287 A89-25452
- Viscous shock-layer solutions for the low-density hypersonic flow past long slender bodies
- [AIAA PAPER 88-0460] p 295 A89-28251 An experimental investigation of the aerodynamic
- characteristics of slanted base ogive cylinders using magnetic suspension technology [NASA-CR-1846241 p 300 N89-16758
- Full-potential integral solutions for steady and unsteady transonic airfoils with and without embedded Euler domains p 301 N89-17566

P

Pennsylvania State Univ., University Park.

computing flows in chemical nonequilibrium

cambered delta wings at supersonic speeds

Pratt and Whitney Aircraft, East Hartford, CT.

Coolant passage heat transfer with rotation

coating

modeling of coated single crystal superalloys

materials (ISOTROPIC) fifth year progress review

Pratt and Whitney Aircraft, West Palm Beach, FL.

Pratt and Whitney Aircraft Group, West Paim Beach,

Pratt and Whitney Aircraft of Canada Ltd., Longueuil

Fault management in aircraft power plant controls

The development of an automated flight test management system for flight test planning and

PRC Systems Services Co., Hampton, VA. An Euler analysis of leading-edge vortex flows on a

forebody-strake at supersonic speeds

F100-PW-220 engine monitoring system

Planning Research Corp., Hampton, VA.

[AIAA PAPER 89-0199]

[AIAA PAPER 89-0027]

[AIAA PAPER 89-0085]

[AIAA PAPER 89-0563]

[AIAA PAPER 89-0658]

section components

component design

(Quebec).

monitoring

supersonic through-flow fan

[AIAA PAPER 89-0010]

PRC Kentron, Edwards, CA.

[AIAA PAPER 89-0343]

development

Thermal barrier

unstructured grid Euler solver

for transonic flows

long-endurance airfoil

- An experimental study of shock wave/vortex . interaction
- [AIAA PAPER 89-0082] p 273 A89-25072 Diverging boundary layers with zero streamwise pressure oradient
- [AIAA PAPER 89-0134] p 343 A89-25118 A set of strongly coupled, upwind algorithms for

Design and experimental results for a high-altitude.

Evaluation of leading- and trailing-edge flaps on flat and

Influence of wing geometry on leading-edge vortices and

Integral equation solution of the full potential equation

A three-dimensional upwind finite element point implicit

Three-dimensional inelastic analysis methods for hot

High temperature constitutive and crack initiation

Creep fatigue life prediction for engine hot section

Relationships of nondestructive evaluation needs and

Performance potential of air turbo-ramjet employing

life

vortex-induced aerodynamics at supersonic speeds

D 277

A89-25174

p 312 A89-27740

p 272 A89-25023

p 274 A89-25075

p 287 A89-25452

p 289 A89-25521

p 351 N89-17314

p 351 N89-17316

prediction model

p 351 N89-17333

p 342 N89-17334

p 352 N89-17336

p 320 N89-16795

p 349 N89-17256

p 322 A89-25006

p 327 N89-16809

p 312 A89-27613

p 293 A89-26371

CORPORATE SOURCE

Fore-and-aft stiffness and damping characteristics of 30 x 11.5-14.5, Type VIII, bias-ply and radial-belted aircraft tires

- [SAE PAPER 881357] p 313 A89-28176 Purdue Univ., West Lafayette, IN.
- Oscillating aerodynamics and flutter of an aerodynamically detuned cascade in an incompressible flow
- [AIAA PAPER 89-0289] p 280 A89-25246
- Propeller/wing interaction [AIAA PAPER 89-0535] p 311 A89-25429 Experimental investigation of transonic oscillating cascade aerodynamics
- [AIAA PAPER 89-0321] p 293 A89-26369 Real-time comparison of X-29A flight data and simulation
- p 332 A89-27736 data Effect of heavy rain on aviation engines

[AIAA 89-0799] p 326 A89-28462 Vibration and aeroelastic tailoring of advanced composite plate-like lifting surfaces p 351 N89-17263

Q

- Queensland Univ., Brisbane (Australia).
- Thermodynamics and wave processes in high Mach number propulsive ducts p 278 A89-25219 TAIAA PAPER 89-02611

R

- RAND Corp., Santa Monica, CA. Aircraft airframe cost estimating relationships: All
- mission types p 269 N89-16719 [AD-A200262]
- Aircraft airframe cost estimating relationships: Fighters p 270 N89-16720 [AD-A200263]
- Aircraft airframe cost estimating relationships: Bombers and transports AD-A2002641 p 270 N89-16721
- Aircraft airframe cost estimating relationships: Attack aircraft
- [AD-A200265] p 270 N89-16722 Rice Univ., Houston, TX.
- Overview of optimal trajectories for flight in a windshear p 306 A89-28464
- [AIAA 89-0812] Rockwell International Corp., Lakewood, CA. B-1B CITS engine monitoring p 319 N89-16788
- Rockwell International Corp., Los Angeles, CA. Superplastic formed aluminum-lithium aircraft structure
- p 316 N89-17591 [AD-A200245] Rolls-Rovce Ltd., Bristol (England),
- Military engine condition monitoring systems: The UK p 320 N89-16797 experience

- Rolls-Royce Ltd., Derby (England). COMPASS (Trademark): A generalized ground-based monitoring system p 321 N89-16819 Need for common AGARD approach and actions p 350 N89-17260
- Royal Air Force, London (England).
- Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Information management systems for on-board onitoring systems p 319 N89-16786 monitoring systems
- Royal Aircraft Establishment, Bedford (England). The accurate measurement of drag in the 8 ft x 8 ft p 337 N89-16855 tunnel

Royal Armament Research and Development

- Establishment, Christchurch (England).
- Test specimens for bearing and by-pass stress interaction in carbon fibre reinforced plastic laminates p 342 N89-17696
- Royal Inst. of Tech., Stockholm (Sweden). An analysis method for bolted joints in primary composite p 317 N89-17691 aircraft structure

S

- Saab-Scania, Linkoping (Sweden). An analysis method for bolted joints in primary composite
- p 317 N89-17691 aircraft structure Sandia National Labs., Albuquerque, NM.
- Aviation security: A system's perspective
- p 306 N89-16766 [DE89-002020] Advanced Fighter Technology Integration/Sandia Inertial Terrain-Aided Navigation (AFTI/SITAN) p 309 N89-17587 [DE89-004000]
- Societe de Fabrication d'Instruments de Mesure. Massy (France).
 - Maintenance aid system for wide body aircraft p 327 N89-16805

- Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry Cedex (France). Service life calculator for the M53 turbofan engine
 - p 326 N89-16796 Short term developments in non-destructive evaluation
- p 350 N89-17258 applicable to turbine engine parts State-of-the-art in non-destructive evaluation of turbine p 350 N89-17261 engine parts
- Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France).
- Design methodology for advanced High Pressure (HP) p 330 N89-16840 compressor first stage Sparta, Inc., Laguna Hills, CA.
- The development of an automated flight test management system for flight test planning and p 312 A89-27613 monitoring Stanford Univ., CA.
- Diverging boundary layers with zero streamwise pressure oradienť
- AIAA PAPER 89-01341 p 343 A89-25118 The effect of Mach number on the stability of a plane supersonic wave
- [AIAA PAPER 89-0285] p 280 A89-25242 Low speed wind tunnel investigation of the flow about delta wing, oscillating in pitch to very high angle of attack
- p 281 A89-25252 [AIAA PAPER 89-0295] Numerical study of the effect of tangential leading edge
- blowing on delta wing vortical flow [AIAA PAPER 89-0341] p 282 A89-25288
- Direct numerical simulation of compressible free shear flows
- [AIAA PAPER 89-0374] p 283 A89-25317 Nonequilibrium effects for hypersonic transitional flows using continuum approach
- [AIAA PAPER 89-0461] p 284 A89-25377 Stewart Hughes Ltd., Southhampton (England).
- Gas path condition monitoring using electrostatic p 321 N89-16817 techniques Stuttgart Univ. (Germany, F.R.).
- Inverse methods for blade design, controlled diffusion blading for supercritical compressor flow p 329 N89-16832
- Sundstrand Corp., Rockford, IL. An experimental study and prediction of a two-phase
- pressure drop in microgravity [AIAA PAPER 89-0074] p 343 A89-25065
- Sverdrup Technology, Inc., Middleburg Heights, OH. Comparison of 3D computation and experiment for non-axisymmetric nozzles p 325 A89-28403 [AIAA PAPER 89-0007]
- Modeling of surface roughness effects on glaze ice cretion
- [AIAA 89-0734] p 305 A89-28451 Sverdrup Technology, Inc., Cleveland, OH. Performance of the forward scattering spectrometer
- probe in NASA's Icing Research Tunnel [AIAA PAPER 89-0769] p 346 A89-25570
- An experimental investigation of multi-element airfoil ice accretion and resulting performance degradation p 297 A89-28453 [AIAA 89-0752]
- Experimental verification of the thermodynamic properties for a jet-A fuel [NASA-TM-101475] p 342 N89-17017

т

- Technische Univ., Darmstadt (Germany, F.R.).
- Balance accuracy and repeatability as a limiting parameter in aircraft development force measurements in conventional and cryogenic wind tunnels p 338 N89-16873
- Technische Univ., Munich (Germany, F.R.). System-theoretical method for dynamic on-condition
- monitoring of gas turbines p 321 N89-16812 Tennessee Univ., Knoxville,
- An experimental study and prediction of a two-phase pressure drop in microgravity
- p 343 A89-25065 AIAA PAPER 89-0074 Progress on a Taylor weak statement finite element algorithm for high-speed aerodynamic flows
- p 289 A89-25517 [AIAA PAPER 89-0654] Tennessee Univ., Tullahoma
- Pattern-based fault diagnosis using neural networks p 354 A89-27602 Hierarchical representation and machine learning from
- faulty jet engine behavioral examples to detect real time p 355 A89-27622 abnormal conditions Automatic acquisition of domain and procedural knowledge p 318 A89-27624
- Texas A&M Univ., College Station. Determination of aerodynamic sensitivity coefficients in
- the transonic and supersonic regimes [AIAA PAPER 89-0532] p 286 A89-25426

- Vigyan Research Associates, Inc.
- Development of direct-inverse 3-D methods for applied transonic aerodynamic wing design and analysis p 300 N89-16761 [NASA-CR-184788]
- Nonlinear dynamic responses of composite rotor blades
- p 315 N89-16774 (AD-A200145) Texas Univ., Arlington.
- An experimental investigation of the perpendicular vortex-airfoil interaction at transonic speeds p 301 N89-17569
- Tokyo Univ. (Japan). Numerical study of the effect of tangential leading edge
- blowing on delta wing vortical flow [AIAA PAPER 89-0341] p 282 A89-25288
- A numerical simulation of flows about two-dimensional bodies of parachute-like configuration p 302 N89-17580 [ISAS-629]
- Development of new redundant flight safety system using inertial sensors
- [ISAS-634] p 306 N89-17585 Toledo Univ., OH.
- Thermal analysis of engine inlet anti-icing systems [AIAA PAPER 89-0759] p 311 A89-25565 A computational procedure for automated flutter
- analysis p 348 A89-28070 Investigation of the flow in the diffuser section of the NASA Lewis Icing Research Tunnel
 - p 336 A89-28455 [AIAA 89-0755]

U

- United Technologies Corp., Windsor Locks, CT.
- Prop-fan airfoil icing characteristics [AIAA PAPER 89-0753] p 303 A89-25561 United Technologies Research Center, East Hartford,
- CT. Performance potential of air turbo-ramiet employing
- supersonic through-flow fan [AIAA PAPER 89-0010] p 322 A89-25006
- Measurement of airfoil heat transfer coefficients on a turbine stage p 351 N89-17311
- University Coll., London (England). Review of existing NDT technologies and their
- capabilities p 349 N89-17255 University Coll. of Swansea (Wales).
- A three-dimensional upwind finite element point implicit unstructured grid Euler solver [AIAA PAPER 89-0658] p 289 A89-25521

ν

Heat transfer and pressure comparisons between

computation and wind tunnel for a research hypersonic

A patched-grid algorithm for complex configurations directed towards the F-18 aircraft

Sidewall boundary-layer removal effects on wall

Three-dimensional flow simulation about the AFE vehicle

Upwind Navier-Stokes solutions for leading-edge vortex

Navier-Stokes solutions for vortical flows over a

Navier-Stokes solutions about the F/A-18 forebody-LEX

Numerical solutions on a Pathfinder and other

Prediction of separated transonic wing flows with a

Navier-Stokes calculations for DFVLR F5-wing in wind

Effect of sidewall boundary layer on a wing in a wind

Emerging technology for transonic wind-tunnel-wall

tunnel using Runge-Kutta time-stepping scheme

interference assessment and corrections

configurations using unstructured grids and a finite element

adaptation in the Langley 0.3-meter transonic cryogenic

Vigyan Research Associates, Inc., Hampton, VA.

An adaptive implicit/explicit finite element scheme for

p 344 A89-25307

p 272 A89-25025

p 310 A89-25106

p 334 A89-25131

p 278 A89-25207

p 278 A89-25223

p 281 A89-25284

p 281 A89-25285

p 282 A89-25306

p 287 A89-25447

p 291 A89-25867

p 294 A89-27742

p 336 A89-28220

C-5

University of Wales, Swansea.

[AIAA PAPER 89-0363]

[AIAA PAPER 89-0029]

[AIAA PAPER 89-0121]

[AIAA PAPER 89-0148]

in the transitional regime

[AIAA PAPER 89-0245]

[AIAA PAPER 89-0265]

tangent-ogive cylinder [AIAA PAPER 89-0337]

[AIAA PAPER 89-0338]

[AIAA PAPER 89-0362]

[AIAA PAPER 89-0558]

[SAE PAPER 881454]

non-equilibrium algebraic model

configuration

solver

tunnel

aircraft

tunnel

compressible viscous high speed flow

Virginia Polytechnic Inst. and State Univ.

Viscous shock-layer solutions	for the	low-density
hypersonic flow past long slender bo	odies	•
[AIAA PAPER 88-0460]	p 295	A89-28251
Virginia Polytechnic Inst. and State	Úniv.,	Blacksburg.
Fast half-loop maneuvers for a high	n alpha fi	ohter aircraft
using a singular perturbation feedbar	ck contro	ollaw
[AIAA PAPER 89-0018]	p 331	A89-25014
A patched-grid algorithm for corr	plex co	nfigurations
directed towards the F-18 aircraft	•	-
[AIAA PAPER 89-0121]	p 310	A89-25106
Two-dimensional Euler computat	tions on	a triangular
mesh using an upwind, finite-volume	scheme	1
[AIAA PAPER 89-0470]	p 354	A89-25385
Von Karman Inst. for Fluid Dynamic	B,	
Rhode-Saint-Genese (Belgium).		
Intake Aerodynamics, volume 1		
{VKI-LS-1988-04-VOL-1]	p 298	N89-16738
Introduction to intake aerodynamic	s	
	p 298	N89-16739
Transonic cowl design	p 315	N89-16746
Intake Aerodynamics, volume 2		
[VKI-LS-1988-04-VOL-2]	p 299	N89-16748
Transonic Compressors, volume 1		
[VKI-LS-1988-03-VOL-1]	p 328	N89-16825
Transonic Compessors, volume 2		
[VKI-LS-1988-03-VOL-2]	p 329	N89-16833
Variable geometry in supersonic c	ompress	ors
	p 330	N89-16838
Axial supersonic inlet compound	p 330	N89-16839

W

Washington State Univ., Puliman.		
Superplastic formed aluminum-lithium aircraft structure		
[AD-A200245]	p 316	N89-17591

West Virginia Univ., Morgantown.		
Computational design of low aspect ratio wing-winglets		
for transonic wind-tunnel testing		
[AIAA PAPER 89-0644]	p 311	A89-25509

Wyoming Univ., Laramie. The measurement of temperature from an aircraft in cloud p 353 N89-17978

i

ł

FOREIGN TECHNOLOGY INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 240)

June 1989

Typical Foreign Technology Index Listing



Listings in this index are arranged alphabetically by country of intellectual origin. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the citation in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

AUSTRALIA

- Thermodynamics and wave processes in high Mach number propulsive ducts [AIAA PAPER 89-0261] p 278 A89-25219
- Design of an all boron/epoxy doubler reinforcement for the F-111C wing pivot fitting - Structural aspects p 313 A89-27925
- Reliable information from performance engine monitoring [SAE PAPER 881444] p 356 A89-28215
- Gas path analysis and engine performance monitoring in a Chinook helicopter p 327 N89-16802

В

BELGIUM

Infrared thermography in blowdown and intermittent hypersonic facilities [AIAA PAPER 89-0042] p 334 A89-25036

• • • • • • • • • • • • • • • • • • • •		
Intake Aerodynamics, volume 1		
[VKI-LS-1988-04-VOL-1]	p 298	N89-16738
Introduction to intake aerodynamic	s	
	p 298	N89-16739
Transonic cowl design	p 315	N89-16746
Intake Aerodynamics, volume 2		
[VKI-LS-1988-04-VOL-2]	p 299	N89-16748
Transonic Compressors, volume 1		
[VKI-LS-1988-03-VOL-1]	p 328	N89-16825
Transonic Compessors, volume 2		
[VKI-LS-1988-03-VOL-2]	p 329	N89-16833
Variable geometry in supersonic co	ompress	ors
	p 330	N89-16838
Axial supersonic inlet compound	p 330	N89-16839

С

CANADA Unsteady wall interference in rotary tests

- AIAA PAPER 89-00461 p 273 A89-25040 Passage-averaged Navier-Stokes equations with finite element applications
- [AIAA PAPER 89-02081 p 344 A89-25183 Moving surface boundary-layer control as applied to vo-dime insional airfoils
- [AIAA PAPER 89-02961 p 281 A89-25253 The turbulent free jet issuing from a sharp-edged elliptical slot
- [AIAA PAPER 89-0664] p 345 A89-25526 Use of the median volume droplet diameter in the
- characterization of cloud droplet spectra [AIAA PAPER 89-0756] p 352 A89-25562 Flow visualization investigation of dynamic stall on a
- pitching airfoil [AIAA PAPER 89-0842] p 290 A89-25611 for SAR motion Evaluation of a Kalman filter compensation p 347 A89-26721
- The Honeywell/DND helicopter integrated navigation system (HINS) p 308 A89-26741 Finite element simulation of 3D turbulent free shear flows p 294 A89-26946
- Canadian forces aircraft condition/health monitoring: p 326 N89-16784 Policy, plans and experience CF-18 engine performance monitoring
- p 326 N89-16787
- The effects of a compressor rebuild on gas turbine engine performance N89-16803 p 327 Installed thrust as a predictor of engine health for jet
- p 327 N89-16806 engines Fault management in aircraft power plant controls p 327 N89-16809
- Identification of dynamic characteristics for fault isolation purposes in a gas turbine using closed-loop p 328 N89-16813 measurements
- CF-18/F404 transient performance trending p 328 N89-16814 Importance of sensitivity and reliability of NDI techniques
- on damage tolerance based life prediction of turbine p 350 N89-17257 CHILE
- On a distributed parameter model for detecting cracks p 354 A89-25870 in a roto CHINA. PEOPLE'S REPUBLIC OF
- Experimental and analytical study on exit radial temperature profile of experimental 2D combustor [AIAA PAPER 89-0493] p 340 A89-25403
- A numerical method for unsteady transonic flow about pered wings p 291 A89-25929 Applications of an efficient algorithm to transonic tapered wings
- conservative full-potential flow past 3-D wings p 291 A89-25930
- Computation for supersonic and turbulent separated flow p 292 A89-25931 over a compression corner A prediction of the stalling of the multielement airfoils p 292 A89-25932
- Longitudinal stability analysis for deformable aircraft p 332 A89-25934
- Experimental research of flow separation, heat transfer and ablation on flat plate-wedges in supersonic, turbulent flow p 292 A89-25938
- Testing on two dimensional vertical models p 292 A89-25939 conventional wind tunnel
- Applications of AF3 efficient iteration scheme to transonic nonconservative full-potential flow past airfoils p 292 A89-25940
- A numerical method for calculating the low-speed aerodynamic characteristics of the strake-wing p 292 A89-25941 configurations An integral method for calculating turbulent boundary p 292 A89-25942 layer flow on practical wings Derivation of an integral equation for large disturbing transonic flow and its numerical method of undercritical
- p 293 A89-25944 flow An effective modeling method of unsteady aerodynamics for state-space aeroelastic models p 293 A89-25946
- MPC-75 feeder civil aircraft [AD-A200907] p 317 N89-17594

FRANCE

Relation between diffusor losses and the inlet flow conditions of turbojet combustors p 322 A89-24916 Combined propulsion for hypersonic and space shicles p 322 A89-24917 vehicles Numerical and experimental study of the crash behavior of helicopters and fixed-wing aircraft p 309 A89-24919 Stability and transition of two-dimensional laminar boundary layers in compressible flow over an adiabatic p 270 A89-24922 wali Fast laminar near wake flow calculation by an implicit method solving the Navier-Stokes equations p 270 A89-24923 Infrared technique to measure the skin temperature on an electrothermal de-icer - Comparison with numerical simulations [AIAA PAPER 89-0760] p 303 A89-25566 Boundary layer transition and turbulence modelling in three-dimensional flow p 346 A89-25860 Source localization technique for impulsive multiple p 356 A89-27741 p 315 N89-16749 sources Transport aircraft intake design Wind tunnel air intake test techniques p 299 N89-16751 Study of the aerodynamic situation along the C 160 aircraft in parachuting configuration [DAT-88-06] p 299 N89-16756 Reynolds number effects in transonic flow p 300 N89-16760 AGARD-AG-3031 The CFM 56-5 on the A-320 at Air France p 320 N89-16793 Service life calculator for the M53 turbofan engine p 326 N89-16796 Trend monitoring of a turboprop engine at low and mean p 321 N89-16801 power Maintenance aid system for wide body aircraft p 327 N89-16805 Design methodology for advanced High Pressure (HP) compressor first stage p 330 N89-16840 Comparison of the results of tests on A300 aircraft in the RAE 5 metre and the ONERA E1 wind tunnels p 300 N89-16849 Precision improvement of transport aircraft drag p 300 N89-16858 measurements Some difficulties in the wind tunnel prediction of modern civil aircraft buffeting: Proposed remedies p 301 N89-16869 Particular flight mechanics specific ations related to wind tunnel test results p 339 N89-16879 Short term developments in non-destructive evaluation applicable to turbine engine parts p 350 N89-17258 State-of-the-art in non-destructive evaluation of turbine p 350 N89-17261 ngine parts Bolted scarf joints in carbon composite materials. Comparison between assemblies with an interference fit and those with play p 343 N89-17702

F

G

GERMANY, FEDERAL REPUBLIC OF

- High-lift aerodynamics for transport aircraft by interactive experimental and theoretical tool development
- [AIAA PAPER 89-0267] p 278 A89-25225 Analysis of three-dimensional aerospace configurations using the Euler equations
- [AIAA PAPER 89-0268] p 279 A89-25226 An implicit flux-vector splitting scheme for the
- computation of viscous hypersonic flow [AIAA PAPER 89-0274] p 279 A89-25231
- The intelligent wing Aerodynamic developments for future transport aircraft [AIAA PAPER 89-0534] p 269 A89-25428
- An investigation of cell centered and cell vertex multigrid schemes for the Navier-Stokes equations
- [AIAA PAPER 89-0548] p 345 A89-25440 Comparison of two different Navier-Stokes methods for the simulation of 3-D transonic flows with separation [AIAA PAPER 89-0559] p 287 A89-25448

Ē

0

Ř

Ε

ľ,

G

Ν

IAIAA PAPER 89-06401 p 311 A89-25506 Numerical simulation of the transonic DFVLR-F5 wing experiment; Proceedings of the International Workshop on Numerical Simulation of Compressible Viscous-Flow Aerodynamics, Goettingen, Federal Republic of Germany p 290 A89-25856 Sept. 30-Oct. 2, 1987

- DFVLR-F5 test wing experiment for computational p 290 A89-25857 aerodynamics DFVLR-F5 test wing configuration - The boundary value
- p 290 A89-25858 problem Three-dimensional viscous flow simulations using an
- p 291 A89-25865 implicit relaxation scheme Simulation of the DFVLR-F5 wing experiment using a block structured explicit Navier-Stokes method
- p 291 A89-25866 Material defects in a PM-nickel-base superalloy
- p 341 A89-25919 LIBAS - A proposal for an airport traffic safety system p 308 A89-28293
- Ways to solve current flight-safety problems p 305 A89-28294
- GPS antennas for civil aviation p 308 A89-28296 GPS antenna problems for military aircraft
- A89-28297 D 309 An antenna for the GPS installation at DFVLR p 309 A89-28298
- A GPS receiver antenna with integrated down-mixed A89-28299 p 309
- Intake swirl and simplified methods for dynamic pressure p 299 N89-16742 distortion assessment
- On board life monitoring system Tornado (OLMOS) p 319 N89-16785
- Engine life consumption monitoring program for RB199 integrated in the on-board life monitoring system n 320 N89-16789
- The advantage of a thrust rating concept used on the N89-16800 RB199 engine p 327
- Gas path modelling, diagnosis and sensor fault p 321 N89-16811 detection
- System-theoretical method for dynamic on-condition p 321 N89-16812 monitoring of gas turbines Loss development in transonic compressor cascades
- p 328 N89-16826 Incidence angle rules in supersonic cascade
- p 328 N89-16827 Exit angle rules in supersonic cascades
- p 329 N89-16828 Shock losses in transonic and supersonic compressor p 329 N89-16829
- cascades Axial velocity density ratio influence on exit flow angle p 329 N89-16830 in transonic/supersonic cascades
- Inverse methods for blade design, controlled diffusion blading for supercritical compressor flow p 329 N89-16832
- Expriments on the DFVLR-F4 wing body configuration several European windtunnels p 337 N89-16848 in several European windtunnels
- Accuracy requirements for high-speed test with engine simulation on transport aircraft models in the NLR-HST p 338 N89-16870
- Balance accuracy and repeatability as a limiting parameter in aircraft development force measurements in conventional and cryogenic wind tunnels
- p 338 N89-16873 Accuracy problems in wind tunnels during transport p 338 N89-16877 aircraft development Damage tolerance behavior of fiber reinforced
- composite airframes p 316 N89-17278 Activities report in air traffic control p 309 N89-17586
- {ETN-89-93513} p 317 N89-17693 Typical joints in a wing structure Mechanism of single shear fastene ad joints
- p 352 N89-17700 I

- INDIA
- Vibration and flutter analysis of composite wing panels p 346 A89-26273 Free vibration and panel flutter of quadrilateral laminated p 347 A89-26274 plates Aeroelastic flutter of low aspect ratio cantilever
- p 347 A89-26281 composite plate Finite element analysis of composite rudder for DO 228 p 347 A89-26284 aircraft
- Low speed aerodynamics of canard configurations p 294 A89-26689 Structural reliability in aerospace design
- p 340 A89-27175 Numerical solution of flow fields around Delta wings
- using Euler equations method [NAL-TM-FM-8701] p 299 N89-16757

- The integration of European flight-safety systems p 308 A89-28292 ISRAEL
- An experimental evaluation of a low-Reynolds number high-lift airfoil with vanishingly small pitching moment [AIAA PAPER 89-0538] p 286 A89-25432 ITALY
- On the solution of nonequilibrium hypersonic inviscid steady flows
- [AIAA PAPER 89-0671] p 289 A89-25532 Some new ideas in radar antenna technology p 347 A89-26542
- Joining of carbon fiber composite with fasteners p 343 N89-17701

J

JAPAN

- Numerical simulation of hypersonic flow around a space plane at high angles of attack using implicit TVD Navier-Stokes code
- p 279 A89-25230 [AIAA PAPER 89-0273] Superplasticity of HIPped PM superalloys made from attrited prealloy powder p 341 A89-25915
- The current status of the flight test of the ASKA p 314 A89-28208 [SAE PAPER 881433] Preliminary test results of NDA cryogenic wind tunnel
- ind its syste [SAE PAPER 881449] p 336 A89-28219
- A numerical simulation of flows about two-dimensional bodies of parachute-like configuration p 302 N89-17580 [ISAS-629]
- Development of new redundant flight safety system using inertial sensors
- [ISAS-634] p 306 N89-17585

Κ

KOREA(SOUTH)

Some considerations on the liability of air traffic control p 357 A89-26666 agencies

Ν

NETHERLANDS

testing

- An alternative method to solve a variational inequality applied to an air traffic control example
- p 354 A89-26196 The law: The pilot and the air traffic controller - Division of responsibilities p 357 A89-26665 Euler flow solutions for transonic shock wave-boundary
- p 295 A89-28074 layer interaction Accuracy of various wall-corr ction methods for 3D subsonic wind-tunnel testing p 338 N89-16863 Requirements and capabilities in unsteady windtunnel
 - p 339 N89-16878 P

- POLAND Mach number dependence of flow separation induced normal shock-wave/turbulent boundary-laver bv interaction at a curved wall
- p 282 A89-25298 [AIAA PAPER 89-0353] Dynamics of longitudinal motion of an aeroplane after drop of loads p 333 A89-28396 PORTUGAL
- Numerical study of single impinging jets through a crossflow
- [AIAA PAPER 89-0449] p 284 A89-25367

S

SPAIN

- Materials for interiors A brief review of their current p 342 A89-28433 status SWEDEN
- Numerical simulation of viscous transonic flow over the DFVLR F5 wing p 291 A89-25863 A new technique for the production of gas atomized owder p 340 A89-25902 powder
- An analysis method for bolted joints in primary composite aircraft structure p 317 N89-17691 SWITZERLAND
- New design of the nozzle section of a large subsonic wind tunnel
- [F+W-TE-1926] p 339 N89-17601

Т

TAIWAN

U.S.S.R.

- Essentially non-oscillatory schemes for the Euler equations and its application to complex aerodynamic flows
- [AIAA PAPER 89-0562] p 287 A89-25451 Active control of aeroelastic systems governed by inctional differential equations p 332 A89-25871 functional differential equations prediction for the of airfoil flutter Technique p 348 A89-27744 characteristics in separated flow Investigation of internal singularity methods for
- p 294 A89-27748 multielement airfoils U

- Unsteady separation wave in a supersonic boundary p 293 A89-26011 laver Modal control in systems with aftereffect
 - p 354 A89-26038
- Asymptotics of stationary separated flow past a body at large Reynolds numbers p 293 A89-26163
- p 346 Electrical equipment of aircraft A89-26171 Research pressed to improve flight information
- contribution to aircraft accident investigations p 318 A89-27247
- Problems of ensuring civil-aircraft fire safety p 304 A89-27249
- Evolution of perturbations near a surface in supersonic p 294 A89-27384 flow
- Determination of the numerical integration step during the analog-digital modeling of dynamic systems p 354 A89-27405

UNITED KINGDOM Vortex/boundary layer interactions [AIAA PAPER 89-0083] p 273 A89-25073 Visualization measurements of vortex flows [AIAA PAPER 89-0191] p 276 A89-25166 Turbulent mixing in supersonic combustion systems p 323 A89-25218 [AIAA PAPER 89-0260] An adaptive implicit/explicit finite element scheme for compressible viscous high speed flow [AIAA PAPER 89-0363] p 344 A89-25307 A cell-vertex multigrid Euler scheme for use with multiblock grids [AIAA PAPER 89-0472] p 285 A89-25387 Shock capturing using a pressure-correction method p 345 A89-25450 [AIAA PAPER 89-0561] Multiple solutions for aircraft sideslip behaviour at high angles of attack p 331 A89-25510 [AIAA PAPER 89-06451 Measurements of the oscillatory lateral derivatives of a high incidence research model (HIRM 1) at speeds up to M = 0.8p 332 A89-26688 Engineering ceramics - Applications and testing p 347 A89-27632 requirements convergent, annular p 323 A89-27694 Subcritical swirling flows in nozzles An investigation of the physical and chemical factors affecting the perfomance of fuels in the JFTOT [SAE PAPER 881533] p 341 A p 341 A89-28242 The contribution of planform area to the performance of the BEBP rotor p 314 A89-28350 Estimation of drag arising from asymmetry in thrust or airframe configuration [ESDU-88006] p 297 N89-16730 Rolling moment derivative Lxi, for plain ailerons at subsonic speeds p 297 N89-16731 [ESDU-88013] Derivation of primary air-data parameters for hypersonic flight (ESDU-880251 p 298 N89-16732 Yawing moment coefficient for plain ailerons at subonic speeds [ESDU-88029] p 298 N89-16734 Boundaries of linear characteristics of cambered and twisted wings at subcritical Mach numbers p 298 N89-16735 [ESDU-88030] Lift Iongitudinal and forces on ropeller/nacelle/wing/flap systems p 298 [ESDU-88031] N89-16736 p 299 N89-16743 Jaguar/Tornado intake design Intakes for high angle of attack p 315 N89-16745 p 299 N89-16747 Intake drag The design, construction and test of a postbuckled, carbon fibre reinforced plastic wing box p 315 N89-16773 Engine usage condition and maintenance management systems in the UK armed forces p 326 N89-16783 Information management systems for on-board p 319 N89-16786 monitoring systems Recent UK trials in engine health monitoring: Feedback p 326 N89-16790 and feedforward

UNITED KINGDOM

FOREIGN TECHNOLOGY INDEX

•

Military engine condition monitoring systems: The UK
experience p 320 N89-16797
System considerations for integrated machinery health
monitoring p 327 N89-16804
Gas path condition monitoring using electrostatic
techniques p 321 N89-16817
COMPASS (Trademark): A generalized ground-based
monitoring system p 321 N89-16819
Analysis of 3D viscous flows in transonic compressors
p 329 N89-16831
The accurate measurement of drag in the 8 ft x 8 ft
tunnel p 337 N89-16855
Accurate drag estimation using a single component drag
model technique p 337 N89-16856
Development of testing techniques in a large transonic
wind tunnel to achieve a required drag accuracy and flow
standards for modern civil transports
p 337 N89-16857
Review of existing NDT technologies and their
capabilities p 349 N89-17255
Need for common AGARD approach and actions
- 250 NIGO 17060

Need for common AGARD approach and actions p 350 N89-17260 Analytical wing weight prediction/estimation using computer based design techniques p 316 N89-17589 Design synthesis for canard-delta combat aircraft, volumes 1 and 2 p 316 N89-17590 Test specimens for bearing and by-pass stress interaction in carbon fibre reinforced plastic laminates p 342 N89-17696

CONTRACT NUMBER INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 240)

June 1989

Typical Contract Number Index Listing



Listings in this index are arranged alpha-numerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under the contract are arranged in ascending order with the AIAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in the abstract section. Preceding the accession number is the page number on which the citation may be found.

AF-AFOSR-83-0071	p 285	A89-25383
AF-AFOSR-84-0099	D 281	A89-25252
AF-AFOSR-84-0120	n 348	A89-27692
AF-AFOSR-85-0295	n 281	A89.25276
AF-AFOSB-86-0132	p 201	A00-20270
AF AFOSB 96 0152	p 332	A09-20193
APP 2610 147	p 280	A89-25245
DAAG20.92 K 0094	p 328	N89-16814
DAAG29-82-K-0004	p 269	A89-25603
DAAL03-86-K-0120	p 341	A09-27733
DAAL03-87-0-0011	p 204	N09-203/7
DAAL03-87-C-0013	p 315	N09-10//3
DAAL03-87-G-0004	p 237	APO 25602
DAAL03-87-K-0010	p 332	A09-20092
DF-AC04-76DP-00789	p 206	N90 16766
	n 300	N90-17587
DE-EG03-86EB-13608	n 343	ARQ-25118
DEG-DA-183/1-5	p 343	A90-25118
DEG-BU-334/1-6	p 207	A80-25448
DOT-FA01-82-Y-10513	n 346	A89-25590
DOT-FA01-84-C-00001	p 307	A89-26733
	p 307	A89-26734
DOT-FA03-83-A-00328	p 326	A89-28462
DOT-FA03-86-C-00016	p 333	A89-27737
FE220786FRMC4	p 328	N89-16814
F04704-86-C-0031	p 293	A89-26368
F04704-87-C-0100	p 289	A89-25517
F08635-84-C-02281	p 353	A89-25305
F08635-85-C-0122	p 342	N89-17681
F33615-86-C-1073	p 349	N89-17215
F33615-86-C-2604	p 340	A89-25190
	p 340	A89-25193
F33615-86-C-3015	p 284	A89-25377
F33615-86-C-3602	p 285	A89-25420
F33615-87-C-3211	p 284	A89-25365
F33615-87-C-3223	p 316	N89-17591
F33615-87-C-3607	p 312	A89-27735
F49620-84-C-0065	p 270	A89-24925
	p 289	A89-25602
F49620-85-C-0013	p 355	A89-27611
F49620-85-C-0090	p 312	A89-27747
F49620-85-C-0111	p 294	A89-27706
F49620-86-C-0008	p 269	N89-16719
	p 270	N89-16720
	p 270	N89-16721
	p 270	N89-16722
F49620-86-C-0094	p 282	A89-25301
F49620-86-K-0003	p 315	N89-16774
F49620-87-C-0046	p 312	A89-27747
F49620-88-C-0098	p 280	A89-25248
F49720-85-C-0063	p 271	A89-25016

NAGW-1022	. p 287	A89-25446
NAGW-1072	. p 273	A89-25037
NAGW-1195	. p 354	A89-27602
NACIM 1221	p 355	A89-27622
NAGW-478	. p 28/	A89-25446
10.000-470	n 289	A89-25507
NAGW-581	. p 273	A89-25073
	p 343	A89-25118
NAGW-674	. p 278	A89-25219
NAGW-965	. p 284	A89-25377
NAG1-513	. p 318	A89-27624
NAG1-516	. p 306	A89-28464
NAG1-602	. p 356	N89-18046
NAG1-625	. p 300	A89-25509
NAG1-648	. p 273	A89-25071
NAG1-664	. p 285	A89-25379
NAG1-690	. p 335	A89-25591
NAG1-716	p 300	N89-16758
NAG1-727	p 276	A89-25169
NAG1-776	p 354	A89-25385
NAG1-793	p 286	A89-25426
NAG1-866	n 310	A89-25106
NAG1-873	p 331	A89-25014
NAG2-379	p 356	N89-18167
NAG3-481	p 326	A89-28462
NAG3-512	p 342	N89-17325
NAG3-61	p 296	A89-28407
NAG3-665	p 346	A89-25554
NAG3-000	p 304	A89-27739
NAG3-730	p 305	A09-20451 A89-27744
NAG3-767	p 344	A89-25181
NAG3-768	p 288	A89-25485
NAG3-869	p 344	A89-25181
NASA ORDER A-63622-C	p 301	N89-17578
NASA TASK 21	p 272	A89-25031
NAS1-17325	p 2/2	A89-25031
NAS1-17919	p 355	A89-27609 A89-25106
	p 275	A89-25115
	p 281	A89-25284
	p 281	A89-25285
	p 295	A89-28229
NAS1-18000	p 287	A89-25452
NAS1-18235	p 289	A89-25521
NA51-16255	p 2/6	A89-25224
NAS1-18419	p 282	A89-25306
NAS1-18560	p 345	A89-25376
NAS1-18584	p 286	A89-25443
NAS1-18585	p 278	A89-25223
NAS1-18599	p 278	A89-25224
NAS1-18670	p 296	A89-28428
NAS2-12568	p 202	A89-25506
NAS2-12767	p 301	N89-17577
NAS3-23288	p 352	N89-17336
NAS3-23691	p 351	N89-17314
NAS3-23697	p 351	N89-17316
NAS3-23/17	p 351	N89-17311
NAS3-23939	p 342	N89-17334
NAS3-24105	p 325	A89-28403
NAS3-24350	p 348	A89-27693
	p 351	N89-17304
NAS3-24843	p 322	A89-25006
NAS3-24880	p 330	N89-17599
NAS3-25200	p 311	A89-25571
NAS8-37359	µ 325	A09-20403
NAS9-17195	p 343	A89-25065
NCA2-107	p 285	A89-25383
NCA2-162	p 273	A89-25074
	p 276	A89-25167
NCA2-235	p 273	A89-25072
NUA2-243	p 284	A89-25377
NGA2-287	p 281	A89-25252
NGA2-36	p 285	A89-25383
NGC1-22	p 287	A89-25446
NCC2-341	p 282	A89-25288

NCC2-498	p 277	A89-25174
NGL-16-001-043	p 356	A89-26630
NGL-22-009-640	p 335	A89-25591
	p 333	A89-27737
	p 304	A89-27739
	p 305	A89-28451
NGT-43-001-807	p 318	A89-27624
NSC-77-0210-D002-03	p 287	A89-25451
NSC-77-0210-D002-04	p 287	A89-25451
NSERC-A-2181	p 281	A89-25253
NSERC-A-5484	p 345	A89-25526
NSF ATM-82-05468	p 304	A89-26231
NSF ATM-82-18621	p 304	A89-26231
NSF ATM-86-00526	p 304	A89-26231
NSF ATM-87-57013	p 353	A89-25599
NSF OIR-85-00108	p 354	A89-26187
NSG-1607	p 313	A89-28177
NSG-3134	p 311	A89-25429
NSG-3208	p 295	A89-28341
N00014-83-K-0239	p 286	A89-25430
	p 288	A89-25458
N00014-84-K-0232	p 280	A89-25244
N00014-84-K-0372	p 323	A89-25493
	p 323	A89-25494
N00014-84-K-0470	p 322	A89-25092
N00014-85-K-0053	p 289	A89-25602
N00014-85-K-0646	p 275	A89-25111
N00014-87-K-0132	p 283	A89-25319
N00014-87-K-0174	p 283	A89-25315
N00140-85-C-E184	p 341	A89-28243
SERC-GR/E/64046	p 344	A89-25307
505-60-01	p 330	N89-17600
505-61-01-02	p 301	N89-17568
505-61-50	p 301	N89-17578
505-61-51	p 301	N89-17577
505-61-71	p 316	N89-17593
505-62-21	p 342	N89-17017
505-66-41	p 321	N89-16820
533-04-11	p 351	N89-17298

.

REPORT NUMBER INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 240)

June 1989

Typical Report Number Index Listing



Listings in this index are arranged alpha-numerically by report number. The page number indicates the page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche

A-87128	p 302	N89-17579	• #
A-88250	p 333	N89-16845	• #
A-88293	р 330	N89-17600	• #
A-88307	n 316	N89-17593	* #
A-89058	n 306	N89-17594	• 4
	p 000	1103-17 304	77
AD-A199612	n 340	N80-17215	
AD-A199768	n 328	N89-16821	11 4
AD-A200128	0 297	N89-16726	π #
AD-A200145	n 315	N89-16774	#
AD-A200180	p 349	N89-17069	#
AD-A200245	p 316	N89-17591	#
AD-A200255	p 315	N89-16775	#
AD-A200262	p 269	N89-16719	#
AD-A200263	p 270	N89-16720	#
AD-A200264	p 270	N89-16721	#
AD-A200265	p 270	N89-16722	#
AD-A200436	p 297	N89-16728	#
AD-A200626	p 309	N89-17588	#
AD-A200665	p 270	N89-17564	#
AD-A200801	p 342	N89-17681	#
AD-A200907	p 317	N89-17594	#
AD-A201050	p 302	N89-17582	#
AD-A201124	p 317	N89-17595	#
AFESC/ESL-TR-88-17	p 342	N89-17681	#
AFOSR-88-1018TR	p 315	N89-16774	#
AFWAL-1H-88-1042	p 349	N89-17215	#
AFWAL-1H-88-3080	p 316	N89-17591	#
AFWL-TR-88-41	p 349	N89-17069	#
AGARD-AG-303	p 300	N89-16760	#
Al-120	p 330	N89-17599 *	#
AIAA PAPER 88-0460	p 295	A89-28251 *	#
AIAA PAPER 88-2512	p 314	A89-28252	#
AIAA PAPER 89-0003	p 270	A89-25002	#
AIAA PAPER 89-0005	p 271	A89-25003	#
AIAA PAPER 89-0007	p 325	A89-28403 *	#
AIAA PAPER 89-0008	p 322	A89-25004	#
AIAA PAPER 89-0009	p 322	A89-25005 *	#
AIAA PAPER 89-0010	p 322	A89-25006 *	#
AIAA PAPER 89-0012	p 331	A89-25008	#
AIAA PAPER 89-0013	p 310	A89-25009	#
AIAA PAPER 89-0015	p 331	A89-25011	#
AIAA PAPER 89-0016	p 331	A89-25012	#
AIAA PAPER 89-0017	p 331	A89-25013	#
AIAA PAPER 89-0018	p 331	A89-25014 *	#
AIAA PAPER 89-0020	p 271	A89-25016 *	#
AIAA PAPER 89-0021	p 271	A89-25017	#
AIAA PAPER 89-0022	0 271	A89-25018	#

AIAA PAPER 89.002	a	n 27	1 490 25010 * #	
AIAA PAPER 89-002	4	n 271	A89-25019 #	
AIAA PAPER 89-002	5	n 272	AR9-25020 #	
AIAA PAPER 89-002	6	n 273	A89.25021 #	
AIAA PAPER 89-002	7	0 272	A89-25022 #	
AIAA PAPER 89-002	3	. p 272	A89-25024 #	
AIAA PAPER 89-002		. p 272	A89-25025 * #	
AIAA PAPER 89-003		р 272	A89-25026 * #	
AIAA PAPER 89-003	2	. p 272	A89-25028 #	
AIAA PAPER 89-003	3	. p 272	A89-25031 * #	
AIAA PAPER 89-004		. p 334	A89-25035 #	
AIAA PAPER 89-0042		. p 334	A89-25036 #	
AIAA PAPER 89-0043		. p 273	A89-25037 * #	
AIAA PAPER 89-0045		. р 273	A89-25039 * #	
AIAA PAPER 89-0046	·	р 273 р	A89-25040 #	
AIAA PAPER 89-004/		p 310	A89-25041 #	
AIAA PAPER 89-0040		p 334	A89-25042 #	
	• •••••••••••••••	p 343	A89-25065 * #	
		p 273	A89-25071 - #	
AIAA PAPER 89-0083	••••••	p 273	A09-20072 #	
AIAA PAPER 89-0084		p 273	A89-25073 #	
AIAA PAPER 89-0085		n 274	A89-25075 * #	
AIAA PAPER 89-0086		n 274	A89-25076 #	
AIAA PAPER 89-0092		D 310	A89-25081 #	
AIAA PAPER 89-0093		p 343	A89-25082 #	
AIAA PAPER 89-0096		p 274	A89-25085 #	
AIAA PAPER 89-0103		p 274	A89-25090 #	
AIAA PAPER 89-0105		p 322	A89-25092 #	
AIAA PAPER 89-0112		p 274	A89-25099 * #	
AIAA PAPER 89-0113		p 274	A89-25100 #	
AIAA PAPER 89-0114		p 343	A89-25101 #	
AIAA PAPER 89-0115		p 275	A89-25102 * #	
AIAA PAPER 89-0116	•••••	p 275	A89-25103 #	
AIAA PAPER 89-0117	•••••	p 275	A89-25104 #	
AIAA PAPER 09-0121		p 310	A89-25106 * #	j
AIAA PAPER 09-0123	••••••	p 275	A89-25108 #	
AIAA PAPER 89-0126	••••••	p 275	A09-25110 #	
AIAA PAPER 89-0120	•••••	p 275	A09-25111 #	
AIAA PAPER 89-0134		D 343	A89-25118 * #	1
AIAA PAPER 89-0135		p 344	A89-25119 #	1
AIAA PAPER 89-0140	•••••	p 276	A89-25123 #	1
AIAA PAPER 89-0148		p 334	A89-25131 * #	
AIAA PAPER 89-0149		p 334	A89-25132 #	- 1
AIAA PAPER 89-0150	••••••	p 276	A89-25133 * #	2
AIAA PAPER 89-0152		p 334	A89-25135 #	
AIAA PAPER 89.0183	•••••	p 344	A89-25150 #	Ā
AIAA PAPER 89-0184	••••••	n 335	A89.25150 #	A
AIAA PAPER 89-0191		p 276	A89-25166 #	A
AIAA PAPER 89-0192		р 276	A89-25167 * #	A
AIAA PAPER 89-0193		p 276	A89-25168 #	
AIAA PAPER 89-0194		p 276	A89-25169 * #	P
AIAA PAPER 89-0195	•••••	p 276	A89-25170 * #	2
AIAA PAPER 09-0197	•••••	p 2//	A89-25172 #	Å
	•••••	p 277	A69-251/4 * #	Å
AIAA PAPER 89-0204		p 277	A90.25170 #	A
AIAA PAPER 89-0206		n 344	A89-25181 * #	A
AIAA PAPER 89-0207		p 277	A89-25182 #	A
AIAA PAPER 89-0208		D 344	A89-25183 #	A
AIAA PAPER 89-0209		p 295	A89-28404 * #	A
AIAA PAPER 89-0210		р 277	A89-25184 #	A
AIAA PAPER 89-0212		p 277	A89-25186 #	A
AIAA PAPER 89-0214		p 278	A89-25188 #	
AIAA PAPER 89-0216		p 340	A89-25190 #	~
AIAA PAPEH 89-0217	•••••	p 344	A89-25191 #	2
AIAA PAPER 89-0219	••••••	p 340	A89-25193 #	Â
AIAA FAPER 89-0233		p 269	A89-25199 * #	Â
		µ ∠/8	M09-2520/ # #	A
AIAA PAPER 80.0240	••••••	n 323 h 339	ARG.25210 #	A
AIAA PAPER 89-0261		n 278	A89.25210 #	A
AIAA PAPER 89-0263		0 310	A89-25221 * #	A
AIAA PAPER 89-0264		278	A89-25222 #	A
AIAA PAPER 89-0265		0 278	A89-25223 #	Α
AIAA PAPER 89-0266		p 278	A89-25224 * #	A
AIAA PAPER 89-0267		0 278	A89-25225 #	Ą
AIAA PAPER 89-0268		o 279	A89-25226 #	A
AIAA PAPER 89-0269		o 279	A89-25227 #	A
AIAA PAPER 89-0270	I	o 279	A89-25228 * #	A
AIAA PAPER 89-0273		o 279	A89-25230 #	A

AIAA PAPER 89-027	4	р 279	A89-25231 #
AIAA PAPER 89-027	5	p 279	A89-25232 * #
AIAA PAPER 89-027	9	p 310	A89-25236 * #
AIAA PAPER 89-0280		p 279	A89-25237 #
AIAA PAPER 89-028	1	n 280	A89-25238 #
AIAA PAPER 89-028	5	p 280	A89-25242 * #
AIAA PAPER 89-0287	7	p 280	A89-25244 #
AIAA PAPER 89-0288	3	p 280	A89-25245 #
AIAA PAPER 89-0289	•	p 280	A89-25246 * #
AIAA PAPER 89-0291	I	p 280	A89-25248 #
AIAA PAPER 89-0295	5	p 281	A89-25252 * #
AIAA PAPER 89-0296		p 281	A89-25253 #
AIAA PAPER 89-0314		p 293	A89-26368 #
AIAA PAPER 89-0321		p 293	A89-26369 * #
AIAA DADED 90 0000	· · · · · · · · · · · · · · · · · · ·	. p 295	A89-28406 * #
AIAA PAPER 89-0325		µ 201	ABD 25273 #
AIAA PAPER 89-0327		p 201	A89-25274 #
AIAA PAPER 89-0328		. p 281	A89-25276 #
AIAA PAPER 89-0337		. p 281	A89-25284 * #
AIAA PAPER 89-0338		. p 281	A89-25285 * #
AIAA PAPER 89-0339		. p 282	A89-25286 * #
AIAA PAPER 89-0341		. p 282	A89-25288 * #
AIAA PAPER 89-0343		. p 293	A89-26371 * #
AIAA PAPER 89-0353		. p 282	A89-25298 #
AIAA PAPER 89-0354	••••••	. p 282	A89-25299 #
AIAA PAPER 89-0355	••••••	. p 282	A89-25300 #
AIAA FAFER 09-0300	••••••	. p 282	A89-25301 #
AIAA PAPER 80-0361		. p 290	A89-28407 * #
AIAA PAPER 89-0362		n 282	A09-20300 #
AIAA PAPER 89-0363		n 344	A89.25300 #
AIAA PAPER 89-0364		. p 283	A89-25308 * #
AIAA PAPER 89-0365		. p 283	A89-25309 #
AIAA PAPER 89-0366		. p 354	A89-25310 * #
AIAA PAPER 89-0371	·····	p 283	A89-25314 #
AIAA PAPER 89-0372	••••••	. p 283	A89-25315 #
AIAA PAPER 89-0374		. p 283	A89-25317 * #
AIAA PAPER 89-0376	•••••	p 283	A89-25319 #
AIAA PAPER 89-0378		p 311	A89-25320 #
AIAA PAPER 89-0385	•••••	p 283	A89-25326 #
ALAA PAPER 80.0402	••••••	p 284	A89-25328 #
AIAA PAPER 89-0402		p 202	A69-25337 * #
AIAA PAPER 89-0436		n 293	A89-26373 #
AIAA PAPER 89-0437		p 296	A89-28413 * #
AIAA PAPER 89-0445		p 284	A89-25363 #
AIAA PAPER 89-0446		p 284	A89-25364 * #
AIAA PAPER 89-0447		p 284	A89-25365 #
AIAA PAPER 89-0448		p 284	A89-25366 * #
AIAA PAPER 89-0449		p 284	A89-25367 #
AIAA PAPER 89-0460		p 345	A89-25376 * #
AIAA PAPER 89-0401		p 284	A89-25377 * #
AIAA PAPER 89-0468		p 285	A89-25379 * #
AIAA PAPER 89-0470		p 354	A89-25385 * #
AIAA PAPER 89-0472		p 285	A89-25387 #
AIAA PAPER 89-0477		p 285	A89-25390 #
AIAA PAPER 89-0493		p 340	A89-25403 #
AIAA PAPER 89-0522		p 285	A89-25418 * #
AIAA PAPER 89-0525		p 285	A89-25420 #
AIAA PAPER 89-0526	•••••	p 285	A89-25421 #
AIAA PAPER 89-0530	••••••	p 286	A89-25424 #
AIAA PAPER 80.0522		p 286	A89-25426 * #
AIAA PAPER 89.0534	••••••	p 200	A09-2542/ #
AIAA PAPER 89-0535		p 209	A89-25428 #
AIAA PAPER 89-0536		p 286	A89-25430 #
AIAA PAPER 89-0537		p 286	A89-25431 * #
AIAA PAPER 89-0538		p 286	A89-25432 #
AIAA PAPER 89-0539		p 296	A89-28428 * #
AIAA PAPER 89-0548		p 345	A89-25440 * #
AIAA PAPER 89-0549		p 286	A89-25441 #
AIAA PAPER 89-0553	••••••	p 286	A89-25443 * #
ALAA PAPER 89-0554	•••••	p 287	A89-25444 #
AIAA PAPER 80.0557	••••••	p 345	A09-25445 #
AIAA PAPER 89.0559	•••••••	p 20/	A90-25445 #
AIAA PAPER 89-0559	••••••	р 20/ р 287	A89-25441 #
AIAA PAPER 89-0560		p 311	A89-25449 #
AIAA PAPER 89-0561	••••••••••••••••••	p 345	A89-25450 #
AIAA PAPER 89-0562		p 287	A89-25451 #
AIAA PAPER 89-0563		p 287	A89-25452 * #

REPORT

AIAA PAPER 89-0564

AIAA PAPER 89-0564		p 287	A89-25453 #
AIAA PAPER 89-0565		p 288	A89-25454 * #
ALAA DADER 89-0569		n 288	A89-25458 #
		- 20C	A90 08424 #
AIAA PAPEH 89-05/0	•••••	p 296	A09-20434 #
AIAA PAPER 89-0601	······	p 345	A89-25478 #
AIAA PAPER 89-0609		p 288	A89-25485 * #
AIAA PAPER 89-0620		n 323	A89-25491 #
AIAA FAFEN 03-0020		- 000	ABO 25402 #
AIAA PAPEH 89-0622		p 200	M09-20492 #
AIAA PAPER 89-0623		p 323	A89-25493 #
AIAA PAPER 89-0624		p 323	A89-25494 #
ALAA DADER 89-0637		D 296	A89-28442 #
		206	A90-28443 * #
AIAA PAPEH 09-0030	•••••	p 230	A03-20440 #
AIAA PAPER 89-0639	······	p 288	A89-25505 #
AIAA PAPER 89-0640		p 311	A89-25506 #
AIAA PAPER 89-0641		o 288	A89-25507 #
ALAA DADED 80.0642		n 296	489.28444 #
AIAA PAPER 00-0042		- 011	A90 25500 * #
AIAA PAPEH 89-0644	••••••	parr	A09-25509 #
AIAA PAPER 89-0645		p 331	A89-25510 #
AIAA PAPER 89-0647		p 335	A89-25511 * #
AIAA PAPER 89-0648		D 335	A89-25512 * #
AIAA DADER 89.0649		n 357	A89-25513 #
		- 200	APO 25514 * #
AIAA PAPER 89-0650	••••••	p 200	A09-25514 #
AIAA PAPER 89-0654		p 289	A89-2551/ * #
AIAA PAPER 89-0658		p 289	A89-25521 * #
AIAA PAPER 89-0664		p 345	A89-25526 #
ALAA DADED 80-0669		n 289	A89-25530 #
	•••••••	200	AR0 25522 #
AIAA PAPER 89-06/1		h 509	A09-2002 #
AIAA PAPER 89-0672		p 323	A09-20033 #
AIAA PAPER 89-0674		p 289	A89-25534 #
AIAA PAPER 89-0704		p 302	A89-25545 #
ALAA DADED 89.0706		n 305	A89-28448 #
AIAA PAPER 89-0700		- 202	A00 25547 #
AIAA PAPER 89-0/0/	••••••	p 302	A09-25547 #
AIAA PAPER 89-0710		p 352	A89-25549 * #
AIAA PAPER 89-0735		p 302	A89-25553 * #
AIAA PAPER 89-0737		n 346	A89-25554 * #
	•••••	- 202	A80.25555 #
AIAA PAPEH 89-0736	•••••	p 302	A00 05556 #
AIAA PAPER 89-0739		p 303	A89-2000 #
AIAA PAPER 89-0741		p 303	A89-25557 #
AIAA PAPER 89-0743		p 303	A89-25558 #
ALAA DADED 90.0750		0.303	A89-25560 * #
AIAA PAPER 05-0750		- 202	AP0 25561 * #
AIAA PAPEH 89-0753	••••••	p 303	A09-20001 #
AIAA PAPER 89-0756		p 352	A89-25562 #
AIAA PAPER 89-0757		p 303	A89-25563 #
AIAA PAPER 89-0758		p 303	A89-25564 #
AIAA PAPER 89-0759		D 311	A89-25565 * #
		p 202	AR0.25566 #
AIAA PAPER 89-0760	••••	p 303	A00 05567 #
AIAA PAPER 89-0763	••••	p 304	A89-25507 #
AIAA PAPER 89-0764		p 339	A89-25568 #
AIAA PAPER 89-0769		p 346	A89-25570 * #
AIAA PAPER 89-0772		n 311	A89-25571 * #
AIAA PAPED 80 0774	•••••	- 211	A90.25572 #
AIAA PAPER 89-0774	•••••	- 050	A00 05570 #
AIAA PAPER 89-0787		p 352	A89-255/8 #
AIAA PAPER 89-0794		p 352	A89-25583 #
AIAA PAPER 89-0795		p 304	A89-25584 #
ALAA DADER 80.0797		n 304	A89-25585 #
		0 246	A90.25500 #
AIAA PAPER 09-0007		- 005	A00 05501 * #
AIAA PAPER 89-0808		p 335	A09-20091 #
AIAA PAPER 89-0809		p 304	A89-25592 #
AIAA PAPER 89-0810		p 352	A89-25593 #
AIAA PAPER 89-0811		D 353	A89-25594 #
ALAA DADED 80.0821		0.353	A89-25599 #
AIAA PAPER 00-0021		- 000	APO 25602 #
AIAA PAPER 89-0832		p 209	A05-25002 #
AIAA PAPER 89-0833	•••••	p 289	A89-25603 #
AIAA PAPER 89-0836		p 312	A89-25605 #
AIAA PAPER 89-0837		p 290	A89-25606 #
AIAA PAPER 89-0839		n 346	A89-25608 #
AIAA DADED 00 0040		D 346	A89-25609 #
AIAA PAPER 09-0040		- 000	A00 05611 #
AIAA PAPEH 89-0842	•••••	h 590	-00-20011 #
AIAA PAPER 89-0846		p 290	A89-25615 #
AIAA 89-0734		p 305	A89-28451 * #
AIAA 80-0752		D 297	A89-28453 * #
ALAA 00 0764		n 200	A80.28464 * #
AIAA 89-0754	•••••	p 333	A00 00 155 5 "
AIAA 89-0755		p 336	A89-28455 #
AIAA 89-0761		p 314	A89-28456 #
AIAA 89-0762		p 337	A89-28457 * #
AIAA 89.0773		n 337	A89-28458 #
ALAA DO 0709		- 252	480-28461 #
MIAA 03-0/96		P 000	
AIAA 89-0799	••••••	p 326	M03-20402 #
AIAA 89-0806		p 269	A89-28463 * #
AIAA 89-0812		p 306	A89-28464 * #
AMI-9901		n 315	N89-16775 #
AMI-0001		p 313	
			NO0 47524 "
AMSMI/LC-TA-88-01		p 270	N89-17564 #
ARO-25090.1-EG-SBI		p 315	N89-16775 #
ABO-25093 1-EG-SBI		p 297	N89-16726 #
		r	
	314	n 399	A89-24989 * #
ADME FAREN 00-01-			
	•••		
CONF-8810219-1		р 306	N89-16766 #
CONF-8810219-1		р 306	N89-16766 #
CONF-8810219-1		р 306 р 356	N89-16766 # N89-18046 * #

DE89-002020 DE89-004000	р 306 р 309	N89-16766 # N89-17587 #
DOT/FAA/DS-89/06	p 321	N89-16820 * #
E-3745 E-4593	p 351 p 342	N89-17298 * # N89-17017 * #
ESDU-88006 ESDU-88013 ESDU-88025 ESDU-88029 ESDU-88030 ESDU-88031	p 297 p 297 p 298 p 298 p 298 p 298 p 298	N89-16730 N89-16731 N89-16732 N89-16734 N89-16735 N89-16736
ETN-89-93513 ETN-89-93539 ETN-89-93590 ETN-89-93591 ETN-89-93592 ETN-89-93593 ETN-89-93610	p 309 p 339 p 328 p 329 p 298 p 299 p 299 p 299	N89-17586 N89-17601 # N89-16825 # N89-16833 # N89-16738 # N89-16748 # N89-16756 #
F+W-TF-1926	p 339	N89-17601 #
FTD-ID(RS)T-0857-88	p 317	N89-17594 #
ISAS-629 ISAS-634	р 302 р 306	N89-17580 # N89-17585 #
ISBN-0-85679-638-7 ISBN-0-85679-645-X ISBN-0-85679-657-3 ISBN-0-85679-661-1 ISBN-0-85679-662-X ISBN-0-85679-663-8	p 297 p 297 p 298 p 298 p 298 p 298 p 298	N89-16730 N89-16731 N89-16732 N89-16734 N89-16735 N89-16736
ISSN-0141-397X ISSN-0141-397X ISSN-0141-397X ISSN-0141-397X ISSN-0141-4054 ISSN-0141-4054 ISSN-0285-6808 ISSN-0285-6808 ISSN-0285-6808 ISSN-0377-8312 ISSN-0377-8312 ISSN-0377-8312	p 297 p 298 p 298 p 298 p 297 p 298 p 302 p 306 p 298 p 299 p 328 p 329	N89-16731 N89-16735 N89-16735 N89-16730 N89-16730 N89-16730 N89-16730 N89-16738 N89-16738 N89-16738 N89-16738 N89-16738 N89-16738 N89-16738 N89-16625 N89-16825
	F	
L-16385	p 301 p 321	N89-17568 * # N89-16820 * #
L-16385 L-16498 ME-5375-88	p 301 p 321 p 315	N89-17568 * # N89-16820 * # N89-16774 #
L-16385 L-16498 ME-5375-88 NA-88-1347L	p 301 p 321 p 315 p 316	N89-17568 * # N89-16820 * # N89-16774 # N89-17591 #
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701	p 301 p 321 p 315 p 316 p 299	N89-17568 * # N89-16820 * # N89-16774 # N89-17591 # N89-16757 #
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701 NAS 1.15:101033 NAS 1.15:101078 NAS 1.15:101078 NAS 1.26:171475 NAS 1.26:177507 NAS 1.26:177507 NAS 1.26:182233 NAS 1.26:183178 NAS 1.26:184624 NAS 1.26:184624 NAS 1.26:184783	p 301 p 321 p 315 p 316 p 299 p 330 p 316 p 306 p 306 p 306 p 301 p 301 p 301 p 356	N89-17568 * # N89-16820 * # N89-16774 # N89-17591 # N89-17593 * # N89-17503 * # N89-17503 * # N89-17584 * # N89-17577 * # N89-17577 * # N89-17577 * # N89-17578 * # N89-16758 * # N89-18167 * # N89-18046 * #
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701 NAS 1.15:101033 NAS 1.15:101050 NAS 1.15:101078 NAS 1.26:171475 NAS 1.26:177455 NAS 1.26:177455 NAS 1.26:182233 NAS 1.26:184284 NAS 1.26:184783 NAS 1.26:184783 NAS 1.26:184788 NAS 1.55:2493 	p 301 p 321 p 315 p 316 p 299 p 316 p 306 p 316 p 306 p 306 p 301 p 301 p 300 p 356 p 300 p 356 p 300 p 356 p 300 p 351	N89-17568 * # N89-16820 * # N89-16774 # N89-17591 # N89-17593 # N89-17593 * # N89-17593 * # N89-1758 * # N89-17578 * # N89-16758 * # N89-16676 * # N89-1672 * # N89-16758 * # </td
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701 NAS 1.15:101033 NAS 1.15:101078 NAS 1.15:101078 NAS 1.15:101475 NAS 1.26:177455 NAS 1.26:177455 NAS 1.26:18233 NAS 1.26:184624 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:2886 NAS 1.60:2886 NAS 1.60:2880 NAS 1.60:2890 NAS 1.60:2890 NAS 1.60:2890	p 301 p 321 p 315 p 316 p 299 p 316 p 300 p 316 p 306 p 306 p 301 p 301 p 300 p 356 p 300 p 356 p 300 p 356 p 300 p 351	N89-17568 * # N89-16820 * # N89-16774 # N89-17591 # N89-17597 # N89-17593 * # N89-17593 * # N89-17578 * # N89-17577 * # N89-17578 * # N89-17577 * # N89-17577 * # N89-17578 * # N89-17579 * # N89-18167 * # N89-18167 * # N89-16761 * # N89-16763 * # N89-16763 * # N89-16763 * # N89-16763 * # N89-16820 * # N89-16820 * # N89-16820 * # N89-17568 * #
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701 NAS 1.15:101033 NAS 1.15:101050 NAS 1.15:101078 NAS 1.15:101475 NAS 1.26:177455 NAS 1.26:177455 NAS 1.26:1877507 NAS 1.26:18778 NAS 1.26:184783 NAS 1.26:184783 NAS 1.26:184783 NAS 1.26:184783 NAS 1.26:184788 NAS 1.26:184788 NAS 1.55:2493 NAS 1.60:2886 NAS 1.60:2898 NAS 1.60:2898 NAS 1.61:1179	<pre>p 301 p 321 p 315 p 316 p 299 p 330 p 316 p 300 p 356 p 300 p 356 p 300 p 356 p 300 p 351 p 300 p 351 p 301 p 333 p 302</pre>	N89-17568 * N89-16820 * N89-16750 # N89-17591 # N89-17593 # N89-17593 * N89-17593 * N89-17593 * N89-17577 * N89-17578 * N89-17578 * N89-17578 * N89-17578 * N89-17578 * N89-16758 * N89-16758 * N89-16751 * N89-16758 * N89-16751 * N89-16751 * N89-16761 * N89-17568 * N89-17568 * N89-16845 * N89-16845 *
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701 NAS 1.15:101033 NAS 1.15:101078 NAS 1.15:101078 NAS 1.26:177507 NAS 1.26:177507 NAS 1.26:182233 NAS 1.26:184244 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:2896 NAS 1.60:2898 NAS 1.60:2898 NAS 1.61:1179 NASA-CP-2493	p 301 p 315 p 316 p 316 p 300 p 316 p 300 p 316 p 300 p 316 p 300 p 316 p 300 p 300 p 350 p 300 p 351	N89-17568 * # N89-16820 * # N89-16724 # N89-17591 # N89-17597 # N89-17593 # N89-17593 * # N89-17593 * # N89-17598 * # N89-17578 * # N89-17599 * # N89-16765 * # N89-16768 * # N89-16768 * # N89-16845 * # N89-17579 * # N89-16845 * # N89-17579 * # N89-1758 * # N89-16751 * # N89-16751 * # N89-16758 * # N89-16759 * # N89-16845 * # N89-17598 * # N89-17579 * # N89-17579 * # N89-17298 * #
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701 NAS 1.15:101033 NAS 1.15:101078 NAS 1.15:101078 NAS 1.15:101078 NAS 1.26:177455 NAS 1.26:177455 NAS 1.26:182233 NAS 1.26:184624 NAS 1.26:184783 NAS 1.26:184788 NAS 1.60:2896 NAS 1.60:2898 NAS 1.61:1179 NASA-CP-177507 NASA-CR-177507 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788	p 301 p 315 p 316 p 316 p 301 p 316 p 300 p 316 p 301 p 301 p 301 p 301 p 300 p 356 p 300 p 351 p 301 p 301 p 301 p 301 p 301 p 301 p 302 p 301 p 305 p 300 p 356 p 300 p 356 p 300	N89-17568 # N89-16820 # N89-16757 # N89-17591 # N89-16757 # N89-17593 # N89-17573 # N89-17573 # N89-17573 # N89-17584 # N89-17576 # N89-17577 # N89-17577 # N89-17577 # N89-17577 # N89-17579 # N89-18167 # N89-16761 # N89-16768 # N89-17579 # N89-17578 # N89-17599 # N89-16758 # N89-16758 # N89-1676
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701 NAS 1.15:101033 NAS 1.15:101050 NAS 1.15:101078 NAS 1.26:177455 NAS 1.26:177507 NAS 1.26:182233 NAS 1.26:184763 NAS 1.26:184763 NAS 1.26:184768 NAS 1.26:184788 NAS 1.60:2890 NAS 1.60:2898 NAS 1.60:2898 NAS 1.60:2898 NAS 1.61:1179 NASA-CR-177455 NASA-CR-183178 NASA-CR-183178 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184788	p 301 p 315 p 316 p 299 p 330 p 316 p 302 p 301 p 301 p 301 p 301 p 301 p 301 p 302 p 356 p 300 p 356 p 301 p 301 p 350 p 301 p 301 p 350 p 301 p 301 p 302 p 351 p 301 p 301 p 301 p 301 p 302 p 350 p 300 p 356 p 300 p 356 p 300 p 351 p 301 p 301 p 301 p 301 p 301 p 301 p 301 p 301 p 300 p 356 p 300 p 356 p 300 p 357 p 300 p 357 p 301 p 301 p 301 p 300 p 356 p 300 p 356 p 300 p 356 p 300 p 357 p 301 p 301 p 301 p 300 p 356 p 300 p 356 p 300 p 357 p 300 p 357 p 300 p 357 p 301 p 301 p 300 p 356 p 300 p 357 p 300 p 357 p 301 p 301 p 301 p 300 p 356 p 300 p 356 p 300 p 357 p 301 p 301 p 301 p 301 p 300 p 356 p 300 p 356 p 300 p 357 p 301 p 300 p 356 p 300 p 357 p 301 p 300 p 356 p 300 p 356 p 300 p 357 p 300 p 356 p 300 p 356 p 300 p 357 p 300 p 356 p 300 p 357 p 300 p 357 p 300 p 356 p 300 p 300 p 356 p 300 p 300 p 356 p 300 p 300 p 300 p 300 p 356 p 300 p 300 p 300 p 356 p 300 p 300	N89-17568 * N89-16820 * N89-16757 # N89-17591 # N89-16757 # N89-17593 * N89-17583 * N89-17584 * N89-17578 * N89-17578 * N89-16761 * N89-16761 * N89-17568 * N89-17568 * N89-17568 * N89-17568 * N89-17579 * N89-17579 * N89-17578 * N89-17578 * N89-17578 * N89-17578 * N89-16761 * N89-16761 * N89-1676
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701 NAS 1.15:101033 NAS 1.15:101078 NAS 1.15:101078 NAS 1.26:177507 NAS 1.26:177507 NAS 1.26:182233 NAS 1.26:184624 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.60:2890 NAS 1.60:2896 NAS 1.60:2898 NAS 1.61:1179 NASA-CR-177507 NASA-CR-177507 NASA-CR-18233 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184783 NASA-CR-184788	p 301 p 315 p 316 p 316 p 300 p 316 p 300 p 342 p 301 p 301 p 302 p 356 p 300 p 356 p 300 p 351 p 301 p 301 p 301 p 301 p 301 p 301 p 301 p 302 p 350 p 300 p 356 p 300 p 351 p 300 p 356 p 300 p 301 p 301 p 301 p 301 p 301 p 301 p 301 p 300 p 356 p 300 p 356 p 300 p 350 p 300 p 356 p 300 p 356 p 300 p 301 p 300 p 356 p 300 p 300 p 356 p 300 p 300	N89-17568 # N89-16820 # N89-16724 # N89-16757 # N89-17591 # N89-17593 # N89-17593 # N89-17593 # N89-17577 # N89-17584 # N89-17578 # N89-17578 # N89-17578 # N89-17579 # N89-16768 # N89-16768 # N89-16768 # N89-17579 # N89-17579 # N89-17579 # N89-17578 # N89-17579 # N89-17579 # N89-17584 # N89-17579 # N89-16761 # N89-16761 # N89-17579 # N89-17579 # N89-17579 # N89-17579 # N89-1757
L-16385 L-16498 ME-5375-88 NA-88-1347L NAL-TM-FM-8701 NAS 1.15:101033 NAS 1.15:101078 NAS 1.15:101078 NAS 1.26:177455 NAS 1.26:177455 NAS 1.26:184724 NAS 1.26:184783 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:184788 NAS 1.26:2493 NAS 1.60:2890 NAS 1.60:2890 NAS 1.60:2890 NAS 1.60:2890 NAS 1.60:2890 NAS 1.60:2890 NAS 1.60:2890 NAS 1.60:2898 NAS 1.60:2898 NAS 1.61:1179 NASA-CP-2493 NASA-CR-177455 NASA-CR-177455 NASA-CR-1847283 NASA-CR-184783 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184789 NASA-CR-184783 NASA-CR-184783 NASA-CR-184788 NASA-CR-184788 NASA-CR-184783 NASA-CR-184783 NASA-CR-184788 NASA-CR-184783 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184788 NASA-CR-184783 NASA	p 301 p 321 p 315 p 316 p 300 p 351 p 300 p 351 p 301 p 300 p 301 p 300 p 301 p 301 p 300 p 300 p 301 p 300 p 300 p 301 p 300 p 300	N89-17568 # N89-16820 * N89-16724 # N89-16757 # N89-17591 # N89-16757 # N89-17593 * N89-17593 * N89-17593 * N89-17593 * N89-17593 * N89-17578 * N89-17577 * N89-17578 * N89-18167 * N89-18167 * N89-18167 * N89-18167 * N89-16761 * N89-16761 * N89-17578 * N89-17579 * N89-17579 * N89-17579 * N89-16761 * N89-17593 * N89-17579 * N89-17579 * N89-17593 * N89-17593 * N89-17593 * N89-1759

REPORT NUMBER INDEX

NPS67-88-002		p 328	N89-16821	#
NSWC-TR-88-6		p 302	N89-17582	#
NITCO AAD 89.03.SI II	м	n 306	N89-16768	#
N13B-AAR-00-03-30	wi	p 500	100-10700	"
PB88-910414		p 306	N89-16768	#
RAND/N-2283/1-AF		p 269	N89-16719	#
RANU/N-2283/2-AF	••••••	p 270	N09-10720	#
RAND/N-2283/3-AF	••••••	p 270	N89-10/21	#
HAND/N-2203/4-AF		p 210	1009-10722	π
SAE PAPER 880999		p 312	A89-27808	
SAE PAPER 881001	••••••	p 313	A09-2/009	
CAE PAPER 001307		p 313	A89-28177 '	•
SAE PAPER 881359		p 313	A89-28178	
SAF PAPER 881370		p 308	A89-28183	
SAE PAPER 881371		p 318	A89-28184	
SAE PAPER 881373		p 333	A89-28185	
SAE PAPER 881374		p 318	A89-28186	
SAE PAPER 881375		p 304	A89-28187	
SAE PAPER 881376	•••••	p 305	A89-28188	
SAE PAPER 881377		p 305	A89-28189	
SAE PAPER 881378	•••••	p 305	A89-28190	
SAE PAPER 881379		p 305	A89-28191	
CAE PAPER 001301		p 314	A09-20200	
CAE DADED 001300		p 305	A03-20192	
SAE PAPER 001300		p 313	A89-28194	
SAE PAPER 001399		n 336	A89.28196	•
SAE PAPER 881407		n 314	A89-28256	
SAE PAPER 881408		p 324	A89-28257	
SAE PAPER 881409		p 324	A89-28258	
SAE PAPER 881410		p 324	A89-28259	
SAE PAPER 881411		p 324	A89-28260	
SAE PAPER 881413		p 325	A89-28262	
SAE PAPER 881414		p 325	A89-28263	
SAE PAPER 881415		p 318	A89-28199	
SAE PAPER 881416	••••••	p 319	A89-28200	
SAE PAPER 881417	•••••	p 319	A89-28201	
SAE PAPER 881422		p 295	A89-28203	•
SAE PAPER 881428		p 269	A89-28204	
SAE PAPER 881430		p 333	A89-28205	•
SAE PAPER 881431		p 313	A89-28206	*
SAE PAPER 881432		p 313	A89-28207	
SAE PAPEH 881433	••••••	p 314	A09-20200	
SAE PAPER 881438	•••••	n 319	A89-28213	
SAE PAPER 881440		p 319	A89-28214	
SAE PAPER 881444		p 356	A89-28215	
SAE PAPER 881447		p 356	A89-28217	
SAE PAPER 881448		p 295	A89-28218	*
SAE PAPER 881449		p 336	A89-28219	
SAE PAPER 881454		p 336	A89-28220	*
SAE PAPER 881472	••••••	p 319	A89-28224	
SAE PAPER 881481		p 324	A89-28228	*
SAE PAPEN 881484	•••••	h 532	A03-20229	
SAE PAPER 001498	•••••	p 325	A89.28265	
SAE PAPER 881500		n 325	A89.28265	
SAE PAPER 881501		n 349	A89-28267	
SAF PAPER 881504	••••••	p 314	A89-28269	
SAE PAPER 881515		p 333	A89-28236	
SAE PAPER 881533		p 341	A89-28242	
SAE PAPER 881534		p 341	A89-28243	
SAE PAPER 881537		p 341	A89-28244	
SAE SD 758		n 324	489.28254	
GAL 0F-700		p 524		
SAND-88-1325 SAND-88-2629C		p 309 p 306	N89-17587 N89-16766	#
TAMBE-5373-89-01		o 300	N89-16761	• #
LULLENC 90 2010		P 000	N90-19049	* #
VILU-EING-89-2210		p 356	1103-10040	#
			NO0	• •
USAVSCOM-TR-88-4	A-008	p 301	N89-17577	* #
USAVSCOM-TR-88-4 VKI-LS-1988-03-VOL	A-008 -1	p 301	N89-17577 N89-16825	* #
USAVSCOM-TR-88-4 VKI-LS-1988-03-VOL VKI-LS-1988-03-VOL	A-008 -1 -2	p 301 p 328 p 329	N89-17577 N89-16825 N89-16833 N89-16728	* # # # #
USAVSCOM-TR-88-A VKI-LS-1988-03-VOL VKI-LS-1988-03-VOL VKI-LS-1988-04-VOL VKI-LS-1988-04-VOL	A-008 -1 -2 -1	p 301 p 328 p 329 p 298	N89-17577 N89-16825 N89-16833 N89-16738 N89-16748	* # # # # #

ACCESSION NUMBER INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 240)

June 1989

Typical Accession Number Index Listing



Listings is this index are arranged alpha-numerically by accession number. The page number listed to the right indicates the page on which the citation is located. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche

490 04016	- 000		
A00-24910	p 322	A89-25103 #	p 275
A09-24917	p 322	A89-25104 #	p 275
A09-24919	p 309	A89-25106 * #	p 310
A09-24922 #	p 270	A89-25108 * #	p 275
A09-24923 #	p 270	A89-25110 #	n 275
A09-24920 #	p 270	A99.25111 #	p 275
A09-24969 #	p 322	AP0 25115 * #	p 275
A09-24995 #	p 343	APO 25119 #	p 2/5
A09-20002 #	p 270	A90 25110 #	p 343
A89-25003 #	p 271	APO 25122 #	p 344
A09-25004 #	p 322	A90 25123 #	p 270
A09-25005 #	p 322	A00-25131 #	p 334
A09-20000 #	p 322	A90 25122 #	p 034
A89-25008 #	p 331	A09-25133 #	p 2/6
A89-25009 #	p 310	A09-25135 #	p 334
A89-25011 #	p 331	A09-25150 #	p 344
A89-25012 #	p 331	A09-20100 #	p 310
A89-25013 #	p 331	A09-20109 #	p 335
A89-25014 * #	p 331	A09-20100 #	p 276
A89-25016 * #	p 2/1	A09-2010/ #	p 276
A89-25017 #	p 271	A09-20108 #	p 276
A89-25018 #	p 271	A09-25109 #	p 276
A89-25019 #	p 271	A89-25170 * #	p 2/6
A89-25020 #	p 271	A09-25172 #	p 2//
A09-20021 #	p 272	A09-23174 # A00.05170 #	p 277
A89-25022 * #	p 2/2	A09-20170 #	p 277
A69-25023 #	p 2/2	A00 25101 # #	p 2//
A09-20024 #	p 2/2	A00-20101 #	p 344
A09-25025 * #	p 2/2	A00 25102 #	p 2//
A09-25026 #	p 272	A00-20103 #	p 344
A09-20028 * #	p 2/2	A00-25104 #	p 2//
A09-20031 #	p 2/2	A00-20100 #	p 2//
A09-25035 #	p 334	A09-20100 #	p 278
A09-20036 #	p 334	A09-25190 #	p 340
A89-25037 * #	p 273	A09-20191 #	p 344
A89-25039 * #	p 273	A09-25193 #	p 340
A89-25040 #	p 273	A09-25199 #	p 269
A89-25041 #	p 310	A09-25207 #	p 278
A89-25042 #	p 334	A09-25208 #	p 339
A89-25065 #	p 343	A09-20218 #	p 323
A89-250/1 #	p 2/3	A09-20219 #	p 2/8
A89-25072 * #	p 2/3	A09-20221 #	p 310
A89-25073 #	p 273	A09-20222 #	p 278
A89-25074 * #	p 273	A09-20223 #	p 278
A89-25075 * #	p 274	A89-25224 - #	p 278
A89-25076 #	p 274	A09-25225 #	p 278
A89-25081 #	p 310	A89-25226 #	p 2/9
A89-25082 #	p 343	A89-25227 #	p 2/9
A89-25085 #	p 274	A09-20228 #	p 2/9
A89-25090 #	p 274	A89-25230 #	p 2/9
A89-25092 #	p 322	A89-25231 #	p 279
A89-25099 *#	p 274	A69-25232 * #	p 279
A89-25100 #	p 274	A89-25236 #	p 310
A89-25101 #	n 949	A89-25237 #	p 279
AR0.25102 *#	p 075	A89-25238 #	p 280
M09-20102 #	p 275	A89-25242 *#	p 280

A89-25244 #	p 280
A89-25245 #	p 280
A89-25248 #	p 280
A89-25252 * #	p 281
A89-25253 #	p 281
A89-25273 #	p 281
A89-25275 #	p 344
A89-25276 #	p 281
A89-25284 * #	p 281
A89-25286 * #	p 282
A89-25288 * #	p 282
A89-25298 #	p 282
A89-25300 #	p 282
A89-25301 #	p 282
A89-25305 #	p 353
A89-25306 * # A89-25307 * #	p 282 p 344
A89-25308 *#	p 283
A89-25309 #	p 283
A89-25310 *#	p 354
A89-25314 #	p 263
A89-25317 *#	p 283
A89-25319 #	p 283
A89-25320 #	p 311 n 283
A89-25328 #	p 284
A89-25337 *#	p 345
A89-25363 #	p 284
A89-25365 #	p 284 p 284
A89-25366 #	p 284
A89-25367 #	p 284
A89-25376 # A89-25377 * #	p 345 p 284
A89-25379 * #	p 285
A89-25383 * #	p 285
A89-25385 * #	p 354
A89-25390 #	p 285
A89-25403 #	p 340
A89-25418 * #	p 285
A89-25421 #	p 285
A89-25424 #	р 286
A89-25426 * #	p 286
A89-25427 #	p 286 p 269
A89-25429 *#	p 311
A89-25430 #	p 286
A89-25432 #	p.286 p.286
A89-25440 *#	p 345
A89-25441 #	p 286
A89-25443 #	p∠oo p287
A89-25445 #	p 345
A89-25446 * #	p 287
A69-25447 - #	p 287 n 287
A89-25449 #	p 311
A89-25450 #	p 345
A89-25451 #	p 287
A89-25453 #	p 287
A89-25454 *#	p 288
A89-25458 #	p 288
A89-25485 *#	p 288
A89-25491 #	p 323
A89-25492 #	p 288
A89-25493 #	p 323 p 323
A89-25505 #	p 288
A89-25506 #	p 311
A89-25507 #	p 288
A89-25509 "#	p 311
A89-25511 * #	p 335
	-

A89-25512 * #	p 335
A89-25513 #	n 357
A00 06614 * #	- 000
A03-23514 #	p 200
A89-25517 *#	p 289
A89-25521 * #	p 289
A89-25526 #	D 345
A89-25530 #	n 289
A90 25522 #	p 203
A00 05500 #	p 209
A09-25533 #	p 323
A89-25534 #	p 289
A89-25545 #	p 302
A89-25547 #	p 302
A89-25549 * #	n 352
A89-25553 * #	n 302
APO 25554 * #	p 002
A00-20004 #	p 346
A89-25555 #	p 302
A89-25556 #	p 303
A89-25557 #	p 303
A89-25558 #	p 303
A89-25560 * #	n 303
A89-25561 #	p 202
A00 25501 #	p 303
A09-20002 #	p 352
A89-25563 #	p 303
A89-25564 #	p 303
A89-25565 * #	p 311
A89-25566 #	p 303
A89-25567 #	n 304
A90.25550 + 4	p 004
ADD 05570 #	p 339
A89-25570 #	p 346
A89-25571 *#	p 311
A89-25572 #	p 311
A89-25578 #	p 352
489-25583 #	p 252
A90 25504 #	p 352
A09-20064 #	p 304
A89-25585 #	p 304
A89-25590 #	p 346
A89-25591 * #	p 335
A89-25592 #	n 304
A89.25593 #	p 352
A00 25504 #	p 052
A09-20094 #	p 353
A89-25599 #	p 353
A89-25602 #	p 289
A89-25603 #	p 289
A89-25605 #	p 312
A89-25606 #	n 200
480.25600 #	p 230
A00 05000 #	p 346
A89-25609 #	p 346
A89-25611 #	p 290
A89-25615 #	p 290
A89-25683	p 332
A89-25692	p 332
A89-25856	p 290
A89-25857	p 200
489-25858	p 200
A00-20000	p 230
A09-25800	p 346
A89-25862	p 290
A89-25863	p 291
A89-25864 *	p 291
A89-25865	p 291
A89-25866	n 291
A89-25867 *	0 201
A00-20007	p 291
A00 05071	
A89-25871	p 354
A89-25902	р 354 р 332
	р 354 р 332 р 340
A89-25915	р 354 р 332 р 340 р 341
A89-25915 A89-25919	p 354 p 332 p 340 p 341 p 341
A89-25915 A89-25919 A89-25929 #	p 354 p 332 p 340 p 341 p 341 p 341
A89-25915 A89-25919 A89-25929 # A89-25929 #	p 354 p 332 p 340 p 341 p 341 p 291
A89-25915 A89-25919 A89-25929 # A89-25930 #	p 354 p 332 p 340 p 341 p 341 p 291 p 291
A89-25915 A89-25919 A89-25929 # A89-25930 # A89-25931 #	p 354 p 332 p 340 p 341 p 341 p 291 p 291 p 291 p 292
A89-25915 A89-25919 A89-25929 # A89-25930 # A89-25931 # A89-25932 #	p 354 p 332 p 340 p 341 p 341 p 291 p 291 p 292 p 292
A89-25915 A89-25919 A89-25929 # A89-25930 # A89-25931 # A89-25932 # A89-25934 #	p 354 p 332 p 340 p 341 p 341 p 291 p 291 p 292 p 292 p 332
A89-25915 A89-25919 A89-25929 # A89-25930 # A89-25931 # A89-25932 # A89-25934 # A89-25938 #	p 354 p 332 p 340 p 341 p 341 p 291 p 291 p 292 p 292 p 332 p 332 p 292
A89-25915 A89-25919 A89-25929 # A89-25930 # A89-25931 # A89-25932 # A89-25934 # A89-25938 # A89-25938 #	p 354 p 332 p 340 p 341 p 341 p 291 p 291 p 292 p 292 p 292 p 292 p 292 p 292
A89-25915 A89-25939 # A89-25930 # A89-25930 # A89-25931 # A89-25932 # A89-25938 # A89-25938 # A89-25939 #	p 354 p 332 p 340 p 341 p 341 p 291 p 291 p 292 p 292 p 292 p 292 p 292 p 292
A89-25915 A89-25929 # A89-25929 # A89-25930 # A89-25931 # A89-25932 # A89-25938 # A89-25938 # A89-25939 #	p 354 p 332 p 340 p 341 p 341 p 291 p 291 p 292 p 292 p 332 p 292 p 292 p 292 p 292
A89-25915 A89-25919 A89-25930 # A89-25930 # A89-25930 # A89-25932 # A89-25932 # A89-25934 # A89-25938 # A89-25939 # A89-25930 # A89-25934 # A89-25940	p 354 p 332 p 340 p 341 p 341 p 291 p 291 p 292 p 292 p 292 p 292 p 292 p 292 p 292 p 292
A89-25915 A89-25919 A89-25929 A89-25930 A89-25931 A89-25933 A89-25934 A89-25938 A89-25939 A89-25940 A89-25941 A89-25942	p 354 p 332 p 340 p 341 p 341 p 291 p 292 p 292
A89-25915 A89-25919 A89-25930 # A89-25931 # A89-25932 # A89-25934 # A89-25939 # A89-25939 # A89-25930 # A89-25934 # A89-25930 # A89-25934 # A89-25940 # A89-25942 # A89-25944	p 354 p 354 p 340 p 341 p 341 p 291 p 292 p 292
A89-25915 A89-25919 A89-25930 A89-25931 A89-25931 A89-25932 A89-25934 A89-25938 A89-25939 A89-25934 A89-25934 A89-25934 A89-25934 A89-25934 A89-25934 A89-25941 A89-25944 A89-25944 A89-25946	p 354 p 332 p 340 p 341 p 341 p 291 p 292 p 293 p 293
A89-25915 A89-25919 A89-25929 #A89-25930 #A89-25931 #A89-25933 #A89-25934 #A89-25938 #A89-25939 #A89-25939 #A89-25940 #A89-25941 #A89-25942 #A89-25944 #A89-25944 #A89-25946 #A89-25946	p 354 p 332 p 340 p 341 p 341 p 241 p 291 p 292 p 292 p 332 p 292 p 293 p 293
A89-25915 A89-25919 A89-25930 # A89-25930 # A89-25930 # A89-25930 # A89-25932 # A89-25934 # A89-25939 # A89-25939 # A89-25930 # A89-25934 # A89-25934 # A89-25941 # A89-25944 A89-25944 A89-25945 # A89-25946 # A89-26011 A89-26038	p 354 p 332 p 340 p 341 p 241 p 291 p 291 p 292 p 293 p 293 p 293 p 293 p 293 p 293
A89-25915 A89-25919 A89-25929 A89-25930 A89-25931 A89-25932 A89-25933 A89-25934 A89-25938 A89-25939 A89-25940 A89-25940 A89-259441 A89-25944 A89-25944 A89-25944 A89-25946 A89-25046 A89-25046 A89-25041	p 354 p 332 p 340 p 341 p 341 p 291 p 291 p 292 p 292 p 332 p 292 p 293 p 293 p 293 p 293 p 293
A89-25915 A89-25919 A89-25930 A89-25930 A89-25931 A89-25932 A89-25934 A89-25939 A89-25939 A89-25939 A89-25934 A89-25939 A89-25940 A89-25942 A89-25944 A89-25944 A89-25944 A89-25944 A89-26011 A89-26038 A89-26038	p 354 p 332 p 340 p 341 p 291 p 291 p 292 p 293 p 293 p 354 p 293 p 354
A89-25915 A89-25919 A89-25930 #A89-25931 #A89-25931 #A89-25932 #A89-25933 #A89-25934 #A89-25939 #A89-25939 #A89-25939 #A89-25930 #A89-25934 #A89-25940 #A89-25944 #A89-25946 #A89-25036 #A89-25036 #A89-25046 #A89-26011 A89-26018 A89-26163 A89-26171	p 354 p 332 p 332 p 340 p 341 p 291 p 292 p 293 p 353 p 354 p 346

A89-26193 A89-26196 A89-26214 A89-26215 A89-26213 A89-26273 A89-26273 A89-26281 A89-26281 A89-26368 # A89-26368 # A89-26373 # A89-26373 # A89-26373 # A89-26374 A89-26548 A89-26548 A89-26548 A89-26568 A89-26665 A89-26665 A89-26668 A89-26668 A89-26668 A89-26673 # A89-26688 A89-26688 A89-26670 A89-26678 A89-26708 # A89-26724 A89-26733 A89-26735 A89-26738 A89-26740 A89-26740 A89-26740 A89-26740 A89-26738 A89-26740 A89-26740 A89-26740 A89-26738 A89-26740 A89-26740 A89-26740 A89-26740 A89-26758 A89-26740 A89-26778 A89-27778 A89-277778 A89-277778 A89-277777778 A89-2777777777777777777777777777777777777	p 332 p 354 p 353 p 353 p 304 p 347 p 347 p 347 p 347 p 347 p 347 p 347 p 347 p 347 p 353 p 293 p 293 p 293 p 293 p 293 p 293 p 293 p 347 p 356 p 357 p 357 p 357 p 356 p 357 p 357 p 369 p 340 p 347 p 307 p 307 p 307 p 307 p 308 p 308 p 329 g 320 p 327 p 328 p 328
A89-27247 A89-27249 A89-27384	р 340 р 318 р 304 р 294
A89-27405 A89-27602 *	p 354 p 354
A89-27609 * A89-27611	p 355
A89-27613 *	p 312
A89-27618	p 355 p 355
A89-27622	p 355 p 355
A89-27624 - A89-27629	p 318 p 355
A89-27632 A89-27651	р 347 р 348
A89-27653 * # A89-27654 * #	р 335 р 335
A89-27655 # A89-27659 * #	p 335 p 348
A89-27661 A89-27664 * #	p 348 p 318
A89-27668 * # A89-27670	p 318
A89-27674 * # A89-27675 * #	p 336
A89-27692 #	p 348
A89-27694 #	p 323
A89-27706 #	p 294
A89-27728 #	p 294 p 294
A89-27734 * #	p 341 p 332
A89-27735 # A89-27736 * #	p 312 p 332
A89-27737 * # A89-27738 * #	р 333 р 312
A89-27739 * #	p 304
A89-27741 #	p 356

A89-27742 * # p 294

A89-27744

				NO2 40000 #
A89-27744 *#	р 348	A89-28451 * #	p 305	N89-16839 #
A89-27745 #	p 348	A89-28453 * #	p 297	N89-16840 #
A89-27746 #	p 294	A89-28454 *#	p 333	N89-16845 *#
A00 07747 #	p 201	A89-28455 *#	p 336	N89-16847 *#
A89-2//4/ #	p 312	A89-28456 #	p 314	N89-16848 #
A89-27748 #	p 294	A89-28457 * #	в 337	N89-16849 #
A89-27787	p 348	A89-28458 #	n 337	N89-16852 #
A89-27808	p 312	A00-20400 #	p 357	NR0 16855 #
A89-27809	p 313	A09-20401 #	p 353	N00 10055 #
A80.27025	n 313	A89-28462 #	p 326	1089-10850 #
A00-27920	p 010	A89-28463 *#	p 269	N89-16857 #
A89-28070	p 348	A89-28464 *#	р 306	N89-16858 #
A89-28074	p 295	A89-28486	p 306	N89-16863 #
A89-28176 *	p 313		F	N89-16864 * #
A89-28177 *	p 313	NR0 16710 #	n 260	N89-16869 #
A89-28178	p 313	N03-10713 #	- 270	NO0 16970 #
489-28183	n 308	N09-10720 #	p 270	N00-40070 #
A90 20100	0.318	N89-16/21 #	p 270	N89-168/3 #
A00 00105	p 310	N89-16722 #	p 270	N89-16877 #
A89-28185	p 333	N89-16726 #	p 297	N89-16878 #
A89-28186	p 318	N89-16728 #	p 297	N89-16879 #
A89-28187	р 304	N89-16730	n 297	N89-17017 * #
A89-28188	p 305	NR9-16731	n 297	N89-17069 #
A89-28189	p 305	NO0 16722	p 209	N80-17215 #
A89-28190	n 305	1409-10732	- 200	NO0 17055 #
APO 29101	p 305	N89-16/34	p 298	N89-17255 #
A09-20191	p 305	N89-16735	p 298	N89-17256 #
A89-28192	p 305	N89-16736	p 298	N89-17257 #
A89-28193	p 336	N89-16738 #	p 298	N89-17258 #
A89-28194	p 313	N89-16739 #	p 298	N89-17259 #
A89-28196 *	p 336	N89-16740 #	n 298	N89-17260 #
A89-28199	p 318	N89,167/1 #	n 314	N89-17261 #
A89-28200	p 319	NO0 16740 #	p 200	N90-17062
A90 29201	0.310	N89-16/42 #	b 5aa	1109-17203
A09-20201	- 204	N89-16743 #	p 299	N89-1/2/8 #
A69-28202	p 324	N89-16744 #	p 315	N89-17298 *#
A89-28203 *	b 582	N89-16745 #	p 315	N89-17304 *#
A89-28204	p 269	N89-16746 #	0.315	N89-17311 * #
A89-28205 *	p 333	N90-16747 #	n 299	N89-17314 * #
A89-28206 *	p 313	N00-10747 #	p 200	NR0-17916 * #
489-28207	n 313	N09-10/40 #	p 299	N00 47005 1 #
A00-20207	0.214	N89-16/49 #	p 315	N89-1/325 #
A09-20200	p 314	N89-16751 #	p 299	N89-17329 * #
A89-28210	p 349	N89-16753 * #	p 299	N89-17333 *#
A89-28213	p 319	N89-16754 * #	p 299	N89-17334 *#
A89-28214	p 319	N89-16756 #	p 299	N89-17336 * #
A89-28215	p 356	N80-16757 #	n 299	N89-17564 #
A89-28217	p 356	NDO 16759 * #	p 200	N89-17566
A89-28218 *	p 295	N09-10750 #	- 200	NPO 17569 * #
489-28219	n 336	N89-16760 #	p 300	NO9-17560 #
ABO 28220 *	0 336	N89-16/61 #	p 300	N09-17509
A09-20220	p 310	N89-16766 #	p 306	N89-1/5// #
A09-20224	p 319	N89-16768 #	р 306	N89-17578 #
A89-28228 *	p 324	N89-16773	p 315	N89-17579 *#
A89-28229 *	p 295	N89-16774 #	p 315	N89-17580 #
A89-28236	p 333	N89-16775 #	n 315	N89-17582 #
A89-28242	p 341	N90-16778	p 316	N89-17584 * #
A89-28243	p 341	NO0 16700 #	p 310	N80-17585 #
A89-28244	0.341	N09-10/02 #	- 000	N00 17505 #
A00 00051 * #	p 205	N89-16/83 #	p 326	N69-17566
A09-20201 #	p 295	N89-16784 #	p 326	N89-17587 #
A89-28252 #	p 314	N89-16785 #	p 319	N89-17588 #
A89-28254	p 324	N89-16786 #	p 319	N89-17589
A89-28255	p 314	N89-16787 #	p 326	N89-17590
A89-28256	p 314	N89-16788 #	n 319	N89-17591 #
A89-28257	p 324	NO0 16700 #	p 330	N80-17503 * #
489-28258	n 324	1109-10709 #	p 320	NO0 17504 #
A80.28250	0 324	1189-16/90 #	p 320	N03-17334 #
A00-20200	p 324	N89-16/93 #	p 320	1009-17090 #
A03-2020U	P 024	N89-16795 #	p 320	N89-1/599 *#
A89-28262	p 325	N89-16796 #	р 326	N89-17600 *#
A89-28263	p 325	N89-16797 #	p 320	N89-17601 #
A89-28264	р 325	N89-16798 #	p 320	N89-17681 #
A89-28265	р 325	N89-16799 #	p 320	N89-17691 #
A89-28266	p 325	N89,16800 #	n 327	N89-17693 #
A89-28267	p 349	N90 16004 #	p 321	N89,17606 #
A89-28269	D 314	N09-10801 #	p 321	N90.17700 #
480,28202 #	n 308	1489-16802 #	µ 321	NO3-1//UU #
A00 00000 #	p 309	N89-16803 #	p 327	N09-1//U1 #
M03-20293 #	+ 300 - 205	N89-16804 #	p 327	N89-17702 #
A69-26294 #	p 305	N89-16805 #	p 327	N89-17978
A89-28296 #	р 308	N89-16806 #	p 327	N89-18046 * #
A89-28297 #	р 309	N89-16809 #	p 327	N89-18167 * #
A89-28298 #	p 309	N89-16811 #	p 321	N89-18380 * #
A89-28299 #	p 309	N80,16210 #	n 321	N89-18384 * #
A89-28336 #	p 325	1409-10012 #	p 021	NB0.10207 * #
ARO.002000 #	n 325	N89-16813 #	p 328	N09-1030/ #
A00-2033/ #	p 225	N89-16814 #	p 328	1089-16388 #
A09-20341 #	h 290	N89-16817 #	p 321	N89-18401 * #
A89-28342 #	p 325	N89-16819 #	p 321	
A89-28344 *#	p 341	N89-16820 * #	p 321	
A89-28345 #	р 349	N89-16821 #	p 328	
A89-28350	p 314	N80-16925 4	n 328	
A89-28382	p 356	NO0 10020 #	p 020	
489-28396	p 333	1109-10020 #	4 320 - 000	
A80 20402 * #	0.325	N89-16827 #	p 328	
A09-20403 #	p 320	N89-16828 #	р 329	
A69-26404 #	h 592	N89-16829 #	р 329	
A89-28406 *#	p 295	N89-16830 #	p 329	
A89-28407 *#	p 296	N89-16831 #	p 329	
A89-28413 *#	p 296	N89-16832 #	p 329	
A89-28428 *#	p 296	N89-16822 #	n 329	
A89-28433	p 342	ND0 10000 #	p 329	
A89.28434 #	n 296	1009-10034 #	4 32 3	
ARO 20442 4	n 296	N89-16835 #	p 330	
M09-20442 #	P 200	N89-16836 #	p 330	
A69-28443 "#	p 290	N80-16927 * #	n 330	
		1103-1003/ #	P 000 P	
A89-28444 #	p 296	NIDO 10000	- 000	

p 330 p 330 p 337 p 300 p 337 p 307 p 337 p 307 p 337 p 338 p 339 p 342 p 349 p 349 p 349 p 349 p 350 p 350 p 351 p 352 p 308 p 309 p 309 p 309 p 309 p 309 p 306 p 309 p 309 p 309 p 336 p 317 p 352 p 343 p 356 p 357 p 317 p 357 p 357

1

AVAILABILITY OF CITED PUBLICATIONS

IAA ENTRIES (A89-10000 Series)

Publications announced in *IAA* are available from the AIAA Technical Information Service as follows: Paper copies of accessions are available at \$10.00 per document (up to 50 pages), additional pages \$0.25 each. Microfiche⁽¹⁾ of documents announced in *IAA* are available at the rate of \$4.00 per microfiche on demand. Standing order microfiche are available at the rate of \$1.45 per microfiche for *IAA* source documents and \$1.75 per microfiche for AIAA meeting papers.

Minimum air-mail postage to foreign countries is \$2.50. All foreign orders are shipped on payment of pro-forma invoices.

All inquiries and requests should be addressed to: Technical Information Service, American Institute of Aeronautics and Astronautics, 555 West 57th Street, New York, NY 10019. Please refer to the accession number when requesting publications.

STAR ENTRIES (N89-10000 Series)

One or more sources from which a document announced in *STAR* is available to the public is ordinarily given on the last line of the citation. The most commonly indicated sources and their acronyms or abbreviations are listed below. If the publication is available from a source other than those listed, the publisher and his address will be displayed on the availability line or in combination with the corporate source line.

Avail: NTIS. Sold by the National Technical Information Service. Prices for hard copy (HC) and microfiche (MF) are indicated by a price code preceded by the letters HC or MF in the *STAR* citation. Current values for the price codes are given in the tables on NTIS PRICE SCHEDULES.

Documents on microfiche are designated by a pound sign (#) following the accession number. The pound sign is used without regard to the source or quality of the microfiche.

Initially distributed microfiche under the NTIS SRIM (Selected Research in Microfiche) is available at greatly reduced unit prices. For this service and for information concerning subscription to NASA printed reports, consult the NTIS Subscription Section, Springfield, Va. 22161.

NOTE ON ORDERING DOCUMENTS: When ordering NASA publications (those followed by the * symbol), use the N accession number. NASA patent applications (only the specifications are offered) should be ordered by the US-Patent-Appl-SN number. Non-NASA publications (no asterisk) should be ordered by the AD, PB, or other *report number* shown on the last line of the citation, not by the N accession number. It is also advisable to cite the title and other bibliographic identification.

Avail: SOD (or GPO). Sold by the Superintendent of Documents, U.S. Government Printing Office, in hard copy. The current price and order number are given following the availability line. (NTIS will fill microfiche requests, as indicated above, for those documents identified by a # symbol.)

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

- Avail: BLL (formerly NLL): British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England. Photocopies available from this organization at the price shown. (If none is given, inquiry should be addressed to the BLL.)
- Avail: DOE Depository Libraries. Organizations in U.S. cities and abroad that maintain collections of Department of Energy reports, usually in microfiche form, are listed in *Energy Research Abstracts.* Services available from the DOE and its depositories are described in a booklet, *DOE Technical Information Center - Its Functions and Services* (TID-4660), which may be obtained without charge from the DOE Technical Information Center.
- Avail: ESDU. Pricing information on specific data, computer programs, and details on ESDU topic categories can be obtained from ESDU International Ltd. Requesters in North America should use the Virginia address while all other requesters should use the London address, both of which are on the page titled ADDRESSES OF ORGANIZATIONS.
- Avail: Fachinformationszentrum, Karlsruhe. Sold by the Fachinformationszentrum Energie, Physik, Mathematik GMBH, Eggenstein Leopoldshafen, Federal Republic of Germany, at the price shown in deutschmarks (DM).
- Avail: HMSO. Publications of Her Majesty's Stationery Office are sold in the U.S. by Pendragon House, Inc. (PHI), Redwood City, California. The U.S. price (including a service and mailing charge) is given, or a conversion table may be obtained from PHI.
- Avail: NASA Public Document Rooms. Documents so indicated may be examined at or purchased from the National Aeronautics and Space Administration, Public Documents Room (Room 126), 600 Independence Ave., S.W., Washington, D.C. 20546, or public document rooms located at each of the NASA research centers, the NASA Space Technology Laboratories, and the NASA Pasadena Office at the Jet Propulsion Laboratory.
- Avail: Univ. Microfilms. Documents so indicated are dissertations selected from *Dissertation Abstracts* and are sold by University Microfilms as xerographic copy (HC) and microfilm. All requests should cite the author and the Order Number as they appear in the citation.
- Avail: US Patent and Trademark Office. Sold by Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, at the standard price of \$1.50 each, postage free. (See discussion of NASA patents and patent applications below.)
- Avail: (US Sales Only). These foreign documents are available to users within the United States from the National Technical Information Service (NTIS). They are available to users outside the United States through the International Nuclear Information Service (INIS) representative in their country, or by applying directly to the issuing organization.
- Avail: USGS. Originals of many reports from the U.S. Geological Survey, which may contain color illustrations, or otherwise may not have the quality of illustrations preserved in the microfiche or facsimile reproduction, may be examined by the public at the libraries of the USGS field offices whose addresses are listed in this Introduction. The libraries may be queried concerning the availability of specific documents and the possible utilization of local copying services, such as color reproduction.
- Avail: Issuing Activity, or Corporate Author, or no indication of availability. Inquiries as to the availability of these documents should be addressed to the organization shown in the citation as the corporate author of the document.

PUBLIC COLLECTIONS OF NASA DOCUMENTS

DOMESTIC: NASA and NASA-sponsored documents and a large number of aerospace publications are available to the public for reference purposes at the library maintained by the American Institute of Aeronautics and Astronautics, Technical Information Service, 555 West 57th Street, 12th Floor, New York, New York 10019.

EUROPEAN: An extensive collection of NASA and NASA-sponsored publications is maintained by the British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England for public access. The British Library Lending Division also has available many of the non-NASA publications cited in *STAR*. European requesters may purchase facsimile copy or microfiche of NASA and NASA-sponsored documents, those identified by both the symbols # and * from ESA – Information Retrieval Service European Space Agency, 8-10 rue Mario-Nikis, 75738 CEDEX 15, France.

FEDERAL DEPOSITORY LIBRARY PROGRAM

In order to provide the general public with greater access to U.S. Government publications. Congress established the Federal Depository Library Program under the Government Printing Office (GPO), with 50 regional depositories responsible for permanent retention of material, inter-library loan, and reference services. At least one copy of nearly every NASA and NASA-sponsored publication, either in printed or microfiche format, is received and retained by the 50 regional depositories. A list of the regional GPO libraries, arranged alphabetically by state, appears on the inside back cover. These libraries are *not* sales outlets. A local library can contact a Regional Depository to help locate specific reports, or direct contact may be made by an individual.

STANDING ORDER SUBSCRIPTIONS

NASA SP-7037 and its supplements are available from the National Technical Information Service (NTIS) on standing order subscription as PB89-914100 at the price of \$10.50 domestic and \$21.00 foreign. The price of the annual index is \$16.50. Standing order subscriptions do not terminate at the end of a year, as do regular subscriptions, but continue indefinitely unless specifically terminated by the subscriber.

ADDRESSES OF ORGANIZATIONS

American Institute of Aeronautics and Astronautics Technical Information Service 555 West 57th Street, 12th Floor New York, New York 10019

British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England

Commissioner of Patents and Trademarks U.S. Patent and Trademark Office Washington, D.C. 20231

Department of Energy Technical Information Center P.O. Box 62 Oak Ridge, Tennessee 37830

ESA-Information Retrieval Service ESRIN Via Galileo Galilei 00044 Frascati (Rome) Italy

ESDU International P.O. Box 1633 Manassas, Virginia 22110

ESDU International, Ltd. 251-259 Regent Street London, W1R 7AD, England

Fachinformationszentrum Energie, Physik, Mathematik GMBH 7514 Eggenstein Leopoldshafen Federal Republic of Germany

Her Majesty's Stationery Office P.O. Box 569, S.E. 1 London, England

NASA Scientific and Technical Information Facility P.O. Box 8757 B.W.I. Airport, Maryland 21240 National Aeronautics and Space Administration Scientific and Technical Information Division (NTT) Washington, D.C. 20546

National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

Pendragon House, Inc. 899 Broadway Avenue Redwood City, California 94063

Superintendent of Documents U.S. Government Printing Office Washington, D.C. 20402

University Microfilms A Xerox Company 300 North Zeeb Road Ann Arbor, Michigan 48106

University Microfilms, Ltd. Tylers Green London, England

U.S. Geological Survey Library National Center - MS 950 12201 Sunrise Valley Drive Reston, Virginia 22092

U.S. Geological Survey Library 2255 North Gemini Drive Flagstaff, Arizona 86001

U.S. Geological Survey 345 Middlefield Road Menlo Park, California 94025

U.S. Geological Survey Library Box 25046 Denver Federal Center, MS914 Denver, Colorado 80225

NTIS PRICE SCHEDULES

(Effective January 1, 1989)

Schedule A STANDARD PRICE DOCUMENTS AND MICROFICHE

PRICE CODE	NORTH AMERICAN PRICE	FOREIGN PRICE
A01	\$ 6.95	\$13.90
A02	10.95	21.90
A03	13.95	27.90
A04-A05	15.95	31.90
A06-A09	21.95	43.90
A10-A13	28.95	57.90
A14-A17	36.95	73.90
A18-A21	42.95	85.90
A22-A25	49.95	99.90
A99	•	•
NO1	55.00	70.00
NO2	55.00	80.00

Schedule E EXCEPTION PRICE DOCUMENTS AND MICROFICHE

PRICE CODE	NORTH AMERICAN PRICE	FOREIGN PRICE
E01	\$ 9.00	18.00
E02	11.50	23.00
E03	13.00	26.00
E04	15.50	31.00
E05	17.50	35.00
E06	20.50	41.00
E07	23.00	46.00
E08	25.50	51.00
E09	28.00	56.00
E10	31.00	62.00
E11	33.50	67.00
E12	36.50	73.00
E13	39.00	78.00
E14	42.50	85.00
E15	46.00	92.00
E16	50.50	101.00
E17	54.50	109.00
E18	59.00	118.00
E19	65.50	131.00
E20	76.00	152.00
E99	•	•

*Contact NTIS for price quote.

IMPORTANT NOTICE

NTIS Shipping and Handling Charges U.S., Canada, Mexico — ADD \$3.00 per TOTAL ORDER All Other Countries — ADD \$4.00 per TOTAL ORDER

Exceptions — Does NOT apply to: ORDERS REQUESTING NTIS RUSH HANDLING ORDERS FOR SUBSCRIPTION OR STANDING ORDER PRODUCTS ONLY

NOTE: Each additional delivery address on an order requires a separate shipping and handling charge.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
NASA SP-7037 (240)			
4. Title and Subtitle		5. Report Date	
Aeronautical Engineering		June 1989	
A Continuing Bibliography (Suppleme	nt 240)	6. Performing Organization	Code
7. Author(s)		8. Performing Organization	Report No.
		10. Work Unit No.	<u>.,</u>
9. Performing Organization Name and Address	1. A		
National Aeronautics and Space Admi Washington, DC 20546	nistration	11. Contract or Grant No.	
		13. Type of Report and Pe	riod Covered
12. Sponsoring Agency Name and Address		14. Sponsoring Agency Co	ode
15. Supplementary Notes			
16. Abstract			
This bibliography lists 629 reports,	articles and other documents in	troduced into the NASA scientific	
and technical information system in	May, 1989.		
17. Key Words (Suggested by Authors(s))	18. Distribu	ution Statement	
17. Key Words (Suggested by Authors(s)) Aeronautical Engineering	18. Distribu Uncla	ution Statement assified - Unlimited	
17. Key Words (Suggested by Authors(s)) Aeronautical Engineering Aeronautics	18. Distribu Uncla	ution Statement assified - Unlimited	
17. Key Words (Suggested by Authors(s)) Aeronautical Engineering Aeronautics Bibliographies	18. Distribu Uncla	ution Statement assified - Unlimited	
17. Key Words (Suggested by Authors(s)) Aeronautical Engineering Aeronautics Bibliographies	18. Distribu Uncla	ution Statement assified - Unlimited	22 Price *
17. Key Words (Suggested by Authors(s)) Aeronautical Engineering Aeronautics Bibliographies 19. Security Classif. (of this report)	20. Security Classif. (of this page)	ution Statement assified - Unlimited 21. No. of Pages	22. Price *

*For sale by the National Technical Information Service, Springfield, Virginia 22161

1