

NASA SP-7037 (243)  
September 1989

National Aeronautics and  
Space Administration

**Aeronautical Engineering Aeronaut  
al Engineering Aeronautical Engin  
ng Aeronautical Engineering Aer  
ical Engineering Aeronautical En  
onautical Engineering Aeronau  
Engineering Aeronautical Enginee  
g Aeronautical Engineering Aero  
Engineering Aeronautic Engineer  
ering Aeronautical Engineering A  
atic al  
ng**

# AERONAUTICAL ENGINEERING

## A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 243)

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 August 1989 in

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



National Aeronautics and Space Administration  
Office of Management  
Scientific and Technical Information Division  
Washington, DC

1989

This supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161, price code A06.

# INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 423 reports, journal articles and other documents originally announced in August 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 cumulative 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

	<b>Page</b>
<b>Category 01     Aeronautics (General)</b>	<b>507</b>
<b>Category 02     Aerodynamics</b> Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.	<b>508</b>
<b>Category 03     Air Transportation and Safety</b> Includes passenger and cargo air transport operations; and aircraft accidents.	<b>522</b>
<b>Category 04     Aircraft Communications and Navigation</b> Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.	<b>524</b>
<b>Category 05     Aircraft Design, Testing and Performance</b> Includes aircraft simulation technology.	<b>527</b>
<b>Category 06     Aircraft Instrumentation</b> Includes cockpit and cabin display devices; and flight instruments.	<b>532</b>
<b>Category 07     Aircraft Propulsion and Power</b> Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.	<b>533</b>
<b>Category 08     Aircraft Stability and Control</b> Includes aircraft handling qualities; piloting; flight controls; and autopilots.	<b>538</b>
<b>Category 09     Research and Support Facilities (Air)</b> Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.	<b>541</b>
<b>Category 10     Astronautics</b> Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.	<b>544</b>
<b>Category 11     Chemistry and Materials</b> Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.	<b>545</b>

<b>Category 12     Engineering</b>	<b>551</b>
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.	
<b>Category 13     Geosciences</b>	<b>562</b>
Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.	
<b>Category 14     Life Sciences</b>	<b>N.A.</b>
Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.	
<b>Category 15     Mathematical and Computer Sciences</b>	<b>562</b>
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.	
<b>Category 16     Physics</b>	<b>564</b>
Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.	
<b>Category 17     Social Sciences</b>	<b>566</b>
Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.	
<b>Category 18     Space Sciences</b>	<b>N.A.</b>
Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.	
<b>Category 19     General</b>	<b>566</b>
 <b>Subject Index .....</b>	 <b>A-1</b>
<b>Personal Author Index .....</b>	<b>B-1</b>
<b>Corporate Source Index .....</b>	<b>C-1</b>
<b>Foreign Technology Index .....</b>	<b>D-1</b>
<b>Contract Number Index .....</b>	<b>E-1</b>
<b>Report Number Index .....</b>	<b>F-1</b>
<b>Accession Number Index .....</b>	<b>G-1</b>

# TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED  
↓  
ON MICROFICHE

ACCESSION NUMBER → **N89-10029\*** # North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering. ← CORPORATE SOURCE

TITLE → **A TRANSONIC INTERACTIVE BOUNDARY-LAYER THEORY FOR LAMINAR AND TURBULENT FLOW OVER SWEEP WINGS Final Report**

AUTHORS → SHAWN H. WOODSON and FRED R. DEJARNETTE  
Washington Oct. 1988 82 p

CONTRACT NUMBER → (Contract NCC1-22)

REPORT NUMBERS → (NASA-CR-4185; NAS 1.26:4185) Avail: NTIS HC A05/MF A01 ← PUBLICATION DATE

COSATI CODE → CSCL 01A ← PRICE CODE

AVAILABILITY SOURCE

A 3-D laminar and turbulent boundary-layer method is developed for compressible flow over swept wings. The governing equations and curvature terms are derived in detail for a nonorthogonal, curvilinear coordinate system. Reynolds shear-stress terms are modeled by the Cebeci-Smith eddy-viscosity formulation. The governing equations are discretized using the second-order accurate, predictor-corrector finite-difference technique of Matsuno, which has the advantage that the crossflow difference formulas are formed independent of the sign of the crossflow velocity component. The method is coupled with a full potential wing/body inviscid code (FLO-30) and the inviscid-viscous interaction is performed by updating the original wing surface with the viscous displacement surface calculated by the boundary-layer code. The number of these global iterations ranged from five to twelve depending on Mach number, sweep angle, and angle of attack. Several test cases are computed by this method and the results are compared with another inviscid-viscous interaction method (TAWFIVE) and with experimental data. Author

# TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED  
↓  
ON MICROFICHE

ACCESSION NUMBER → **A89-12562\*** # National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

TITLE → **EFFICIENT VIBRATION MODE ANALYSIS OF AIRCRAFT WITH MULTIPLE EXTERNAL STORE CONFIGURATIONS**

AUTHOR → M. KARPEL (NASA, Langley Research Center, Hampton, VA; Israel Aircraft Industries, Ltd., Lod) Journal of Aircraft (ISSN 0021-8669), vol. 25, Aug. 1988, p. 747-751. refs ← JOURNAL TITLE

A coupling method for efficient vibration mode analysis of aircraft with multiple external store configurations is presented. A set of low-frequency vibration modes, including rigid-body modes, represent the aircraft. Each external store is represented by its vibration modes with clamped boundary conditions, and by its rigid-body inertial properties. The aircraft modes are obtained from a finite-element model loaded by dummy rigid external stores with fictitious masses. The coupling procedure unloads the dummy stores and loads the actual stores instead. The analytical development is presented, the effects of the fictitious mass magnitudes are discussed, and a numerical example is given for a combat aircraft with external wing stores. Comparison with vibration modes obtained by a direct (full-size) eigensolution shows very accurate coupling results. Once the aircraft and stores data bases are constructed, the computer time for analyzing any external store configuration is two to three orders of magnitude less than that of a direct solution. Author

# AERONAUTICAL ENGINEERING

*A Continuing Bibliography (Suppl. 243)*

SEPTEMBER 1989

01

## AERONAUTICS (GENERAL)

**A89-36900**

### THE MATURING OF COMMERCIAL AVIATION

DUANE W. FREER (International Civil Aviation Organisation, Montreal, Canada) Exxon Air World (ISSN 0014-5068), vol. 41, no. 1, 1989, p. 45-48.

Of all the major operational factors influencing the character of commercial aviation's development over the next 50 years, none will be so profound and pervasive in its influence as that of airport capacity and the difficulty of existing capacity's expansion. This fundamental constraint will necessarily influence commercial aircraft size and design as well as fleet composition, and lead to continued regulatory encroachments on 'freedom of airspace' and a widening of current ATC restrictions. Collision-avoidance systems will be employed globally, in conjunction with satellite navigation systems. Tilt-rotor VTOL aircraft are anticipated to be a major success among the most recent design innovations. O.C.

**A89-37003#**

### THE PROBLEMS OF THE INFRARED STEALTH OF THE FLYING VEHICLES

YIHE YANG and CHANGCHENG BAI (Northwest Telecommunication Engineering Institute, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 9, Dec. 1988, p. B549-B554. In Chinese, with abstract in English. refs

The significance and direction of IR stealth research on military objects are discussed. The relationship between IR stealth and anti-IR stealth and the technical design of the IR stealth are addressed. The research has significant value for the development of IR stealth research in China today. C.D.

**A89-37875#**

### HYPERSONIC TECHNOLOGY FOR MILITARY APPLICATION

Research supported by USAF, Washington, DC, National Academy Press, 1989, 111 p.  
(Contract F49620-87-C-0122)

This comprehensive consideration of technology-readiness and prospective technology development requirements associated with hypersonic-cruise vehicles generally and the National Aerospace Plane in particular presents the consensus that has emerged to date in the joint deliberations of the Committee on Hypersonic Technology for Military Application, the USAF Studies Board, the National Research Council, and the Commission on Engineering and Technical Systems. Attention is given to the severe aerothermodynamics of hypersonic vehicles and the materials requirements that they impose, as well as recent advancements in airframe/propulsion integration. The role of CFD in further, detailed characterizations of hypersonic flow is stressed. O.C.

**A89-38514**

### FUNDAMENTALS OF AVIATION (4TH REVISED AND ENLARGED EDITION) [OSNOVY AVIATSII /4TH REVISED AND ENLARGED EDITION/]

BORIS K. GUSEV and VLADIMIR F. DOKIN Moscow, Izdatel'stvo Transport, 1988, 192 p. In Russian.

The present textbook contains the basics of aircraft and helicopter aerodynamics, general aircraft design, and operations. In particular, attention is given to the principal equations of gas motion, the structure of the earth atmosphere, and the principal concepts and laws of aerodynamics. The discussion also covers the principal components and systems of aircraft, the main types of powerplants and their systems, and the principal stages and types of flight. V.L.

**A89-38800#**

### THE JOINED WING - THE BENEFITS AND DRAWBACKS. I [ZAMKNIETE SKRZYDLO - ZALETY I WADY. I]

STANISLAW DANILECKI (Warszawa, Politechnika, Warsaw, Poland) Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol. 43, Sept. 1988, p. 4-7. In Polish.

Problems encountered in the design of an aircraft with a joined wing are examined. The advantages and disadvantages of this configuration are assessed. B.J.

**N89-22568\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

### EVALUATION OF THE RIDE QUALITY OF A LIGHT TWIN ENGINE AIRPLANE USING A RIDE QUALITY METER

ERIC C. STEWART Jun. 1989 27 p  
(NASA-TP-2913; L-16524; NAS 1.60:2913) Avail: NTIS HC A03/MF A01 CSCL 01/2

A ride quality meter was used to establish the baseline ride quality of a light twin-engine airplane planned for use as a test bed for an experimental gust alleviation system. The ride quality meter provides estimates of passenger ride discomfort as a function of cabin noise and vibration (acceleration) in five axes (yaw axis omitted). According to the ride quality meter, in smooth air the cabin noise was the dominant source of passenger discomfort, but the total discomfort was approximately the same as that for the smooth-air condition. The researcher's subjective opinion, however, is that the total ride discomfort was much worse in the moderate turbulence than it was in the smooth air. The discrepancy is explained by the lack of measurement of the low-frequency accelerations by the ride quality meter. Author

**N89-22569\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**NASA'S PROGRAM ON ICING RESEARCH AND TECHNOLOGY**  
JOHN J. REINMANN, ROBERT J. SHAW, and RICHARD J. RANAUDO 1989 55 p Presented at the Symposium on Flight in Adverse Environmental Conditions, Gol, Norway, 8-12 May 1989; sponsored by AGARD  
(NASA-TM-101989; E-4692; NAS 1.15:101989) Avail: NTIS HC A04/MF A01 CSCL 01/2

NASA's program in aircraft icing research and technology is reviewed. The program relies heavily on computer codes and modern applied physics technology in seeking icing solutions on a finer scale than those offered in earlier programs. Three major goals of this program are to offer new approaches to ice protection,

## 01 AERONAUTICS (GENERAL)

to improve our ability to model the response of an aircraft to an icing encounter, and to provide improved techniques and facilities for ground and flight testing. This paper reviews the following program elements: (1) new approaches to ice protection; (2) numerical codes for deicer analysis; (3) measurement and prediction of ice accretion and its effect on aircraft and aircraft components; (4) special wind tunnel test techniques for rotorcraft icing; (5) improvements of icing wind tunnels and research aircraft; (6) ground de-icing fluids used in winter operation; (7) fundamental studies in icing; and (8) droplet sizing instruments for icing clouds.

Author

**A89-22570#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.

### **ACTA AERONAUTICA ET ASTRONAUTICA SINICA (SELECTED ARTICLES)**

7 Feb. 1989 41 p Transl. into ENGLISH from Hong Kong Xueboa (Peoples Republic of China), v. 8, no. 12, Dec. 1987 p B578-B584, B594-B600  
(AD-A205128; FTD-ID(RS)T-0912-88) Avail: NTIS HC A03/MF A01 CSDL 01/2

The formula of requisite linear damping for overcoming landing-gear shimmy according to the point-contact theory is derived. However, the damping property of the hydraulic shimmy damper is mostly nonlinear. Two methods are presented to treat this case; the tangent method and the minimum equivalent linear damping method. Their correlation is also found. It is demonstrated by computation that both methods are effective and reliable. The requirements for measuring ground load on an aircraft is discussed. A practical data treatment method has been developed for the case that the measurement satisfy the minimum requirement. Although the method is illustrated with taxiing data, however, it is also applicable to the treatment of turning and braking load data.

Author

## 02

### **AERODYNAMICS**

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

**A89-36186#**

#### **UNSTEADY INTERACTION EFFECTS ON A TRANSITIONAL TURBINE BLADE BOUNDARY LAYER**

D. A. ASHWORTH (Rolls-Royce, PLC, Derby, England), J. E. LAGRAFF (Syracuse University, NY), and D. L. SCHULTZ (Oxford University, England) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 111, April 1989, p. 162-168. refs  
(Contract AF-AFOSR-85-0295)

The behavior of the suction surface boundary layer of a transonic gas turbine rotor in a two-dimensional cascade under the influence of both free-stream turbulence and simulated nozzle guide vane wakes and shocks is discussed. Thin film resistance thermometers were used together with electrical analogs of the one-dimensional heat conduction equations to obtain wide-bandwidth heat transfer rate measurements in a short-duration wind tunnel. A direct relationship was found between the passage of wake disturbances and transient surface heat transfer enhancements.

K.K.

**A89-36901\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

#### **EXTENSION AND APPLICATION OF FLUX-VECTOR SPLITTING TO CALCULATIONS ON DYNAMIC MESHES**

W. KYLE ANDERSON, JAMES L. THOMAS, and CHRISTOPHER L. RUMSEY (NASA, Langley Research Center, Hampton, VA) (Computational Fluid Dynamics Conference, 8th, Honolulu, HI, June

9-11, 1987, Technical Papers, p. 546-558) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 673, 674. Abridged. Previously cited in issue 18, p. 2800, Accession no. A87-42098.

**A89-36902\*#** Michigan State Univ., East Lansing.

#### **NUMERICAL AND EXPERIMENTAL EVALUATIONS OF THE FLOW PAST NESTED CHEVRONS**

J. F. FOSS (Michigan State University, East Lansing), J. K. FOSS (Southern California, University, Los Angeles, CA), and P. R. SPALART (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 675, 676.

An effort is made to contribute to the development of CFD by relating the successful use of vortex dynamics in the computation of the pressure drop past a planar array of chevron-shaped obstructions. An ensemble of results was used to compute the loss coefficient  $k$ , stimulating an experimental program for the assessment of the measured loss coefficient for the same geometry. The most provocative result of this study has been the representation of kinetic energy production in terms of vorticity source terms.

O.C.

**A89-36903#**

#### **LINEAR INSTABILITY WAVES IN SUPERSONIC TURBULENT MIXING LAYERS**

SAAD A. RAGAB (Virginia Polytechnic Institute and State University, Blacksburg) and J. L. WU AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 677-686. Previously cited in issue 19, p. 2941, Accession no. A87-44948. refs  
(Contract N00014-87-K-0168)

**A89-36904\*#** High Technology Corp., Hampton, VA.

#### **BOUNDARY-LAYER TRANSITION ON A CONE AND FLAT PLATE AT MACH 3.5**

F.-J. CHEN, M. R. MALIK (High Technology Corp., Hampton, VA), and I. E. BECKWITH (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 687-693. Previously cited in issue 07, p. 935, Accession no. A88-22303. refs

**A89-36905\*#** Boeing Helicopter Co., Philadelphia, PA.

#### **BLADE-VORTEX INTERACTION**

DAVID R. POLING, LEO DADONE (Boeing Helicopters, Philadelphia, PA), and DEMETRI P. TELIONIS (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 694-699. Previously cited in issue 09, p. 1193, Accession no. A87-24971. refs  
(Contract NGT-47-004-801)

**A89-36907#**

#### **WAKES OF FOUR COMPLEX BODIES OF REVOLUTION AT ZERO ANGLE OF ATTACK**

VEYSEL ATLI (Istanbul Technical University, Turkey) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 707-711. refs

The wakes of four complex bodies of revolution were investigated experimentally with a constant-temperature hot-wire anemometer. All tests were performed at a low Mach number (freestream Mach of about 0.1) and zero angle of attack. Mean and turbulence velocity profiles were obtained along and across the wakes. The structure of the axisymmetric wake and the effects of the geometric differences of the models on their wakes were investigated.

Author

**A89-36910#**

#### **POTENTIAL FLOW OVER BODIES OF REVOLUTION IN UNSTEADY MOTION**

PABLO GARCIA-FOGEDA, D. D. LIU (Arizona State University, Tempe), and MING-SHIN WU AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 725-733. Research supported by the U.S. Army. Previously cited in issue 21, p. 3333, Accession no. A87-48651. refs

**A89-36911\*#** Texas Univ., Austin.

**SEPARATION SHOCK MOTION IN FIN, CYLINDER, AND COMPRESSION RAMP - INDUCED TURBULENT INTERACTIONS**

D. S. DOLLING (Texas, University, Austin) and L. BRUSNIAK AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 734-742. Research sponsored by the U.S. Navy and NASA. refs (Contract AF-AFOSR-86-0112)

In conjunction with new experimental results at Mach 5, an examination has been made of published data on unsteadiness of shock-induced turbulent boundary-layer separation. The data are all wall pressure fluctuation measurements made under the unsteady separation shock and are from interactions induced by compression ramps, blunt and sharp fins, and circular cylinders. There is little evidence of a link between the separation shock zero-crossing frequency and characteristic frequency of the incoming boundary layer. The low shock frequencies and low shock speeds, and the trends with changes in model geometric parameters and incoming boundary layer, suggest that turbulent or global fluctuations at the upstream boundary of the separated flow drive the shock motion. Author

**A89-36912\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**EXPLICIT RUNGE-KUTTA METHOD FOR UNSTEADY ROTOR/STATOR INTERACTION**

PHILIP C. E. JORGENSEN and RODRICK C. CHIMA (NASA, Lewis Research Center, Cleveland, OH) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 743-749. Previously cited in issue 10, p. 1477, Accession no. A88-27715. refs

**A89-36914#**

**AERO-OPTICAL ANALYSIS OF COMPRESSIBLE FLOW OVER AN OPEN CAVITY**

PHILIP E. CASSADY, STANLEY F. BIRCH, and P. JOHN TERRY (Boeing Aerospace, Seattle, WA) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 758-762. Research supported by Boeing Aerospace and Boeing Commercial Airplanes. Previously cited in issue 19, p. 2941, Accession no. A87-44943. refs

**A89-36922\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**SEPARATION CONTROL ON AN AIRFOIL BY PERIODIC FORCING**

A. BAR-SEVER (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 820, 821. refs

The introduction of transverse velocity fluctuations into a separated shear layer on an airfoil at high angles of attack is presently demonstrated to be an effective separation-control technique. Airfoil aerodynamic characteristics, including poststall lift and drag as well as maximum lift coefficient and stall angle, all exhibited improvements controlled forcing at 20 deg angle of attack led to an increased spreading of the mean velocity profile, together with increased turbulence activity; separation moved from the leading edge to about 80 percent of chord. O.C.

**A89-36923#**

**MODELING OF DENSITY FLUCTUATIONS IN SUPERSONIC TURBULENT BOUNDARY LAYER**

STEVEN A. LUTZ (Johns Hopkins University, Laurel, MD) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 822, 823. Research sponsored by the U.S. Army. refs (Contract N00039-87-C-5301)

A method is presented for the determination of the density fluctuation profile in a compressible, turbulent boundary layer which is based on the Crocco-Busemann temperature solutions' differential form. Local density fluctuations were determined on the basis of thermal anemometry; a comparison of model results with adiabatic-wall, supersonic turbulent boundary layer data has shown good agreement. Model results are unable to predict the quantitative behavior of nonadiabatic-wall, turbulent boundary layer data. O.C.

**A89-36985#**

**A METHOD FOR SHOCK-FREE WING DESIGN**

ZI QIANG ZHU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 9, Nov. 1988, p. A499-A508. In Chinese, with abstract in English. refs

A method for shock-free wing design using the 'fictitious gas' concept is introduced. The main points of this method are briefly described. Several fictitious gas laws are presented. A space-matching procedure adopted in supersonic flow region is concretely explained. The gain in two- or three-dimensional design conditions and off-design conditions is also discussed. Finally, an engineering approach for nearly shock-free wing design is introduced. Author

**A89-36986#**

**TRANSFINITE INTERPOLATION METHOD FOR 3-D GRID GENERATIONS**

JUNHUI LIU and TIEYOU MA (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 9, Nov. 1988, p. A509-A514. In Chinese, with abstract in English.

This paper presents a study of transfinite interpolation grid generation. The developed procedure is used to generate two-dimensional grids around airfoils and three-dimensional ones around wing-body configurations. As a noniterative method, it requires less computational work and can be applied to different grid topologies. The computational results show the effectiveness of the present method. Author

**A89-36987#**

**LATERAL INDUCED VELOCITY DISTRIBUTION OF A HELICOPTER ROTOR**

SHICUN WANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 9, Nov. 1988, p. A515-A520. In Chinese, with abstract in English. refs

In order to clarify the essential features of the lateral induced velocity distributions of a helicopter rotor, the contributions of circulations  $\Gamma(0)$  and  $\Gamma(1s)$  to the sine component of the induced velocity are analyzed based on classical vortex theory. Using the flapping condition of the rotor blade, a critical radius position is found. On the outboard blade (outside the critical radius position) the induced velocity on the advancing side is smaller than that on the retreating side, while on the inboard blade (inside of the critical radius position) the induced velocity on the advancing side is larger than that on the retreating side. This conclusion is experimentally verified. C.D.

**A89-37355**

**AERODYNAMIC CHARACTERISTICS OF ARBITRARILY ROTATING BODIES IN A VARIABLE-DENSITY GAS [AERODINAMICHESKIE KHKARISTIKI PROIZVOL'NO VRASHCHAIUSHCHIKHSIA TEL V GAZE RAZLICHNOI RAZREZHENNOSTI]**

A. I. BUNIMOVICH and A. V. DUBINSKII Kosmicheskie Issledovaniia (ISSN 0023-4206), vol. 27, Mar.-Apr. 1989, p. 180-185. In Russian. refs

**A89-37460**

**A NUMERICAL METHOD FOR THE ANALYSIS OF A FLIGHT VEHICLE WITH A SOLID FUSELAGE [CHISLENNYI METOD RASCHETA LETATEL'NOGO APPARATA S TELESNYM FIUZELIAZHEM]**

E. D. KOVALEV, I. K. LIFANOV, A. A. MIKHAILOV, M. I. NISHT, and G. G. POLIKARPOV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669), vol. 29, April 1989, p. 589-597. In Russian. refs

The paper is concerned with flow of an ideal incompressible fluid past (1) a plane with a fuselage in the form of a smooth closed surface and a plane wing and (2) a helicopter with a solid piecewise plane fuselage and a thin rotor. The problem is solved

by the method of discrete vortices based on the use of closed vortex filaments. V.L.

**A89-37653\*#** Pennsylvania State Univ., University Park.

### SHOCK STRUCTURE IN NON-CIRCULAR JETS

PHILIP J. MORRIS and THOMAS R. S. BHAT (Pennsylvania State University, University Park) AIAA, Aeroacoustics Conference, 12th, San Antonio, TX, Apr. 10-12, 1989. 10 p. refs

(Contract NAG1-657)

(AIAA PAPER 89-1083)

The shock-cell structure of supersonic jets with non-circular exit geometry is modeled using a linearized analysis. The model takes into account the finite thickness of the jet shear layer using realistic velocity and density profiles. The effects of the shear layer turbulence are included by incorporating eddy-viscosity terms. A finite-difference numerical method is used to solve the steady linearized equations of motion. A body-fitted coordinate system is used to describe the shear layer. The variation of the pressure fluctuation with downstream distance is given for circular jets and for an elliptic jet of aspect ratio 2.0. Comparisons with experimental data are made. Difficulties with the numerical technique are also discussed. Author

**A89-37776#**

### ON THE UNSTEADY LEADING EDGE SUCTION OF A SWEEPBACK WING

ZHENHAO LI (Chinese Helicopter Research and Development Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 1-11. refs

The unsteady flowfield near the leading edge of an oscillating sweepback wing is obtained by using three-dimensional subsonic lifting surface theory. It is shown that this flowfield is composed of two parts: (1) a continuous part and (2) a singular part. The formula of leading edge suction is derived theoretically. The famous assumption that the leading edge suction depends only on the nature of the velocity at and perpendicular to this edge has been substantiated analytically and extended to unsteady flow. Author

**A89-37777#**

### THE COMPUTATION OF THE VISCOUS/INVISCID INTERACTION

ZIJIANG ZHU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 12-25. In Chinese, with abstract in English. refs

Different computational methods and results of viscous/inviscid interaction are reviewed in this paper. The emphasis is placed on introduction to the computation of the weak interaction in the steady flow. The mathematical model of the weak interaction is described at first. Using direct coupling, some results of viscous/inviscid interaction are given in both incompressible and transonic flow. Why direct mode of boundary layer fails near separation is discussed. The inverse mode of boundary layer and the semiinverse coupling between viscous/inviscid interaction for flow with separation region are then described. Application in the three-dimensional case and strong interaction are also briefly reviewed in this paper. Author

**A89-37778#**

### AN EXPLICIT MULTISTAGE FINITE-AREA METHOD FOR 2D TRANSONIC FLOW CALCULATIONS

LEI WANG and FENGGAN ZHUANG (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 26-33. In Chinese, with abstract in English. refs

Based on the work of Jameson et al. (1981), an explicit multistage finite-area method is established and the formula for coefficients of the artificial viscosity terms is suggested in analogy to upwind schemes. The numerical results for NACA0012 and RAE2822 airfoils show that for the proposed method, effective capture of shock waves can be obtained and the suitable values of the coefficient of the added viscosity term do not have to be changed from case to case. Author

**A89-37779#**

### ROTOR VORTEX WAKE DISTORTION AND ITS INDUCED VELOCITY IN GROUND EFFECT AT LOW SPEED

MAO SUN (Beijing University of Aeronautics and Astronautics, People's Republic of China) and H. C. CURTISS, JR. (Princeton University, NJ) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 35-41. In Chinese, with abstract in English. refs

The vortex wake and its induced velocity of a helicopter rotor operating near the ground at low forward speeds have been studied using a simplified free wake-ground vortex model. The vortex wake near the rotor plane is distorted significantly because of the flowfield of the ground and ground vortex, resulting in large variation on the induced velocity distribution at the rotor plane, especially near the rotor leading edge. The variation of the induced velocity distribution at the rotor plane caused by the ground and ground vortex through distorting the rotor near-wake is much larger than that induced directly by the ground and ground vortex. The free wake-ground vortex model can be used to predict the induced velocity distribution at the rotor plane with reasonable accuracy. Author

**A89-37780#**

### THE EFFECTS OF VORTEX BREAKDOWN ON THE AERODYNAMIC PROPERTIES OF A WING AND THE ENGINEERING PREDICTING METHOD

HUIYANG MA (University of Science and Technology of China, Hefei, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 43-49. In Chinese, with abstract in English.

This paper introduces the effects of vortex breakdown on the longitudinal and lateral aerodynamic properties of a delta wing. On the foundation of experimental measurements the engineering predicting method is developed. Author

**A89-37782#**

### INVESTIGATION OF MACH REFLECTION FOR A PLANAR MOVING SHOCK PROPAGATING INTO STEADY SUPERSONIC FLOW FIELD AROUND WEDGE

XIEZHEN YIN and ZHAOYUAN HAN (University of Science and Technology of China, Hefei, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 67-74. In Chinese, with abstract in English. refs

The experiment of Mach reflection for a planar moving shock propagating into a steady supersonic flowfield around a wedge was conducted in a double driver shock tunnel. The reflection phenomenon is pseudo-stationary. Reflections of four different types (RR, SMR, CMR and DMR) were observed in the experiment. The angles of the first-triple-point and the kink and the transition boundaries between various reflections were calculated. It is found that the angles and the transition boundaries in the plane depended on the steady supersonic flow Mach number ahead of the moving shock, whereas the boundaries in another plane do not. Author

**A89-37785#**

### EXPERIMENTAL INVESTIGATION OF AERODYNAMIC HEATING BY FLOW THROUGH CONTROL SURFACE GAPS

GUIMING TANG (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 88-93. In Chinese, with abstract in English. refs

Detailed aerodynamic heating distributions were measured over a flat plate equipped with a flap and inside the gap between the plate and the flap in order to study the effects of gap width, flap deflection, Reynolds number, and Mach number on thermal environment in the flap gap. Various flap deflection angles with variable leakage were used. The results indicate that the ratio of gap heating rate to local plate value increases with flap deflection, free-stream Reynolds number, and increases with Mach number for turbulent external flow. In the case of attached flow on the plate ahead of the flap, turbulent heating distributions on both the plate and the flap are not affected by gap leakage. Within the gap, a separation bubble develops on the upstream face of the

gap. The heating peak occurs at an attached point at a distance of two to three times the width of the gap from the entrance where low heating rate occurs. C.D.

**A89-37787#**

**THE APPLICATION OF THE TWO-DIMENSIONAL UNSTEADY EULER EQUATIONS PERTURBATION SOLUTIONS ON THE SUPERSONIC RECTANGULAR WINGS**

JINGSONG CHEN (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 102-107. In Chinese, with abstract in English. refs

In this paper, the approximate analysis solutions of aerodynamic coefficients are given, which belong to plunging and pitching oscillating supersonic rectangular wings. The solutions are that the frequency perturbation solutions of two-dimensional unsteady Euler equations for oscillating supersonic flat plate combine with the loading coefficient analysis solution of the steady supersonic linearized theory for the rectangular wings. Numerical results are presented which confirm the accuracy and very high efficiency of the method. The present method is an efficient computation method of unified supersonic and hypersonic unsteady aerodynamic forces for rectangular wings. Author

**A89-37790#**

**THE CONSTRAINT WAKE ANALYSIS FOR HOVERING ROTORS**

WUJIANG LOU and CHICUN WANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 117-122. In Chinese, with abstract in English. refs

The concept of the constraint wake analysis is applied to hovering helicopter rotors, which leads to the development of the Constraint Wake Analysis for Hovering Rotors (CWAHR). The CWAHR is characterized by a lifting line vortex system, a self-persevering hover wake model, an accelerated distorting formula, and a dual-exponential relation of the wake boundary which is derived from the prescribed wake equations and taken as a geometrical constraint of the procedure. The CWAHR shows higher accuracy when compared with other data sources, and a high convergent speed. It is believed that the CWAHR will be applicable for all rotor design geometries when further modifications are included. Author

**A89-37791#**

**AF-2 SCHEME FOR SOLUTION OF AXIAL SYMMETRIC TRANSONIC INLET-FLOWFIELD**

YINGKAI YANG (Chengdu Aircraft Co., Development Div., People's Republic of China), HUILI SHEN, and SHIJUN LUO (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 123-129. In Chinese, with abstract in English. refs

An AF-2 scheme of the axisymmetric small transverse potential equation is formulated and applied in solving external and internal transonic flow about an IC inlet. A linearized analysis of stability for AF-2 scheme is carried out. Analysis shows that the stability of AF-2 is better than SLOR, and the speed of convergence of AF-2 is at least 10 times than that of SLOR. Author

**A89-37792#**

**NONLINEAR SUPERSONIC POTENTIAL FLOW OVER SIDESLIP CONICAL BODIES, DELTA WINGS AND FUSELAGES**

HONGQUAN CHEN and MINGKE HUANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 130-134. In Chinese, with abstract in English. refs

The governing equation of supersonic nonlinear full-potential flow past aircraft in the spherical crossflow plane has the salient mathematical features of two-dimensional transonic potential flow. Thus, a marching technique can be developed through the application of Jameson's rotated difference scheme and line relaxation iteration for capture of both bow and embedded shocks.

The results obtained by this technique in this paper are presented first for the sideslip conical bodies such as model delta wings of thin-elliptic cones and then for the nonconical bodies such as wings of practical configuration, noncircular sectional fuselages with their canopies, and are compared with available experimental data, Euler's equation solutions, and the results from linearized theories. A fixed-mesh nose shock fitting technique which reduces many mesh points so as to further reduce the computation time has been developed. Author

**A89-37939**

**CONDENSATION PHENOMENA IN A TURBINE BLADE PASSAGE**

S. A. SKILLINGS (Central Electricity Generating Board, Central Electricity Research Laboratories, Leatherhead, England) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 200, March 1989, p. 409-424. refs

Experiments are performed to investigate the behavior of condensing steam flows in a turbine blade passage. The significance of droplet nucleation in modifying the single-phase flow structure is shown, and results are presented showing the change in shock wave pattern when inlet superheat and outlet Mach number are varied. Implications of these results for turbine performance are also discussed. S.A.V.

**A89-38122**

**MACH NUMBER EFFECTS ON HIGH-ANGLES-OF-ATTACK AERODYNAMIC CHARACTERISTICS OF A CONE-CYLINDER WITH VARIOUS NOSE SHAPES**

HIROTOSHI KUBOTA (Tokyo, University, Japan), KIYOSHI SATO, TATSUYA TANIKATSU (Institute of Space and Astronautical Science, Sagami-hara, Japan), KOJIRO SUZUKI, TSUYOSHI ISHIHARA et al. IN: International Symposium on Space Technology and Science, 16th, Sapporo, Japan, May 22-27, 1988, Proceedings. Volume 1. Tokyo, AGNE Publishing, Inc., 1988, p. 709-714.

Static aerodynamic characteristics of nonyawed high-angle-of-attack cone-cylinders are investigated in transonic wind tunnel testing. The effects of Mach number and attack angle are discussed. The tripping wire method is adopted for side force alleviation and its effectiveness is studied. The schlieren photograph and the fluorescent mini-tuft method are used to visualize such high-speed vortex-dominant flow fields. Author

**A89-38123**

**EXPERIMENTAL INVESTIGATION OF APPLICABILITY OF WAVERIDER CONFIGURATION TO HYPERSONIC TRANSPORT AND AEROSPACE-PLANE**

KOICHI HOZUMI and SHIGEYAMA WATANABE (National Aerospace Laboratory, Chofu, Japan) IN: International Symposium on Space Technology and Science, 16th, Sapporo, Japan, May 22-27, 1988, Proceedings. Volume 1. Tokyo, AGNE Publishing, Inc., 1988, p. 715-724. refs

The aerodynamic characteristics of a series of cone-derived waverider configurations are examined with a view of the application of such configurations to the Hypersonic Transport. For an optimized configuration and its variations, six-component tests at  $M = 7.1$  at angle of attack between  $-12$  and  $10$  deg and side-slip angle of  $0$  deg are performed in a blow-down hypersonic wind tunnel. From comparisons between present aerodynamic data and those of conventional flat-bottom type configurations, high  $L/D$  and low lift characteristics of the present configurations are confirmed. The merits of the present cone-derived waveriders having high  $L/D$  and low lift characteristics relative to the aerodynamic behavior of HST configurations having high  $L/D$  and high lift characteristics are discussed. Author

**A89-38124**

**NUMERICAL SIMULATION OF SUPERSONIC FLOWS PAST A SPACE-PLANE**

SUSUMU TAKANASHI (National Aerospace Laboratory, Chofu, Japan), KISA MATSUSHIMA (Fujitsu, Ltd., Ota, Japan), and KOZO FUJII (Institute of Space and Astronautical Science, Sagami-hara,



Japan) IN: International Symposium on Space Technology and Science, 16th, Sapporo, Japan, May 22-27, 1988, Proceedings. Volume 1. Tokyo, AGNE Publishing, Inc., 1988, p. 731-742. refs

Supersonic flows past a research model of a spaceplane are simulated numerically. A single block O-C grid is generated around the model and the Reynolds-average thin-layer Navier-Stokes equations are solved using the implicit finite difference method based on an upwind TVD scheme. The predicted lift, drag, and moment are compared with experimental data, showing fairly good agreement. R.B.

**A89-38125**  
**HIGHLY-RESOLVED FLOWFIELD INDUCED BY MACH REFLECTION**

TADAYOSHI SUGIMURA (Meijo University, Nagoya, Japan) and TOSHI FUJIWARA (Nagoya University, Japan) IN: International Symposium on Space Technology and Science, 16th, Sapporo, Japan, May 22-27, 1988, Proceedings. Volume 1. Tokyo, AGNE Publishing, Inc., 1988, p. 743-748. refs

The interaction between the chemical reaction and shear flow behind a Mach reflection shock is examined, focusing on the ignition mechanism caused by the interaction. Using the two-dimensional Euler equations where the incident Mach number is 3, the flow around a forward-facing step is solved, neglecting the chemical reaction. It is found that, by increasing the resolution, the flowfield is changed to generate a more conspicuous shear layer behind the first Mach reflection from the upper surface of the forward-facing step. R.B.

**A89-38129**  
**INVISCID, UNSTEADY, TRANSONIC AXISYMMETRIC FLOW WITH SHOCK WAVES - RESPONSE TO TIME AND SPACE-TIME DEPENDENT PERTURBATIONS**

CARLOS FREDERICO EST ALVES (Centro Tecnico Aeroespacial, Instituto de Atividades Espaciais, Sao Jose dos Campos, Brazil) and DEMETRIO BASTOS-NETTO (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil) IN: International Symposium on Space Technology and Science, 16th, Sapporo, Japan, May 22-27, 1988, Proceedings. Volume 1. Tokyo, AGNE Publishing, Inc., 1988, p. 775-780. refs

The problem of an inviscid, unsteady, transonic, axisymmetric flow is discussed and results are presented using analytical and numerical methods. The flow is described using the method of asymptotic expansions for the velocity potential. A weak shock was assumed to be present downstream of the throat and disturbances were assumed to exist at a given location, downstream of the shock. The occurrence of discontinuities in the solution near the throat and the shock leads to the need of inner solutions for these regions. Numerical results are given for known initial conditions and profiles. The imposed perturbations - which can be either time or space-time dependent - were chosen to be trigonometric and hypergeometric functions modulated by a step functional. Author

**A89-38426**  
**SOME PROPERTIES OF NONISENTROPIC TRANSONIC FLOWS [NEKOTORYE SVOISTVA NEIZENTROPICHESKIKH TRANSVUKOVYKH TECHENII]**

G. G. VILENSKII Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), Jan. 1989, p. 50-54. In Russian. refs

Solutions to the plane and axisymmetric Laval nozzle problem that are linear with respect to the longitudinal coordinate are obtained for an arbitrary entropy function using the transonic approximation. The use of physical variables results in an accurate representation of the flow pattern for any form of entropy. It is found that the change of the position of the sonic line relative to the critical section may differ significantly from the classical case for small accelerations. The importance of considering the characteristics of vortex flows in the modeling of nonisentropic problems is emphasized. V.L.

**A89-38427**  
**APPROXIMATE CALCULATION OF SUPERSONIC FLOW PAST BODIES OF REVOLUTION WITH A FRONT SEPARATION ZONE AT A SMALL ANGLE OF ATTACK [PRIBLIZHENNYI RASCHET SVERKHZVUKOVOGO OBTEKANIIA TEL VRASHCHENIIA S PEREDNEI SRYVNOI ZONOI POD NEBOL'SHIM UGLOM ATAKI]**

E. F. ZHIGALKO Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), Jan. 1989, p. 58-61. In Russian. refs

A computational model based on a modified coarse-particle method is applied to the analysis of the restructuring of supersonic flow past bodies of revolution with a front separation zone at a small angle of attack. Details of the numerical solution are presented for a circular cylinder and an axisymmetric disk-cylinder configuration in the path of supersonic flow at a small angle of attack. V.L.

**A89-38432**  
**CONSIDERATION OF THE EFFECT OF SURFACE ROUGHNESS ON REGIME COEFFICIENTS IN LOCAL INTERACTION THEORY [UCHET VLIIANIIA SHEROKHOVATOSTI POVERKHNOSTI NA KOEFFITSIENTY REZHIMA V TEORII LOKAL'NOGO VZAIMODEISTVIA]**

V. D. KHABALOV Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), Jan. 1989, p. 80-83. In Russian. refs

A simple numerical method is proposed for calculating regime coefficients and aerodynamic characteristics of bodies in free molecular flow of a rarefied gas. To improve the accuracy of aerodynamic calculations, the effect of surface roughness of the body is considered under the assumption that reflection from a smooth surface conforms to local interaction theory. The results indicate that the method proposed here can be used for calculating the aerodynamic characteristics of bodies with an accuracy sufficient for practical applications. V.L.

**A89-38435**  
**DEPENDENCE OF REGIME COEFFICIENTS ON REGIME PARAMETERS IN LOCAL INTERACTION THEORY [ZAVISIMOST' KOEFFITSIENTOV REZHIMA V TEORII LOKAL'NOGO VZAIMODEISTVIA OT PARAMETROV REZHIMA]**

O. A. AKSENOVA Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), Jan. 1989, p. 100-102. In Russian.

The dependence of regime coefficients on regime parameters (Re number and temperature factor) is determined in the context of local interaction theory. A known approximation of the impulse flow based on experimental data is transformed for a simple model using a decomposition in terms of Legendre polynomials. As a result, the calculation of the aerodynamic characteristics and regime coefficients is simplified without any loss of accuracy. V.L.

**A89-38437**  
**NONSTATIONARY SUPERSONIC FLOW PAST A BODY [O NESTATSIONARNOM SVERKHZVUKOVOM OBTEKANII TELA]**

V. I. BOGATKO and G. A. KOLTON Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), Jan. 1989, p. 104-106. In Russian.

The problem of flow past a body moving with a variable supersonic velocity in a stationary gas is investigated analytically. In particular, the effect of the initial conditions on the characteristics of flow past a wedge-shaped body is examined using the formalism of singular perturbation theory. V.L.

**A89-38438**  
**STABILITY OF GAS FLOWS IN LAVAL NOZZLES [USTOICHIVOST' TECHENII GAZA V SOPLAKH LAVALIA]**

A. G. KUZ'MIN Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), Jan. 1989, p. 108-110. In Russian. refs

Results of a study of the stability of transonic gas flows with

respect to infinitely small nonstationary perturbations of nozzle wall shape and conditions at the nozzle inlet section are presented. Attention is also given to transonic MHD flows; the stability of these flows against stationary perturbations is analyzed. V.L.

A89-38445

**A STUDY OF SHOCK WAVE RADIATION NEAR MODELS AT HYPERSONIC VELOCITIES IN AIR [ISSLEDOVANIIE IZLUCHENIIA UDARNOGO SLOIA OKOLO MODELEI, LETIASHCHIKH V VOZDUKHE S GIPERZVUKOVYMI SKOROSTIAMI]**

N. N. BAULIN, O. V. ZVEREV, N. N. PILIUGIN, and S. G. TIKHOMIROV (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) *Teplofizika Vysokikh Temperatur* (ISSN 0040-3644), vol. 27, Mar.-Apr. 1989, p. 306-311. In Russian. refs

A method is proposed for measuring the brightness of gas emission at a wavelength of 0.63 microns in a ballistic experiment. Experimental data are presented on the brightness of air emission in a shock layer near models moving at velocities of 4-6 km/s. Good agreement is obtained between the calculated and measured spectral emissivities of air, making it possible to determine temperature in the shock layer with an accuracy to within 7 percent. V.L.

**A89-38553\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**AN EXPERIMENTAL AND COMPUTATIONAL STUDY OF ROTOR-VORTEX INTERACTIONS**

FRANCIS X. CARADONNA, ROGER C. STRAWN (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA), and JOHN O. BRIDGEMAN (Woodside Summit Group, Inc., Mountain View, CA) *Vertica* (ISSN 0360-5450), vol. 12, no. 4, 1988, p. 315-327. refs

An experimental and computational study has been performed on a close rotor-blade/vortex interaction. Surface pressure data was obtained from a rotor operating close to the tip-vortex from an upstream wing in a wind tunnel. Data was obtained for a wide range of blade-vortex proximities, orientations, and blade-tip Mach numbers (up to the transonic regime). A numerical model of these interactions was constructed using the unsteady, three-dimensional, full-potential rotor code called FPR. The model employed an undistorted full-field representation of the measured vortex. This simple model gave excellent comparisons with the data for a wide range of conditions, including parallel head-on interactions. Computational studies have also been performed on the manner of vortex representation and the influence of vortex-core size.

Author

**A89-38555\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**ANALYTICAL MODELING OF HELICOPTER STATIC AND DYNAMIC INDUCED VELOCITY IN GRASP**

DONALD L. KUNZ (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) and DEWEY H. HODGES (Georgia Institute of Technology, Atlanta) (University of Missouri-Rolla, International Conference on Mathematical Modelling, 6th, Saint Louis, MO, Aug. 4-7, 1987) *Vertica* (ISSN 0360-5450), vol. 12, no. 4, 1988, p. 337-344. Previously announced in STAR as N88-10777. refs

The methodology used by the General Rotorcraft Aeromechanical Stability Program (GRASP) to model the characteristics of the flow through a helicopter rotor in hovering or axial flight is described. Since the induced flow plays a significant role in determining the aeroelastic properties of rotorcraft, the computation of the induced flow is an important aspect of the program. Because of the combined finite-element/multibody methodology used as the basis for GRASP, the implementation of induced velocity calculations presented an unusual challenge to the developers. To preserve the modelling flexibility and generality of the code, it was necessary to depart from the traditional methods of computing the induced velocity. This is accomplished by calculating the actuator disk contributions to the rotor loads in a

separate element called the air mass element, and then performing the calculations of the aerodynamic forces on individual blade elements within the aeroelastic beam element. Author

A89-38578

**MORE HELICOPTER AERODYNAMICS**

RAY W. PROUTY Peoria, IL, PJS Publications, Inc., 1988, 114 p.

A comprehensive introductory treatment is presented for the operating principles, aerodynamics, and prospective design developments of rotary-wing aircraft, with attention to the complex aerodynamic interactions that arise between helicopter propulsion system and airframe components in such distinct operational phases as hover, fast forward flight, and maneuvering. The peculiarities of helicopter piloting that these complex interactions give rise to are discussed. Evaluations are given of the impact on helicopter design and performance of such emerging factors as fly-by-wire, low military observability, CFD, advancing-plate concept coaxial rotors, and 'smart' control systems. O.C.

**A89-38614\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**ESTIMATION OF AIRCRAFT AERODYNAMIC PARAMETERS FROM FLIGHT DATA**

VLADISLAV KLEIN (NASA, Langley Research Center; George Washington University, Hampton, VA) *Progress in Aerospace Sciences* (ISSN 0376-0421), vol. 26, no. 1, 1989, p. 1-77. refs

Several ways for obtaining aerodynamic parameters of an aircraft from flight data are presented. A brief description of data analysis from steady measurements is given, and a concept of system identification is introduced. This is followed by a mathematical model of an aircraft with aerodynamic forces and moments approximated either by polynomials or splines and a detailed treatment of two often-used techniques for parameter estimation. Because of renewed interest in frequency-domain analysis, one section of the paper is devoted to this problem. The methods are demonstrated in several examples using real flight data. Author

A89-38620

**PULSATING FLOW OVER AN ELLIPSE AT AN ANGLE OF ATTACK**

D. S. MATHIOULAKIS and D. P. TELIONIS (Virginia Polytechnic Institute and State University, Blacksburg) *Journal of Fluid Mechanics* (ISSN 0022-1120), vol. 201, April 1989, p. 99-121. refs

(Contract AF-AFOSR-82-0228)

Two-component LDV measurements are obtained over an ellipse at an angle of attack. Detailed information is provided for the stagnation region, the two separation regions and the two free shear layers. Steady and unsteady flow measurements are presented. Periodic disturbances in the oncoming stream are introduced and ensemble-averaged unsteady data are obtained. An integral picture of laminar flow over a lifting body with no sharp edges is thus presented, which is readily available for comparison with asymptotic or numerical calculations. Author

**A89-38624\*** Florida State Univ., Tallahassee.

**ON THE THREE FAMILIES OF INSTABILITY WAVES OF HIGH-SPEED JETS**

CHRISTOPHER K. W. TAM and FANG Q. HU (Florida State University, Tallahassee) *Journal of Fluid Mechanics* (ISSN 0022-1120), vol. 201, April 1989, p. 447-483. refs  
(Contract NAG1-421; N0014-87-J-1130)

An analytical and computational study of the normal-mode small-amplitude waves of high-speed jets is presented. Three families of instability waves have been identified: (1) the familiar Kelvin-Helmholtz instability waves; (2) supersonic instability waves; and (3) subsonic waves. It is demonstrated that the computed wave patterns and propagation characteristics of these three wave types are consistent with the findings of Oetel (1979, 1980, 1982). The subsonic waves are shown to be unstable only for jets with mixing layers of finite thickness. R.R.

A89-38873

**ISOTHERMAL FLOW IN A GAS TURBINE COMBUSTOR - A BENCHMARK EXPERIMENTAL STUDY**

P. KOUTMOS and J. J. MCGUIRK (Imperial College of Science and Technology, London, England) Experiments in Fluids (ISSN 0723-4864), vol. 7, no. 5, April 1989, p. 344-354. Research supported by the Ministry of Defence. refs

An experimental investigation of the three-dimensional flow field within a water model of a can-type gas turbine combustion chamber is presented. Flow visualization demonstrated that internal flow patterns simulated closely those expected in real combustors. The combustor comprised a swirl driven primary zone, annulus fed primary and dilution jets and an exit contraction nozzle. LDA measurements of the three mean velocity components and corresponding turbulence intensities were obtained to map out the flow development throughout the combustor. Besides providing information to aid understanding of the complex flow events inside combustors, the data are believed to be of sufficient quantity and quality to act as a benchmark test case for the assessment of the predictive accuracy of computational models for gas-turbine combustors. Author

A89-38939

**NOTE ON THE LIFTING-SURFACE PROBLEM FOR A CIRCULAR WING IN INCOMPRESSIBLE FLOW**

J. BOERSMA (Eindhoven, Technische Universiteit, Netherlands) Quarterly Journal of Mechanics and Applied Mathematics (ISSN 0033-5614), vol. 42, Feb. 1989, p. 55-64. refs

The lifting-surface problem for thin circular wings in steady incompressible potential flow is investigated analytically, with a focus on the solution obtained using linearized theory by Hauptman and Miloh (1986). The derivation is examined in detail, and numerical results for a plane wing and a wing with parabolic camber are presented in tables. It is shown that the solution of Hauptman and Miloh does not rigorously satisfy the prescribed-wing-downwash boundary condition and hence represents only an approximate solution to the problem. T.K.

A89-39034\*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**THREE-DIMENSIONAL NAVIER-STOKES SIMULATIONS OF TURBINE ROTOR-STATOR INTERACTION. I - METHODOLOGY**

MAN MOHAN RAI (NASA, Ames Research Center, Moffett Field, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, May-June 1989, p. 305-319. Previously cited in issue 20, p. 3143, Accession no. A87-45386. refs

A89-39035#

**NAVIER-STOKES COMPUTATIONS OF TWO- AND THREE-DIMENSIONAL CASCADE FLOWFIELDS**

KAZUHIRO NAKAHASHI (Osaka Prefecture, University, Sakai, Japan), OSAMU NOZAKI, KAZUO KIKUCHI, and ATSUSHI TAMURA (National Aerospace Laboratory, Tokyo, Japan) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, May-June 1989, p. 320-326. Previously cited in issue 18, p. 2807, Accession no. A87-42381. refs

A89-39038\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**NUMERICAL SIMULATION OF FLOW THROUGH A TWO-STRUT SCRAMJET INLET**

AJAY KUMAR (NASA, Langley Research Center, Hampton, VA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, May-June 1989, p. 341-345. refs

A three-dimensional, Reynolds-averaged Navier-Stokes code has been used to numerically analyze flow through a two-strut, supersonic combustion ramjet (scramjet) inlet configuration. It solves the governing equations in full conservation form using either a fully explicit or explicit-implicit method. An algebraic, two-layer eddy-viscosity model is used for turbulent flow calculations. The analysis allows inclusion of end effects that are caused by the aft placement of the cowl on the underside of the inlet. A special grid has been developed to accommodate the

struts embedded in the inlet flowfield. Detailed numerical results are presented here for the two-strut configuration, and a comparison is made with the available experimental results. Author

A89-39039#

**EXPERIMENTAL INVESTIGATION OF SHOCK WAVE/BOUNDARY-LAYER INTERACTIONS IN AN ANNULAR DUCT**

RICHARD D. STOCKBRIDGE (Johns Hopkins University, Laurel, MD) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, May-June 1989, p. 346-352. Previously cited in issue 07, p. 930, Accession no. A88-22199. refs  
(Contract N00039-87-C-5301)

A89-39185\*# Kansas Univ., Lawrence.

**EXPERIMENTAL INVESTIGATION OF DYNAMIC GROUND EFFECT**

PAI-HUNG LEE, C. EDWARD LAN, and VINCENT U. MUIRHEAD (Kansas, University, Lawrence) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 497, 498. Previously announced in STAR as N88-12458.  
(Contract NAG1-616)

A 60-degree delta wing, an F-106B, and an XB-70 model with and without flap deflections were tested in static and dynamic ground effect in the 36-by-51-inch subsonic wind tunnel at the University of Kansas. Dynamic ground effect was measured with movable sting support. For flow visualization, a tufted wire grid was mounted on the movable sting behind the model. Test results showed that lift and drag increments in dynamic ground effect were always lower than static values. Effect of the trailing edge flap deflections on lift increments was slight. The fuselage reduced the lift increments at a given ground height. From flow visualization under static conditions, the vortex core was seen to enlarge as the ground was approached. Author

A89-39187#

**INFLUENCE OF PITCHING MOTION ON SUBSONIC WING ROCK OF SLENDER DELTA WINGS**

J. M. ELZEBDA, D. T. MOOK, and A. H. NAYFEH (Virginia Polytechnic Institute and State University, Blacksburg) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 503-508. Previously cited in issue 09, p. 1193, Accession no. A87-24970. refs  
(Contract AF-AFOSR-85-0158)

A89-39188#

**NUMERICAL SIMULATION OF THE UNSTEADY WAKE BEHIND AN AIRFOIL**

D. T. MOOK, S. ROY, G. CHOKSI, and B. DONG (Virginia Polytechnic Institute and State University, Blacksburg) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 509-514. Research supported by the United Technologies Corp. Previously cited in issue 09, p. 1191, Accession no. A87-24934. refs  
(Contract AF-AFOSR-85-0158)

A89-39189\*# Flow Research, Inc., Kent, WA.

**OPTIMIZING ADVANCED PROPELLER DESIGNS BY SIMULTANEOUSLY UPDATING FLOW VARIABLES AND DESIGN PARAMETERS**

MAGDI H. RIZK (Flow Research, Inc., Kent, WA) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 515-522. Previously cited in issue 16, p. 2593, Accession no. A88-40718. refs  
(Contract NAS3-24855)

A89-39190\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**EFFECT OF SPATIAL WIND GRADIENTS ON AIRPLANE AERODYNAMICS**

DAN D. VICROY and ROLAND L. BOWLES (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 523-530. Previously cited in issue 07, p. 938, Accession no. A88-22437. refs

**A89-39191\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**UNSTEADY TRANSONIC SMALL-DISTURBANCE THEORY INCLUDING ENTROPY AND VORTICITY EFFECTS**

JOHN T. BATINA (NASA, Langley Research Center, Hampton, VA) (Structures, Structural Dynamics and Materials Conference, 29th, Williamsburg, VA, Apr. 18-20, 1988, Technical Papers. Part 1, p. 520-529) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 531-538. Previously cited in issue 12, p. 1819, Accession no. A88-32232. refs

**A89-39192\*#** Virginia Polytechnic Inst. and State Univ., Blacksburg.

**EFFECTS OF SWIRL AND HIGH TURBULENCE ON A JET IN A CROSSFLOW**

M. S. KAVSAOGLU and J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 539-546. Research supported by NASA. refs

An experimental study has been conducted on the effects of initial swirl and high turbulence in the exhaust of a circular jet injected from a flat plate at a 90-deg angle into a crossflow. The different jet types studied were low-exit turbulence (3 percent), high-exit turbulence (over 10 percent), and 40 and 58 percent swirl. Surface pressure distributions and mean velocity vector plots were obtained for all of these cases. For the surface pressure distribution tests, the jet to crossflow velocity ratios  $R$  were 2.2, 4, and 8 for most of the jet types. For the mean velocity vector plots,  $R = 4$  was chosen. Turbulence information in the jet plume was also obtained for the low-exit turbulence case at  $R = 4$ . The results showed that the higher-exit turbulence reduced the penetration height, and it also reduced the surface area influenced by negative pressures. The swirl-caused asymmetric pressure distributions and the swirl effects were more pronounced for lower-velocity ratios. Author

**A89-39196\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**RIBLET DRAG AT FLIGHT CONDITIONS**

MICHAEL J. WALSH, WILLIAM L. SELLERS, III, and CATHERINE B. MCGINLEY (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 570-575. Previously cited in issue 16, p. 2597, Accession no. A88-40764. refs

**A89-39197#**

**BUFFETING CRITERIA FOR A SYSTEMATIC SERIES OF WINGS**

D. G. MABEY (Royal Aircraft Establishment, Bedford, England) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 576-582. refs

In 1970, wind-tunnel measurements were made by NASA of the buffeting on a systematic series of 11 swept wings mounted on top of a simple fuselage. The wings generally had a quarter chord swept 35 deg and an aspect ratio of 6. The emphasis in the original program was on the variation in the onset of buffeting due to wide variations in the wing geometry. In the present paper, approximate criteria for the severity of buffeting have been derived from these measurements. These criteria provide a more complete picture of the effect of variations in wing geometry on the wing buffeting. Author

**A89-39349**

**NUMERICAL STUDY OF TURBULENCE MODEL IN A SUPERSONIC NOZZLE**

A. NEBBACHE (Universite des Sciences et de la Technologie, Algiers, Algeria), D. ZEITOUN, M. IMBERT, R. BRUN (Aix-Marseille I, Universite, Marseille, France), and C. BEGUIER (Institut de Mecanique Statistique de la Turbulence, Marseille, France) European Journal of Mechanics, B/Fluids (ISSN 0750-7240), vol. 8, no. 2, 1989, p. 143-161. refs

The compressible turbulent two-dimensional flow of gas in a convergent-divergent nozzle is numerically determined. The

algebraic closure model of Baldwin and Lomax is used and includes two characteristic turbulent length scales which are well adapted for both supersonic and transonic flows. A modification of the second scale is discussed. The results show a better stability of the calculation with this modification which also does not alter the mean velocity field determination. Author

**A89-39461#**

**NUMERICAL CALCULATIONS OF HYPERSONIC NONEQUILIBRIUM FLOW OVER A BLUNT WEDGE**

JIANWEI SHEN and ZHANGHUA QU (National University of Defense Technology, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 10, Jan. 1989, p. A67-A69. In Chinese, with abstract in English. refs

A numerical method is used to compute the hypersonic, nonequilibrium, viscous shock-layer flow over a blunt wedge. A truncated series is used to develop the differential equations at the stagnation streamline. As a result, the initial value for the viscous shock-layer equations can be improved. The continuity equation and the transversal momentum equation are solved in a coupled way, so that the calculations can be matched with the solutions at far downstream of the planar blunt-bodies. The numerical results are given and compared with those from other methods. Author

**A89-39462#**

**A COMPUTATIONAL METHOD OF AERODYNAMICS FOR SUBSONIC, FULLY UNSTEADY WINGS AT HIGH ANGLES OF ATTACK IN TIME-DOMAIN**

ZHENGYIN YE, LINGCHENG ZHAO, and YONGNIAN YANG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 10, Jan. 1989, p. A70-A73. In Chinese, with abstract in English.

A potential difference method for computing the aerodynamic loads on wings in fully unsteady, subsonic, high angles of attack flows with leading-edge or side-edge separations is presented. For this type of nonlinear problems, the developed method can provide the time-varying aerodynamic loads and the velocity fields in time domains. The numerical results show in good agreement with experimental data. Author

**A89-39473#**

**A PHYSICAL MODEL OF THE STREAMWISE CORNER VORTEXES IN A COMPRESSOR CASCADE**

YANPING TNAG and FANG CHEN (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 10, Feb. 1989, p. B36-B43. In Chinese, with abstract in English. refs

The flow visualization by means of smoke and measurement of a three-dimensional flow field are conducted to investigate a physical model of the streamwise corner vortexes in a compressor cascade. The experimental results describe not only the flow pattern and structural characteristics, but also the interaction of the corner vortexes with the blade surface boundary layers in the cascade. Based on this physical model, the mechanism has been discussed in which high losses are caused by the corner vortexes. Author

**A89-39474#**

**THE APPLICATION OF DYNAMIC SCHLIEREN-PHOTON CORRELATION TECHNIQUE TO A SUPERSONIC SHEAR LAYER**

LIPING XU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 10, Feb. 1989, p. B44-B51. In Chinese, with abstract in English. refs

By applying the dynamic schlieren-photon correlation technique to a two-dimensional separated supersonic shear layer, the convection velocity of large eddies inside the shear layer and the frequency of the self-sustaining oscillation of the shear layer induced by the shedding of large eddies have been obtained. The distribution of the turbulence intensity inside the shear layer can

## 02 AERODYNAMICS

also be estimated. It has been observed that the large eddies in a high speed shear layer possess some special features. It is shown that the method has potential in the measurement of high-speed complex flows. Author

**A89-39666**

### **LIFETIME AEROFOIL CALCULATIONS USING VON MISES VARIABLES**

RONALD M. BARRON (Windsor, University, Canada) and R. K. NAEEM Communications in Applied Numerical Methods (ISSN 0748-8025), vol. 5, April 1989, p. 203-210. Research supported by NSERC. refs

A natural-streamline coordinate system has been developed for steady two-dimensional incompressible lifting-flow problems. Flow equations with appropriate boundary conditions are presented in terms of von Mises coordinates ( $x, \psi$ ), where  $\psi$  is the stream function for the flow. The finite-difference method is used to discretize the nonlinear elliptic equation describing the flow. Favorable agreement with available results is obtained. Author

**N89-21762\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

### **THE NASA LANGLEY LAMINAR-FLOW-CONTROL EXPERIMENT ON A SWEEPED SUPERCRITICAL AIRFOIL: BASIC RESULTS FOR SLOTTED CONFIGURATION**

CHARLES D. HARRIS, CUYLER W. BROOKS, JR., PATRICIA G. CLUKEY, and JOHN P. STACK Washington Jun. 1989 121 p (NASA-TM-4100; L-16474; NAS 1.15:4100) Avail: NTIS HC A06/MF A01 CSDL 01A

The effects of Mach number and Reynolds number on the experimental surface pressure distributions and transition patterns for a large chord, swept supercritical airfoil incorporating an active Laminar Flow Control suction system with spanwise slots are presented. The experiment was conducted in the Langley 8 foot Transonic Pressure Tunnel. Also included is a discussion of the influence of model/tunnel liner interactions on the airfoil pressure distribution. Mach number was varied from 0.40 to 0.82 at two chord Reynolds numbers, 10 and 20 x 1,000,000, and Reynolds number was varied from 10 to 20 x 1,000,000 at the design Mach number. Author

### **N89-21764** Iowa State Univ. of Science and Technology, Ames. **PRIMITIVE NUMERICAL SIMULATION OF CIRCULAR COUETTE FLOW Ph.D. Thesis**

JAN FRANCISZEK HASIUK 1988 104 p  
Avail: Univ. Microfilms Order No. DA8825399

The azimuthal-invariant, 3-D cylindrical, incompressible Navier-Stokes equations are solved to steady state for a finite-length, physically realistic model. The numerical method relies on an alternating-direction implicit (ADI) scheme that is formally second-order accurate in space and first-order accurate in time. The equations are linearized and uncoupled by evaluating variable coefficients at the previous time iteration. Wall grid clustering is provided by a Roberts transformation in radial and axial directions. Subject to no-slip, Dirichlet boundary conditions, except for the inner cylinder rotation velocity (impulsive start-up) and zero-flow initial conditions, nonturbulent solutions are obtained for sub- and supercritical Reynolds numbers of 100 to 400 for a finite geometry where  $R_{\text{sub outer}}/R_{\text{sub inner}} = 1.5$ ,  $H/R_{\text{sub inner}} = 0.73$  and  $H/\delta R = 1.5$ . An axially-stretched model solution is shown to asymptotically approach the 1-D analytic Couette solution at the cylinder midheight. Flowfield change from laminar to Taylor-vortex flow is discussed as a function of Reynolds number. Three-dimensional velocities, vorticity and streamfunction are presented via 2-D graphs and 3-D surface and contour plots. A Prandtl-Van Driest turbulence model based on an effective isotropic eddy viscosity hypothesis was applied resulting in accurate 1-D turbulent flow solutions assuming long cylinders. A small aspect ratio correction factor was empirically determined. Comparisons to experiment are very good. Extending the nonturbulent analysis, 3-D turbulent flow equations are developed for Prandtl-Van Driest

and energy-dissipation turbulence models. The energy-dissipation model includes corrections for streamline curvature, system rotation, and low-Re effects. Dissert. Abstr.

**N89-21765** Cranfield Inst. of Tech., Bedford (England).

### **THE USE OF THE COLLEGE OF AERONAUTICS WHIRLING ARM FACILITY TO DETERMINE THE EFFECT OF FLOW CURVATURE ON THE AERODYNAMIC CHARACTERISTICS OF AN OGIVE-CYLINDER BODY Ph.D. Thesis**

D. I. T. P. LLEWELYN-DAVIES 1987 430 p  
Avail: Univ. Microfilms Order No. BRDX83492

The aerodynamic characteristics of a simple ogive-cylinder body was determined in two flow fields, one a straight flow as generated by a wind tunnel and the other a flow of constant curvature as generated by the whirling arm method of test. Theoretical estimates were made for both flow conditions for comparison with the experimental results. This thesis divides itself naturally into three parts: (1) the redesign of the College of Aeronautics Whirling Arm facility to make it suitable for the experimental work; (2) the tests in straight flow, (these showed that the afterbody normal-force loadings were very sensitive to conditions in the base region and that the high loadings present over the last 10 pct of the body length were not predicted by the theoretical method used although it predicted the loading distributions over the rest of the body reasonably well); and (3) the tests in curved flow, which showed that there were high positive normal-force loadings present over the afterbody at both positive and negative pitch angles resulting in both increased normal-force and a further aft position of the center of pressure as compared with the results obtained in straight flow. These features were not predicted by the analytical method used initially. However, it was found that the general level of the experimental afterbody loading distributions was predicted by two other analysis programs based on inviscid slender-body and linear theory respectively, with the linear theory loading predictions agreeing very closely with experiment over both the forebody and afterbody. Dissert. Abstr.

**N89-21766** Maryland Univ., College Park.

### **UNSTEADY FORCE CALCULATIONS ON CIRCULAR CYLINDERS AND ELLIPTICAL AIRFOILS WITH CIRCULATION CONTROL Ph.D. Thesis**

VENKATRAMAN RAGHAVAN 1988 184 p  
Avail: Univ. Microfilms Order No. DA8818204

A numerical method is developed to study unsteady circulation control aerodynamics airfoils. Two cases of unsteadiness are considered: the unsteadiness arising from an unsteady, periodic freestream and the unsteadiness due to unsteady blowing momentum. A simple solution for the potential flow is obtained using conformal mapping. In unsteady flows, reversed flow is found to be possible even though flow separation has not taken place. The finite difference method uses backward differences whenever reversed flow is encountered. Also unsteady separation point was determined by detecting the singularity at the separation point. Potential flow and boundary layer and walljet calculations are combined in an iterative procedure to get a converged solution. The solution provides the velocity and pressure fields which is used to determine the lift and drag forces under given freestream and jet momentum conditions. Pressure distribution obtained from the potential flow is used to calculate the lift and the pressure drag forces. Wall shear data obtained from the boundary layer flow gives the skinfriction drag. Satisfactory correlation of predicted results with experimental data is achieved for steady lift over circular cylinders as well as elliptic airfoils. Substantial changes due to unsteady effects were observed for thick airfoils at large blowing and reduced frequencies. Unsteady effects are bound to be more significant for unsteadiness in the freestream velocity than for the unsteadiness in the blowing momentum. Dissert. Abstr.

**N89-21767** Purdue Univ., West Lafayette, IN.

### **NUMERICAL SOLUTIONS OF UNSTEADY INVISCID TRANSONIC TURBINE CASCADE FLOWS Ph.D. Thesis**

RICHARD MCCREA MOORE 1988 266 p  
Avail: Univ. Microfilms Order No. DA8825564

A numerical analysis was developed to solve two-dimensional inviscid transonic turbine-type cascade flowfields. This analysis combines accuracy comparable to that of the numerical method of characteristics with the efficiency of finite difference methods. The MacCormack explicit finite difference method is used to solve the unsteady Euler equations. Steady solutions are calculated as asymptotic solutions in time. A conservation variable formulation of the Kentzer method was developed in this investigation and is used to derive appropriate equations for the flowfield boundaries. The Kentzer method is based on characteristic theory, but uses a finite difference method, consistent with the method used at interior points, to integrate the appropriate boundary equations. A grid generator was developed to create C-type grids around cascade blades using techniques similar to the Poisson equation grid generation techniques developed by Steger and Sorensen. Two different planar turbine-type cascades were studied. The AACE II cascade blades are typical of the nozzle blades found in the first stator in a turbine. The GMA 400 cascade blades are typical of later turbine stator blades. Numerical studies were performed with maximum Mach numbers in the flowfields ranging from 0.8 to 1.35. Numerical results are verified using experimentally measured blade surface static pressure data. A numerical method of characteristics cascade flow solver was developed to provide a relative standard for numerical results. The MacCormack code and the characteristics code produce very similar results and both are in excellent agreement with the experimental results.

Dissert. Abstr.

**N89-21768\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**STATIC INTERNAL PERFORMANCE OF CONVERGENT SINGLE-EXPANSION-RAMP NOZZLES WITH VARIOUS COMBINATIONS OF INTERNAL GEOMETRIC PARAMETERS**

E. ANN BARE and FRANCIS J. CAPONE Washington May 1989 106 p

(NASA-TM-4112; L-16535; NAS 1.15:4112) Avail: NTIS HC A06/MF A01 CSDL 01A

An investigation was conducted in the Static Test Facility of the Langley 16-Foot Transonic Tunnel to determine the effects of five geometric design parameters on the internal performance of convergent single expansion ramp nozzles. The effects of ramp chordal angle, initial ramp angle, flap angle, flap length, and ramp length were determined. All nozzles tested has a nominally constant throat area and aspect ratio. Static pressure distributions along the centerlines of the ramp and flap were also obtained for each configuration. Nozzle pressure ratio was varied up to 10.0 for all configurations.

Author

**N89-21769\*** Cornell Univ., Ithaca, NY. School of Mechanical and Aerospace Engineering.

**AERODYNAMICS OF ENGINE-AIRFRAME INTERACTION Final Report, 1-30 Oct. 1988**

DAVID A. CAUGHEY 17 Apr. 1989 25 p

(Contract NAG2-373)

(NASA-CR-184824; NAS 1.26:184824) Avail: NTIS HC A03/MF A01 CSDL 01A

The development of the variational approach for the solution of inviscid aerodynamic problems using solution adaptive grids is discussed. The formulation of a new, directional weighting, functional has been shown to have desirable properties. The scheme has been applied to compute the transonic flow past two-dimensional airfoils using the Euler equations of inviscid, compressible flow. Transonic flows in quasi-one-dimensional nozzles and over the two dimensional airfoils are solved on the various solution-adaptive-grids to demonstrate the applicability of the proposed directional-concentration functional and the grid adaptation process from the stand point of improving the solution accuracy and demonstrating the overall convergence.

Author

**N89-21770** Manchester Univ. (England).

**FLOW PAST BLUFF BODIES Ph.D. Thesis**

MICHAEL BENSON 1987 168 p

Avail: Univ. Microfilms Order No. BRD83908

Various areas of research are examined concerning the flow of fluid past bluff shaped bodies. The use of boundary integral techniques was investigated for solving two-dimensional potential flow problems. The rate of convergence of various methods is examined by numerical experiments performed on a circle and an ellipse. The results are supported by detailed mathematical analysis and many of the conclusions are expected to apply to arbitrarily shaped bodies without corners. In particular it is shown that improvements in the rate of convergence of the straight line/constant source panel method formulation are possible without resort to a higher order source density approximation. It is important to note that in the case of bluff bodies, potential flow models bear little resemblance to the physical flow. The construction of viscous models using vortex methods was then investigated. It is believed that a major deficiency of such models was the simulation of diffusive effects. An alternative to the common random walk technique is developed and used to simulate both symmetric and asymmetric laminar flow past a circular cylinder. The solutions compare well with existing finite difference solutions. On a slightly different note, towing tank experiments designed to investigate the movement of the separation point on a circular cylinder for Reynolds numbers below 550 were described. In contrast with numerical results no oscillations of this separation point are observed. It is suggested that further experimental investigations may clarify this discrepancy.

Dissert. Abstr.

**N89-21771** Princeton Univ., NJ.

**ORGANIZED STRUCTURES IN A SUPERSONIC TURBULENT BOUNDARY LAYER Ph.D. Thesis**

ERIC FRANCIS SPINA 1988 251 p

Avail: Univ. Microfilms Order No. DA8827776

A supersonic, zero-pressure-gradient, flat plate turbulent boundary layer ( $M$  approximately equals 2.9,  $Re$  sub theta approximately equals 80000) was experimentally investigated. The emphasis of this work was to investigate the nature of the organized structures in supersonic turbulent boundary layers. The data were obtained from arrays of high-frequency response hot wires and wall-pressure transducers with streamwise, vertical, and spanwise spacings. Correlation methods were used to determine the time-averaged structure of the boundary layer, and conditional sampling techniques were used to probe the time-dependent behavior of the organized motions. Many characteristics of the large-scale organized structures in supersonic flow are revealed, including: the largest structures span the entire boundary layer and are inclined at an average angle of 45 to 60 deg with a wide distribution of individual structure angles, the spanwise extent of the structures is slightly smaller than the vertical extent, and the convection velocity of the structures is uniform across the boundary layer and approximately equal to 0.9  $U$  sub infinity. The upstream interface of the large-scale structures is associated with a sharp streamwise mass-flux gradient and this interface is in turn associated with dominant shear stress motions within and behind the structure. A comparison of the turbulence characteristics in supersonic and subsonic flow indicates that although there are broad similarities there are also fundamental differences in the form which the large-scale structures assume.

Dissert. Abstr.

**N89-21772\*** Sandia National Labs., Livermore, CA. Combustion Research Facility.

**FEASIBILITY OF FLIGHT EXPERIMENTS AND INSTRUMENTATION HARDWARE FOR IN-FLIGHT HYPERSONIC BOUNDARY-LAYER MEASUREMENTS**

R. J. CATTOLICA, R. L. SCHMITT, and R. E. PALMER Feb. 1989 66 p

(Contract NASA ORDER L-96920-B; DE-AC04-76DR-00789)

(NASA-CR-184896; NAS 1.26:184896; DE89-007943;

SAND-89-8204) Avail: NTIS HC A04/MF A01 CSDL 01A

We have examined the feasibility of implementing nonintrusive optical diagnostics to measure the properties of the boundary layer surrounding a hypersonic vehicle. Measurements of density, temperature, location of the shock front, and  $N_2$ ,  $O_2$ , and  $NO$  concentrations are feasible using electron-beam fluorescence, for which instrumentation appropriate for flight experiments already



exists. In particular, NO will be a key indicator of the chemistry occurring at the vehicle nose and leading edges. Measurements of velocity and O<sub>2</sub> and NO concentrations will be feasible using laser-induced fluorescence when rugged and reliable miniature UV laser sources become available; such laser sources should be developed in the next few years. Optical and sensor instrumentation for spectrally resolving the fluorescence along a line emanating from the vehicle and passing radially through the shock front is presently available. Laboratory and wind tunnel experiments will be required to develop the technology base needed to apply these advanced diagnostics. Nevertheless, experimental data acquired from these diagnostic methods, both in flight experiments and in wind tunnel tests, will be invaluable for validating computational fluid dynamics computer codes and for designing next-generation high-performance hypersonic flight vehicles. DOE

**N89-21773#** Sandia National Labs., Albuquerque, NM.  
**WAKE RECONTACT: AN EXPERIMENTAL INVESTIGATION  
 USING A RINGSLLOT PARACHUTE**

JAMES H. STRICKLAND and J. MICHAEL MACHA 13 Jan. 1989 45 p  
 (Contract DE-AC04-76DP-00789)  
 (DE89-008320; SAND-88-3058) Avail: NTIS HC A03/MF A01

A series of tests was conducted on a 10-ft diameter ringslot parachute with a geometric porosity of 20 percent to establish the conditions under which wake recontact occurs. The vertical helicopter drop tests covered a range of mass ratios from 0.5 to 3.0 and a range of Froude numbers from 70 to 400. Data consisted of velocity time histories obtained using a laser tracker and diameter time histories obtained from photometric data. A collapse parameter based on the ratio of the maximum parachute diameter to the subsequent minimum diameter was correlated with the mass ratio  $M$  sub  $R$  and the Froude number  $Fr$ . This pair of similarity parameters was subsequently replaced by the equivalent pair  $M$  sub  $R$  and  $V$  sub  $o$   $V$  sub  $t$  in order to provide more intuitive results ( $V$  sub  $o$   $V$  sub  $t$  is the initial to final velocity ratio). For large values of  $V$  sub  $o$   $V$  sub  $t$  the collapse parameter  $R$  sub  $C$  appears to be a function of  $M$  sub  $R$  alone. Non-dimensional opening time and collapse time data were also correlated with  $M$  sub  $R$  and  $V$  sub  $o$   $V$  sub  $t$ . In addition, opening load factors  $C$  sub  $X$  were calculated from the data and plotted as a function of  $V$  sub  $o$   $V$  sub  $t$ . DOE

**N89-21774#** Calspan-Buffalo Univ. Research Center, NY. Dept. of Physical Sciences.

**STUDIES OF THE STRUCTURE OF ATTACHED AND  
 SEPARATED REGIONS OF VISCOUS/INVISCID INTERACTION  
 AND THE EFFECTS OF COMBINED SURFACE ROUGHNESS  
 AND BLOWING IN HIGH REYNOLDS NUMBER HYPERSONIC  
 FLOWS Final Report, 1 Aug. 1985 - 1 Jun. 1988**

MICHAEL S. HOLDEN, R. BERGMAN, J. HARVEY, G. DURYEA,  
 and J. MOSELLE 2 Dec. 1988 141 p  
 (Contract F49620-85-C-0130)  
 (AD-A204364; CUBRC-88682; AFOSR-89-0033TR) Avail: NTIS  
 HC A07/MF A01 CSCL 01/1

The first of these 2 studies examined the detailed structure of the hypersonic boundary layer over a large cone/flare configuration. Emphasis was on development and use of instrumentation with which to obtain flow field measurements of the mean and fluctuating properties of the attached and separated shear layers. Development and use of holographic interferometry and electron beam techniques in the high Mach number and Reynolds number environment developed in the shock tunnel are described. In the second study, detailed measurements of heat transfer, pressure and skin friction were made on a unique blowing and roughness model constructed to simulate the aerothermal phenomena associated with a rough ablating maneuverable reentry vehicle. In the 2nd study emphasis was placed on development and use of unique heat transfer and skin friction instrumentation to obtain measurements of the combined effects of blowing and roughness and to understand how such effects influence boundary layer separation in regions of shock wave/boundary layer interaction. Each focused around providing information with which

to construct and evaluate the modeling required in time-averaged Navier-Stokes equations to predict the structure of compressible hypersonic boundary layers in regions of strong pressure gradient, shock wave/boundary layer interaction and flow separation over smooth, rough and ablating surfaces. GRA

**N89-21775#** Computational Mechanics Co., Austin, TX.  
**ANALYSIS OF FLOW-, THERMAL- AND  
 STRUCTURAL-INTERACTION OF HYPERSONIC STRUCTURES  
 SUBJECTED TO SEVERE AERODYNAMIC HEATING Annual  
 Technical Report No. 1, 1 Nov. 1987 - 1 Nov. 1988**

J. T. ODEN and E. A. THORNTON 30 Nov. 1988 56 p  
 (Contract F49620-88-C-0001)  
 (AD-A205077; TR-88-12; AFOSR-89-0089TR) Avail: NTIS HC  
 A04/MF A01 CSCL 20/13

This first annual report presents progress in the modelling of hypersonic fluid-thermal-structural interaction. In this phase of the effort, the basic mechanisms of heat transfer and fluid-structure interaction were identified. Mathematical models for heat transfer, structural deformation and fluid flow analysis were formulated. New unified viscoplastic theories were adapted for the modelling of complex visco-elasto-plastic structural deformation, with temperature-dependent material properties. A general procedure for the analysis of fluid-thermal-structure interaction was formulated, and relevant finite element codes were developed. These problems were applied in the solution of representative examples of thermo-structural analysis of structures subject to aerodynamic heating. GRA

**N89-21777#** Max-Planck-Institut fuer Stroemungsforschung,  
 Goettingen (Germany, F.R.).

**THE EVALUATION AND REPRESENTATION OF  
 INTERFEROGRAMS OF TRANSONIC FLOW FIELDS Thesis  
 [ZUR AUSWERTUNG UND DARSTELLUNG VON  
 INTERFEROGRAMMEN TRANSSONISCHER  
 STROEMUNGSFELDER]**

HANS-HERMANN BARTELS Dec. 1987 76 p In GERMAN  
 (MPIS-21/1987; ISSN-0436-1199; ETN-89-93808) Avail: NTIS  
 HC A05/MF A01; Max-Planck Inst. fuer Stroemungsforschung,  
 Boettinger Strasse 6-8, 3400 Goettingen, Fed. Republic of  
 Germany, DM 20

A system for the evaluation of experimental interferograms was further developed, and the possibilities of quasi-three-dimensional representation of the obtained flow fields were investigated. The system allows a largely automatic evaluation of the interferograms and interactive control to guarantee an error-free evaluation. The calculated fields can be represented using quasi-3-D techniques. Proposals for the production of higher quality interferograms are given. ESA

**N89-22571#** Jiaotong Univ., Shanghai (China).

**UNSTEADY AERODYNAMIC COMPUTATIONAL METHOD OF  
 NON-COPLANAR WING-TAIL COMBINATIONS IN SUBSONIC  
 FLOW**

JIGUANG AN, WENBO ZHOU, MING YAN, KANGYAN CHEN,  
 XIANCHAI SUN, ZHEN YAN, and CHUANREN QIU (Shanghai  
 Aircraft Co., China) 1987 12 p Sponsored by Institute of  
 Scientific and Technical Information of China, Beijing  
 (PB89-111470; ISTIC-TR-C-000196) Avail: NTIS HC A03/MF  
 A01 CSCL 01/1

An unsteady aerodynamic computational method is presented for 3-D non-coplanar wing-tail combination (namely, an airplane with horizontal tail plane located higher or lower than wing) at subsonic speed. The velocity potential function of unsteady vortex ring is chosen as an elementary solution of governing equation of flow field. The whole computational method follows strictly the physical mechanism of unsteady aerodynamic phenomenon, so it can be widely used in predicting those unsteady aerodynamic data needed in aircraft design and performance evaluation. Author

**N89-22572** Stanford Univ., CA.

**A NUMERICAL STUDY OF VISCOUS VORTEX RINGS USING A**

**SPECTRAL METHOD Ph.D. Thesis**

SHARON KAY STANAWAY 1988 199 p  
 Avail: Univ. Microfilms Order No. DA8826238

Viscous, axisymmetric vortex rings are investigated numerically by solving the incompressible Navier-Stokes equations using a spectral method designed for this type of flow. The results presented are axisymmetric, but the method is developed to be naturally extended to three dimensions. The spectral method relies on divergence-free basis functions. The basis functions are formed in spherical coordinates using Vector Spherical Harmonics in the angular directions, and Jacobi polynomials together with a mapping in the radial direction. Simulations are performed of a single ring over a wide range of Reynolds numbers ( $Re$  is identical with  $\gamma$   $\mu$ ), 0.001 is less than or equal to  $Re$  is less than or equal to 1000, and of two interacting rings. At large times, regardless of the early history of the vortex ring, it is observed that the flow approaches a Stokes solution that depends only on the total hydrodynamic impulse, which is conserved for all time. At small times, from an infinitely thin ring, the propagation speeds of vortex rings of varying  $Re$  are computed and comparisons are made with the asymptotic theory by Saffman. The results are in agreement with the theory; furthermore, the error is found to be smaller than Saffman's own estimate by a factor of the square root of  $(\nu t/r^2)$  (at least for  $Re=0$ ). The error also decreases with increasing  $Re$  at fixed core-to-ring radius ratio, and appears to be independent of  $Re$  as  $Re$  approaches infinity. Following a single ring, with  $Re = 500$ , the vorticity contours indicate shedding of vorticity into the wake and a settling of an initially circular core to a more elliptical shape, similar to Norbury's steady inviscid vortices. Finally, the case of leapfrogging vortex rings with  $Re = 1000$  is considered. The results show severe straining of the inner vortex core in the first pass and merging of the two cores during the second pass. Dissert. Abstr.

**N89-22574\*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.

**THE INVISCID AXISYMMETRIC STABILITY OF THE SUPERSONIC FLOW ALONG A CIRCULAR CYLINDER Final Report**

PETER W. DUCK (Manchester Univ., England) Feb. 1989 74 p  
 (Contract NAS1-18605; NAS1-18107)  
 (NASA-CR-181816; NAS 1.26:181816; ICASE-89-19) Avail: NTIS HC A04/MF A01 CSCL 01/1

The supersonic flow past a thin straight circular cylinder is investigated. The associated boundary layer flow (i.e., the velocity and temperature field) is computed; the asymptotic, far downstream solution is obtained, and compared with the full numerical results. The inviscid, linear, axisymmetric (temporal) stability of this boundary layer is also studied. A so called doubly generalized inflexion condition is derived, which is a condition for the existence of so called subsonic neutral modes. The eigenvalue problem (for the complex wavespeed) is computed for two freestream Mach numbers (2.8 and 3.8), and this reveals that curvature has a profound effect on the stability of the flow. The first unstable inviscid mode is seen to rapidly disappear as curvature is introduced, while the second (and generally the most important) mode suffers a substantially reduced amplification rate. Author

**N89-22575#** National Aeronautical Establishment, Ottawa (Ontario).

**COMPARISON OF BOUNDARY LAYER TRIPS OF DISK AND GRIT TYPES ON AIRFOIL PERFORMANCE AT TRANSONIC SPEEDS**

Y. Y. CHAN Dec. 1988 40 p  
 (AD-A205206; NAE-AN-56; NRC-29908) Avail: NTIS HC A03/MF A01 CSCL 21/1

The effects on aerodynamic performance of a supercritical airfoil applying disk or grit tripping for boundary layer transition has been investigated for a typical supercritical airfoil at transonic speeds. It is observed that by allowing the laminar flow passing through the space between the disks, transition takes place a short distance downstream from the disk trip line. The boundary layer developed

downstream from disk trip is therefore slightly thinner than that from a grit trip. The vortex generating mechanism of the disks may also enhance this development. This small difference has negligible effect on aerodynamics of the airfoil at low lift. However, at high lift, the difference in boundary layer developments is amplified by the strong shock wave and the severe adverse pressure gradient. The thinner and more energetic boundary layer induced by the disk trip will yield higher lift, lower drag and higher trailing edge pressure. GRA

**N89-22576#** Sandia National Labs., Albuquerque, NM. Parachute Systems Div.

**A PRELIMINARY CHARACTERIZATION OF PARACHUTE WAKE RECONTACT**

JAMES H. STRICKLAND and J. MICHAEL MACHA 1989 8 p  
 Presented at the 10th AIAA Aerodynamic Decelerator Systems Technical Conference, Cocoa Beach, FL, 18 Apr. 1989  
 (Contract DE-AC04-76DP-00789)  
 (DE89-006442; SAND-88-3058C; CONF-8904118-3) Avail: NTIS HC A02

A series of tests was conducted on a 10 ft diameter ringslot parachute with a geometric porosity of 20 percent to establish the conditions under which wake recontact occurs. The vertical helicopter drop tests covered a range of mass ratios from 0.5 to 3.0 and a range of Froude numbers from 70 to 400. Data consisted of velocity time histories obtained using a laser tracker and diameter time histories obtained from photometric data. A collapse parameter based on the ratio of the maximum parachute diameter to the subsequent minimum diameter was correlated with the mass ratio  $M$  sub  $R$  and the Froude number  $Fr$  or equivalently with the initial to final velocity ratio  $V$  sub  $o/V$  sub  $t$ . For large values of  $V$  sub  $o/V$  sub  $t$  the collapse parameter  $R$  sub  $c$  appears to be a function of  $M$  sub  $R$  alone. Non-dimensional opening time and collapse time data were also correlated with  $M$  sub  $R$  and  $V$  sub  $o/V$  sub  $t$ . DOE

**N89-22577\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**RECTANGULAR NOZZLE PLUME VELOCITY MODELING FOR USE IN JET NOISE PREDICTION**

U. H. VONGLAHN 1989 36 p Presented at the 25th Joint Propulsion Conference, Monterey, CA, 10-12 Jul. 1989; sponsored by AIAA, ASME, SAE and ASEE  
 (NASA-TM-102047; E-4739; NAS 1.15:102047; AIAA-89-2357)  
 Avail: NTIS HC A03/MF A01 CSCL 01/1

A modeling technique for predicting the axial and transverse velocity characteristics of rectangular nozzle plumes is developed. In this technique, modeling of the plume cross section is initiated at the nozzle exit plane. The technique is demonstrated for the plume issuing from a rectangular nozzle having an aspect ratio of 6.0 and discharging into quiescent air. Application of the present procedures to a nozzle discharging into a moving airstream (flight effect) are then demonstrated. The effects of plume shear layer structure modification on the velocity flowfield are discussed and modeling procedures are illustrated by example. Author

**N89-22578#** Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

**COMPRESSIBLE EULER SOLUTION AROUND A WING CANARD STING CONFIGURATION**

TORSTEN BERGLIND 12 Feb. 1988 33 p  
 (Contract FMV-FLYGLF-82260-88-061-73-001)  
 (FFA-TN-1988-62; ETN-89-94316) Avail: NTIS HC A03/MF A01

A patched multiblock grid around a 65 deg canard attached to a sting is constructed by transfinite interpolation. The wing-sting is enveloped by a C-O type grid with a polar singularity at the apex. The grid emanates from the wing-sting surface via axisymmetric surfaces, the first contiguous to the trailing edge of the canard, the second contiguous to the leading edge of the canard, and finally the farfield boundary. The grid contains 310,000 grid points. A multiblock Euler solver with a high degree of vectorization (MESCI) was used for the flow computations. The canard is treated as a slit, whereby the grid has to be divided



## 02 AERODYNAMICS

into two blocks, since MESCI does not allow slits in the interior domain. Each time step requires 7.6 CPU seconds on a CYBER-205. The flow field is computed at 10 and 20 deg angle of attack at a free stream Mach number of 0.85. The transonic flow cases are both of high complexity, containing local shock waves and the interaction of the canard tip vortex and the delta wing vortex. The flow solver in conjunction with the grid system is able to capture the dominant flow phenomena such as the canard and delta wing vortices. The C sub p-distributions on the upper side of the wing agree reasonably well with measurements. ESA

**N89-22579#** Centre d'Etudes Aerodynamiques et Thermiques, Poitiers (France).

### **INTERACTION BETWEEN AN ISOLATED VORTEX AND A WING PROFILE Final Report [INTERACTION ENTRE UN TOURBILLON ISOLE ET UN PROFIL D'AILE]**

Mar. 1988 67 p In FRENCH

(Contract DRET-85-092)

(ETN-89-94364) Avail: NTIS HC A04/MF A01

Wind tunnel measurements were carried out in a two-dimensional configuration. A reproducible vortex with an axis parallel to the profile is created by mechanical means in the subsonic wind tunnel. The measurements include the velocity fields with and without profile, the wall pressures, and the lift. Smoke flow visualization was also used. The viscous vortex structure is disintegrated when passing over the profile, and three-dimensional effects appear. The modification of the wall pressure field is most important near the leading edge. ESA

**N89-22580#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Abteilung Hochgeschwindigkeitsstroemungen.

### **TRANSONIC AND SUPERSONIC FLOW PAST A 65 DEG DELTA WING WITH ROUNDED LEADING EDGES: ANALYSIS OF EXPERIMENTAL DATA**

KRISHNASWAMI YEGNA NARAYAN and KLAUS HARTMANN Sep. 1988 67 p

(DFVLR-FB-88-44; ISSN-0171-1342; ETN-89-94378) Avail: NTIS HC A04/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, DM 20.50

Data on a sweptback cropped delta wing with rounded leading edges over a Mach number range of 0.4 to 4, and from tests at Mach 0.85 over a Reynolds number range of 2.4 to 13 million (based on root chord) are discussed. It is shown that the first occurrence of leading edge separation can be determined from one of three (related) criteria: a sudden drop in the peak suction pressure on the leeside, a rapid inboard movement of the location of the suction peak, and a rapid inboard movement of the foot of the pressure rise following the suction peak. Fully attached flow, mixed flow and leading edge separated flow types are identified. Flow attachment at the rounded leading edge occurs at a lower Mach number compared to a wing with sharp leading edge. Leading edge separation on a wing with a drooped leading edge occurs at an angle of attack higher than in the undrooped case by an angle equal to the droop. An increase in Reynolds number causes leading edge separation to occur at higher angles of attack. ESA

**N89-22581#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Abteilung Instabilitaeten und Abloesung.

### **FLOW OVER A LEADING EDGE WITH DISTRIBUTED ROUGHNESS**

JERZY M. FLORYAN and UWE DALLMANN Sep. 1988 52 p (DFVLR-FB-88-45; ISSN-0171-1342; ETN-89-94379) Avail: NTIS HC A04/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, DM 19

Flow over a leading edge with distributed roughness (assumed to have small amplitude, which permits linearization of the governing equations) was analyzed. Explicit solutions are obtained in the limits of large and small wave numbers. Results show that roughness can produce modifications of the flow far away from the solid surface, while modifications of the temperature field are confined to within the thermal boundary layer. Surface stresses

tend to eliminate roughness if erosion or wall flexibility are admitted. It is noted that heat flow tends to concentrate at the tips of the roughness. ESA

**N89-22582#** Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

### **WIND TUNNEL TESTS OF 16 PERCENT THICK AIRFOIL SECTION WITH SPOILERS AT DIFFERENT CHORDWISE POSITIONS**

ANDERS BJORCK Dec. 1988 44 p Sponsored by the Swedish National Energy Administration

(FFA-TN-1987-39; ETN-89-94544) Avail: NTIS HC A03/MF A01

Wind tunnel tests were carried out at low speeds on a 16 percent thick, moderately cambered airfoil section equipped with spoilers at 7 different chordwise positions on the forward half part of the airfoil. Two spoiler positions were on the pressure side, two at the leading edge, and three on the suction side of the airfoil. The effect of spoiler height was examined. The spoiler height varied between 2.5 to 12.5 percent of the airfoil chord. The results indicate that a spoiler on the airfoil suction side positioned 5 percent of the chord from the leading edge is capable of eliminating the strong driving tangential force of the basic airfoil for the entire range of positive angles of attack tested. ESA

**N89-22583#** Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

### **THE INFLUENCE OF THE LEADING EDGE GEOMETRY ON THE WAVE DRAG FOR A 65 DEGREE DELTA WING AT LOW SUPERSONIC SPEED AND SMALL ANGLES OF ATTACK**

TORSTEN BERGLIND, GEORG DROUGGE, and PETER ELIASSON 25 Oct. 1988 15 p Sponsored by the Defence Material Administration of Sweden, Stockholm

(FFA-141; ISSN-0081-5640; ETN-89-94550) Avail: NTIS HC A03/MF A01; Almgvist and Wiksell Booksellers, Printers, Publishers, Stockholm, Sweden, 100 Finnish marks

High speed wind tunnel tests were performed to validate the Euler code WINGA2 at supersonic speeds. As test cases, three 65 deg wings (so-called Euler wings) were used at  $M=1.2$ . The influence of the body on the flow over the wing was computed with the Euler code MESCI. The agreement between computations and experiments is good. Wing design problems were considered. The results show that rather blunt leading edges, drooped or not, can result in good drag performance at low lift and moderate supersonic speeds. Such geometry could be beneficial for the subsonic maneuvering case. ESA

**N89-22584#** Centre d'Etudes et de Recherches, Toulouse (France). Dept. d'Etudes et de Recherches en Aerothermodynamique.

### **SIDEWALL BOUNDARY LAYER STUDY, WITH AND WITHOUT SUCTION, FOR THE 150 MM CHORD CAST 7 AIRFOIL AT THE T2 WIND TUNNEL**

J. B. DOR, J. P. ARCHAMBAUD, and J. F. BREIL Dec. 1987 105 p In FRENCH

(Contract PHASE-3075-AN-225-D)

Avail: NTIS HC A06/MF A01

Tests to investigate sidewall effects realized at the T2 transonic wind tunnel equipped with top and bottom adaptive walls are described. The model was the 150 mm chord CAST 7 airfoil tested with fixed transition at 0.5 deg angle of attack. The flow field was studied near the solid sidewall, above the downstream part of the model upper side and in the wake, at Mach number 0.705 and 0.755, utilizing directional boundary layer probing, static pressure measurements, and wall visualizations. Suction rate ( $q$  suction /  $q$  test section) of about 4/1000 was achieved on sidewalls, on the downstream part of the model upperside and around the trailing edge. The velocity distribution on the airfoil, the lift coefficient and the modifications of the sidewall boundary layers (measurements, visualizations) allowed the suction effect to be analyzed. Author

**N89-22585** Georgia Inst. of Tech., Atlanta.  
**CONVERGENCE OF DISCRETE-VORTEX INDUCED-FLOW CALCULATIONS BY OPTIMUM CHOICE OF MESH** Ph.D.

**Thesis**

YIHWAN DANNY CHIU 1988 239 p

Avail: Univ. Microfilms Order No. DA8904804

A brief review of numerical solutions for the lifting thin-airfoil theories for both fixed-wing and rotary-wing problems is presented. Errors are noted in numerical calculations by conventional VORTEX LATTICE METHODS (VLM) for two-dimensional thin-airfoil, Lifting-Line, and Lifting-Surface theories. Emphasis is made on the optimum choice of mesh and collocation points for VLM to ensure that numerical results will converge and that this convergence will be as rapid as possible. The Fourier Series Method of Lifting-Line theory for fixed-wing problems is extended for rotary-wings problems. An efficient and accurate numerical technique is offered to calculate the induced velocities due to trailing vortices. Applications of these new findings are made in order to develop a simple tip-loss formula for lightly-loaded rotors with rectangular planforms. Dissert. Abstr.

**N89-22586** Georgia Inst. of Tech., Atlanta.  
**AERODYNAMICS OF NONRIGID BODIES UNDERGOING LARGE AMPLITUDE TIME-DEPENDENT MOTIONS** Ph.D.

**Thesis**

JATINDER SINGH 1988 191 p

Avail: Univ. Microfilms Order No. DA8904829

A simplified zonal approach is described to evaluate unsteady aerodynamic forces on nonrigid bodies undergoing large amplitude time-dependent motions or deformations. It analyzes unsteady flow in the limit of high Reynolds numbers. The kinematic aspect of the incompressible viscous flows in the form of an integral representation for the velocity vector is utilized to determine the surface vortex sheet strength representing the vorticity content of the boundary layers. Wake is modeled by the vortex filaments and knowing the surface vortex sheet strength and the strengths and locations of the wake vortices, a viscous theory of aerodynamics is then used to evaluate the resulting unsteady aerodynamic forces. The simplified zonal approach is cast into two alternate formulations, namely, the conformal transformation approach and the boundary element approach. The conformal transformation approach allows for the explicit evaluation of the unsteady aerodynamic forces, while the boundary element approach can solve flows about arbitrary bodies. Using the simplified zonal approach, a number of problems were solved for flows around rigid and nonrigid bodies undergoing a variety of prescribed motions. For the bodies undergoing high frequency oscillations or deformations, even for small amplitude motions, well formed vortex clusters dominate the near wake. The movement of these vortex clusters and the time-dependent changes in the strength of the vortex sheets gives rise to the unsteady aerodynamic forces. Results obtained for some problems are compared with the theoretical and experimental results of other researchers and good quantitative agreement is observed.

Dissert. Abstr.

**N89-22587** Georgia Inst. of Tech., Atlanta.  
**A STUDY OF UNSTEADY TURBULENT FLOW PAST AIRFOILS** Ph.D. Thesis

JIUNN-CHI WU 1988 213 p

Avail: Univ. Microfilms Order No. DA8904832

When a helicopter is in forward flight, the aerodynamics of the rotor blade is very complex. The rotor blade may have transonic flow on the advancing side and may experience dynamic stall on the retreating side. In order to predict the characteristics of above complex flow, a solution procedure must be able to predict the large separated flow, unsteadiness, compressibility effects, and turbulence characteristics. For this purpose, an efficient solution procedure solving the two-dimensional and quasi three-dimensional, unsteady, compressible Navier-Stokes equations were developed and applied to rotor blade sections. Specifically, this work addresses the following areas: (1) reliable prediction of static airloads and dynamic stall hysteresis loops for arbitrary airfoils; (2)

investigation of yaw effects on the airload characteristics; (3) transonic and/or stall flutter characteristics; (4) evaluation of algebraic, one-equation and two-equation turbulence models for strongly separated flows. Numerical results show that good prediction of static loads and dynamic stall hysteresis loops of rotor blade sections was feasible. Yaw effects on airloads were predicted to be less profound than observed in experiments. The present solution procedure was found to be capable of predicting transonic and stall flutter. In attached flows the three turbulence models considered gave good correlation with experimental data. For steady or unsteady separated flows, the three turbulence models only exhibit fair correlation with experimental data. No clear trend could be found favoring the use of higher order turbulence models in separated flows. Dissert. Abstr.

**N89-22588** Purdue Univ., West Lafayette, IN.  
**AERODYNAMIC DETUNING OF A LOADED AIRFOIL CASCADE IN AN INCOMPRESSIBLE FLOW BY A LOCALLY ANALYTICAL METHOD** Ph.D. Thesis

HSIAO-WEI DAVID CHIANG 1988 268 p

Avail: Univ. Microfilms Order No. DA8900647

A mathematical model is developed and utilized to demonstrate the enhanced aeroelastic stability and forced response behavior associated with aerodynamic detuning of a rotor operating in an incompressible flow field. The validity of the tuned cascade model and solution technique are demonstrated by considering the steady and unsteady aerodynamics of both theoretical and experimental cascade configurations. To verify the detuned cascade model and influence coefficient technique, predictions from this model are compared to the steady theoretical results and also the tuned cascade unsteady aerodynamic model predictions. The capabilities of this detuned cascade model are then demonstrated by predicting the flutter stability and forced response behavior of detuned rotor configurations. Nonuniform circumferential airfoil spacing and alternate blade structural detuning are both shown to enhance stability. The greatest stability enhancement resulted from a combination of aerodynamic and structural detuning. Also, the unstable baseline configuration can be stabilized by the introduction of splitter blades. For the forced response behavior, both the alternate circumferential spaced detuning and the alternate blade structural detuning can be beneficial on the response amplitude of the airfoils. By including aspect ratio effects, the alternate splitter blade detuning results in significantly reduced amplitudes of response for most cases considered. In conclusion, this detuning analysis has demonstrated that both the aeroelastic stability and forced responsive behavior can be greatly enhanced by aerodynamic detuning. Therefore, aerodynamic detuning appears to be a viable passive control mechanism for aeroelastic problems of an incompressible cascade. Dissert. Abstr.

**N89-22589#** Georgia Tech Research Inst., Atlanta.  
**SUPERSONIC PARTICLE PROBES: MEASUREMENT OF INTERNAL WALL LOSSES** Final Report, 10 Jun. 1986 - 10 Jun. 1988

J. J. IVIE, L. J. FORNEY, and R. L. ROACH Mar. 1989 106 p  
 (Contract F40600-86-K-0004)  
 (AD-A205863; AEDC-TR-88-37) Avail: NTIS HC A06/MF A01  
 CSDL 20/4

The operating characteristics of supersonic particle probes were investigated. The characteristics such as internal wall deposition, pressure recovery, and ease of operation and construction were examined. Three basic probe designs were tested in a cold flow experiment designed to simulate the hot, hostile environment of rocket and jet engine plumes. The probe designs consisted of two internal shock probes (Dehne and Colket probes) and one external shock probe (McGregor probe). In the internal shock probes, the compression from supersonic to subsonic flow occurred either in a constant area throat (Dehne) or at a sudden expansion (Colket). In the external shock, or McGregor probe the shock was positioned slightly outside the entrance of the probe. From deposition studies performed on the probes, three factors were found to enhance deposition. These factors were: (1) shock-boundary layer interaction, (2) particle-

## 02 AERODYNAMICS

boundary layer interaction, and (3) stagnation zones at sudden expansions. The probe with the lowest deposition was a McGregor probe with a 2.0-deg divergence angle. Using test particles with diameters of 1.0, 1.5, 2.0, and 2.5 micron, the average losses in the McGregor probe were 14 percent, whereas in the Colket and Dehne probes, the losses were 18 and 22 percent, respectively. A correlation was developed to predict the deposition (E) in the McGregor probe using Willeke's dimensionless parameter ( $\Omega$ ):  $E = 1011 \Omega + 1.55$ . GRA

**N89-22590#** Naval Postgraduate School, Monterey, CA.  
**COMPUTATIONAL INVESTIGATION OF INCOMPRESSIBLE AIRFOIL FLOWS AT HIGH ANGLES OF ATTACK M.S. Thesis**  
JOHN M. MATHRE Dec. 1988 158 p  
(AD-A205885) Avail: NTIS HC A08/MF A01 CSCL 01/1

Cebeci's viscous/inviscid interaction program was applied to the analysis of steady, two dimensional, incompressible flow past four airfoils, the NACA 66 sub 3-018, 0010 (Modified), 4412 and the Wortmann FX 63-137. Detailed comparisons with the available experimental results show that the essential features are correctly modelled, but that significant discrepancies are found in regions of flow separations. GRA

**N89-22830\*#** Stanford Univ., CA.  
**TRANSITION TO TURBULENCE IN LAMINAR HYPERSONIC FLOW**

JAAP VANDERVEGT *In its Annual Research Briefs*, 1988 p 115-119 Feb. 1989  
Avail: NTIS HC A08/MF A01 CSCL 01/1

Progress in a recently started project aimed at the prediction of transition to turbulence in hypersonic flow is briefly discussed. The prediction of transition to turbulence is a very important issue in the design of space vessels. Two space vehicles currently under investigation, namely the aeroassisted transfer vehicle (AOTV) and the trans-atmospheric vehicle (TAV), suffer from strong aerodynamic heating. This heating is strongly influenced by the boundary layer structure. These aerospace vehicles fly in the upper atmospheric layer at a Mach number between 10 and 30 at very low atmospheric pressures. At very high altitudes the flow is laminar, but when the space vessel returns to a lower orbit, the flow becomes turbulent and the heating is dramatically increased. The prediction of this transition process is commonly done by means of experiments. The experimental facilities available nowadays cannot model the hypersonic flow field accurately enough by limitations in Mach and Reynolds number. These facilities also have a large free stream disturbance level which makes it very difficult to investigate transition accurately. An alternative approach is to study transition by theoretical means. Up to now numerical studies of hypersonic flow only discussed steady laminar or turbulent flow. This theoretical approach is extended to the study of transition in hypersonic flow by means of direct numerical simulations and additional theoretical investigations to explain the mechanisms leading to transition. A brief outline of how this research is to be performed is given. Author

## 03

### AIR TRANSPORTATION AND SAFETY

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

**A89-36069**  
**HUMAN FACTORS IN CABIN SAFETY**

HELEN C. MUIR and CLAIRE MARRISON (Cranfield Institute of Technology, England) Aerospace (UK) (ISSN 0305-0831), vol. 16, April 1989, p. 18-21.

Safety factors which influence the number of survivors in an aircraft emergency are examined. The configurational, procedural, environmental, and behavioral factors (Snow et al., 1970), which

affect the evacuation of an aircraft are discussed. An experimental evacuation simulation program is described, in which incentive payments were given to the first half of the participants evacuating the plane in order to simulate the competition which occurs during many emergencies. Various widths between galley units, seat pitches, and seat vertical projections were tested. Data concerning the behavior of passengers evacuating the plane was obtained from video cameras and questionnaires. Preliminary results showing the usefulness of the method are presented. R.B.

**A89-36117**  
**SUDDEN INFLIGHT INCAPACITATION IN GENERAL AVIATION**  
C. F. BOOZE, JR. (FAA, Civil Aeromedical Institute, Oklahoma City, OK) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 60, April 1989, p. 332-335. refs

This study considered NTSB data and postcrash medical data received by the Medical Statistical Section of the Civil Aeromedical Institute (CAMI), Oklahoma City, OK from 1975-82, and other related literature to estimate the probability of incapacitation in general aviation. Data for the years studied indicate that approximately 3 accidents per 1000 (15 per 1000 fatal accidents) are known to result from the incapacitation of the pilot for all causes. Results suggest that the likelihood of incapacitation increases with age. The occurrence of incapacitation for obvious medical reasons is less than would be expected based on general population morbidity/mortality data; however, the need for continued vigilance in certification, and education regarding flying with known or suspected medical problems, is emphasized. Author

**A89-36122**  
**EXPERIENCES OF ROCKET SEAT EJECTIONS IN THE SWEDISH AIR FORCE - 1967-1987**

PER SANDSTEDT (Forsvarets Forskningsanstalt, Stockholm, Sweden) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 60, April 1989, p. 367-373. refs

From 1967 to 1987, there were 83 successful and 9 fatal ejections with Saab rocket seats in the Swedish Air Force. Medical consequences and injury factors are reviewed. Thirty-nine survivors had nontrivial injuries; four were seriously injured. The risk for injury has been approximately 50 percent throughout the period. Two-thirds of the survivors resumed flying within a week, the remainder after up to 1 year, except for three pilots who terminated their flying status. Author

**A89-38878**  
**THE AVIATION WIRE STRIKE PROBLEM - THE DUTY TO WARN OF THIS AERIAL HAZARD**

PETER ANDREW WARRICK *Journal of Air Law and Commerce* (ISSN 0021-8642), vol. 54, Spring 1989, p. 857-887. refs

Legal issues related to the aircraft safety hazard posed by wires such as transmission or power lines is examined. Federal regulations dealing with wire strike litigation are discussed, including the problem of determining whether or not the aircraft striking the wire was operating in navigable airspace and the question of whether or not aerial wires are sufficiently hazardous obstructions to warrant the costs of disclosure. Aviation wire strike cases against utility companies and the federal government are reviewed. Also, consideration is given to defenses used in such cases, such as the suggestion that a utility company has no duty to warn pilots about the presence of aerial wires and the argument that the primary responsibility to avoid obstructions rests with the pilot. Finally, proposals for resolving aviation wire strike conflicts are presented. R.B.

**A89-39088**  
**COMING TO TERMS WITH TCAS**

JOHN BAILEY *Flight International* (ISSN 0015-3710), vol. 135, April 15, 1989, p. 40-42.

The certification of the U.S. Traffic Alert and Collision-Avoidance System, or 'TCAS', is expected to occur towards the end of 1989; by January 1, 1992, every large transport aircraft operating in U.S. airspace, foreign and domestic, will have to incorporate TCAS.

If the prospective collision-target aircraft has a mode S transponder with datalink capability, the TCAS computers aboard both aircraft will coordinate a complementary vertical-avoidance maneuver. Still under development is a further refinement of TCAS to yield mutual-avoidance maneuvers in the horizontal plane. Airlines with financial or cash-flow constraints may lose substantial revenue if they are unable to outfit their entire fleet with TCAS by 1992.

O.C.

**A89-39200#****CALCULATED AND EXPERIMENTAL STRESSES IN SOLID AND RING SLOT PARACHUTES**

WILLIAM L. GARRARD and MICHAEL L. KONICKE (Minnesota, University, Minneapolis) *Journal of Aircraft* (ISSN 0021-8669), vol. 26, June 1989, p. 590-592. Research supported by Sandia National Laboratories. Previously cited in issue 03, p. 291, Accession no. A87-13815. refs

**A89-39224****ACCIDENT INVESTIGATION AND THE PUBLIC INTEREST - A PILOT'S VIEW**

RUSSELL F. KANE (International Federation of Air Line Pilots' Associations and Airline Pilots' Association of Japan, Accident Investigation Seminar, Tokyo, Oct. 6, 1988) *Zeitschrift fuer Luft- und Weltraumrecht* (ISSN 0340-8329), vol. 38, March 1989, p. 3-20.

New trends in the application of Paragraph 3.1 of Annex 13 (Aircraft Accident Investigation) to the Chicago Convention are discussed. The paragraph states that: 'The fundamental objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability.' The historical background to this Annex is reviewed, and the problem of conflicting and sometimes simultaneous inquiries into the same accident is considered. The problems which arise in a world which appears increasingly prepared to involve pilots in the processes of the criminal and civil laws are addressed.

C.D.

**N89-21778** Purdue Univ., West Lafayette, IN.**DYNAMICS AND CONTROL OF TRUSS STRUCTURES WITH EXTENDING MEMBERS Ph.D. Thesis**

RONG TYAI WANG 1988 137 p  
Avail: Univ. Microfilms Order No. DA8900749

The effectiveness of using extendable truss members to tailor the vibrational characteristics of large truss structures is investigated. In contrast to the conventional control of structures using actuators mounted externally on the structure, the use of extendable truss members allows one to vary the control force internally, and, thus, achieve a change in natural frequencies and damping factors. If the actuator in the extendable member reacts to the member force instantaneously, then a negative gain will give rise to a stiffening effect and damping effect is also magnified. Explicit relations between the apparent structural stiffness and damping factor are derived in this study. If there is a delayed response in the actuator, then the gain must be chosen positive in order to achieve dynamic stability of the system. Further, the value of the gain must be less than unity. It is found that delay-time can be used most effectively to provide significant damping effect. Power transmission through a cell with extendable members is also studied. The power loss of a wave passing through this cell is found to depend highly on the modes of wave and on its wavelength. The potential use of the extendable members in the cells at the boundary of the structure is also investigated. For a wave with given frequency, it is possible to design the internal control force to completely absorb the energy of the incident wave. For large truss structures consisting of repeating identical cells, the dynamic characteristics can be found from the typical cell. A simple procedure is presented to derive natural frequencies of large structures from a single cell characteristics. Dissert. Abstr.

**N89-21779#** Aeronautical Systems Div., Wright-Patterson AFB, OH.

**GROUND COLLISION WARNING SYSTEM PERFORMANCE CRITERIA FOR HIGH MANEUVERABILITY AIRCRAFT Final Report**

DIANE S. SHAH 1 Dec. 1988 31 p  
(AD-A204390; ASD-TR-88-5034) Avail: NTIS HC A03/MF A01 CSCL 01/4

Controlled flight into terrain (CFIT) constitutes a large category of Class A mishaps. CFIT occurs when the pilot's attention is diverted in a controllable aircraft resulting in impact with the ground. Warning systems which provide aural warning of impending CFIT have existed in commercial aircraft for some time. Because tactical aircraft operate at low altitudes and have high performance capabilities, systems for commercial aircraft have not proven suitable for tactical aircraft. Due to differences in missions, sensors, hardware configurations, performance capability, etc., each warning system developed for a tactical aircraft will be unique. This report presents performance criteria for use in developing a ground collision warning system for tactical aircraft.

GRA

**N89-21780#** Simula, Inc., Phoenix, AZ.

**THE NAVAL AIRCRAFT CRASH ENVIRONMENT: AIRCREW SURVIVABILITY AND AIRCRAFT STRUCTURAL RESPONSE Final Report, Sep. 1982 - May 1988**

JOSEPH W. COLTMAN and STEPHEN M. ARNDT 9 Sep. 1988 100 p  
(Contract N62269-82-C-0275; F41-400)  
(AD-A204825; TR-88490; NADC-88106-60) Avail: NTIS HC A05/MF A01 CSCL 01/2

A study was conducted of U.S. Navy and Marine Corps flight mishaps occurring during the 10-year period of January 1972 to December 1981. One hundred eighty-four helicopter mishaps and 71 maritime aircraft (fixed-wing aircraft without ejection seats) mishaps were examined. Each flight mishap was reconstructed to determine orientation and velocity of the aircraft during the principal impact. Statistical distributions of impact parameters were tabulated for mishaps determined to be survivable. In addition, occupant injuries in each mishap were examined and a hazard which contributed to the injury was assigned. The cost of injuries associated with each hazard were identified and used as criteria for ranking the severity of the hazards. It was found that a significant number of major and fatal injuries occur in helicopter flight mishaps classified as survivable. The hazards which contribute to many of these injuries could be reduced in future helicopter designs through the incorporation of current crashworthiness design criteria (which was not imposed on the fleet examined in this study). A similar analysis of injuries and hazards in maritime aircraft flight mishaps indicates that selective use of crashworthy components would be beneficial; however, adoption of a crashworthiness specification to govern an entire aircraft design does not appear to be justifiable by the injury and cost statistics.

GRA

**N89-21781#** Federal Aviation Administration, Atlantic City, NJ. Technical Center.

**DESCRIPTION OF THE DERIVATION OF THE COLLISION RISK MODEL USED IN THE VERTICAL SEPARATION SIMULATION RISK MODEL**

JOSEPH M. RICHIE Feb. 1989 20 p  
(AD-A205109; DOT/FAA/CT-TN88/38) Avail: NTIS HC A03/MF A01 CSCL 17/7

This report presents a brief description of the derivation of the collision risk equations for the use on the vertical separation Midair Collision Simulation Risk Model. It also describes the estimation of the Collision Risk Model parameters for the current 2000-foot standard and the proposed 1000-foot planned vertical separation standard. The model itself consist of specialized computer programs and systematic procedures that realistically and economically simulate aircraft flight-planned movements in the National Airspace System (NAS). These aircraft movements are based on flight plans and tracking data transmitted to Central Flow Control Facility (CFCF) from all the 20 centers that make up the NAS. The task is to find the frequency, Na, with which a pair

### 03 AIR TRANSPORTATION AND SAFETY

of aircraft flying at and above flight level (FL)290 would, by flight-planned intent, be proximate (near each other) in the NAS. The purpose of this mathematical model is to make a quantitative judgement about the safety of the proposed 1000-foot vertical separation, and provide an estimate of the risk of midair collision due to the loss of 1000-foot planned vertical separation. As the result of this first phase of the study, it is recommended that the model be enhanced to do the following: (1) step climbing, and (2) point-to-point navigation. GRA

**N89-22591#** Office of Technology Assessment, Washington, DC.

#### **SAFE SKIES FOR TOMORROW: AVIATION SAFETY IN A COMPETITIVE ENVIRONMENT**

Jul. 1988 194 p  
(PB89-114318; OTA-SET-381; LC-88-600550) Avail: NTIS HC A09/MF A01; also available SOD HC \$8.50 as 052-003-01126-3 CSCL 01/3

How well existing safety policies, regulations and technologies meet the government's responsibility for ensuring safety in commercial aviation are assessed and the role and capability of FAA to carry out its function are reviewed. Author

**N89-22592#** Sandia National Labs., Albuquerque, NM. Parachute Systems Div.

#### **TESTING OF A NEW RECOVERY PARACHUTE SYSTEM FOR THE F111 AIRCRAFT CREW ESCAPE MODULE: AN UPDATE**

DONALD W. JOHNSON 1989 7 p Presented at the 10th AIAA Aerodynamic Decelerator Systems Technical Conference, Cocoa Beach, FL, 18 Apr. 1989  
(Contract DE-AC04-76DP-00789; AF PROJ. SM-MMK-87-10-324) (DE89-007139; SAND-89-0410C; CONF-8904118-4) Avail: NTIS HC A02/MF A01

A new recovery parachute system has been designed for the F111 crew escape module (CEM). The system includes a cluster of three 49 ft diameter ringslot-solid parachutes, a Kevlar deployment bag, and an explosively fired drogue gun to deploy the pilot parachute. Tests have been conducted that indicate the parachute system will meet the rate of descent requirement of 25 ft/sec at 5000 ft pressure altitude. To control the drag load developed by the parachutes, a new central reefing/disreefing system has been developed. Since the recovery parachute system is normally deployed crosswind from the CEM, line sail of the suspension lines during early tests was a problem but has been minimized by a dual pilot parachute system. DOE

**N89-22593#** National Transportation Safety Board, Washington, DC.

#### **AIRCRAFT ACCIDENT REPORT: TRANS-COLORADO AIRLINES, INC., FLIGHT 2286, FAIRCHILD METRO 3, SA227 AC, N68TC BAYFIELD, COLORADO, JANUARY 19, 1988**

4 Feb. 1989 91 p  
(PB89-910401; NTSB/AAR-89/01) Avail: NTIS HC A05/MF A01 CSCL 01/3

About 1920 mountain standard time on January 19, 1988, N68TC, a Trans-Colorado Airlines Inc., Fairchild Metro 3, operating as a Continental Express flight 2286 from Stapleton International Airport, Denver, Colorado, with 2 flightcrew members and 15 passengers on board, crashed on approach to Durango, Colorado. The two flightcrew members and seven passengers were killed as a result of the accident. The National Transportation Safety Board determines that the probable cause of this accident was the first officer's flying and the captain's ineffective monitoring of an unstabilized approach which resulted in a descent below the published descent profile. Contributing to the accident was the degradation of the captain's performance resulting from his use of cocaine before the accident. The safety issues examined include the execution of a special approach by flightcrews and the effects of cocaine on human performance. Author

**N89-22594#** Wichita State Univ., KS. Inst. for Aviation Research.

#### **ELECTRO-IMPULSE DE-ICING RESEARCH: FATIGUE AND ELECTROMAGNETIC INTERFERENCE TESTS Final Report**

G. W. ZUMWALT, R. A. FRIEDBERG, and J. A. SCHWARTZ Mar. 1989 64 p  
(DOT/FAA/CT-88/27) Avail: NTIS HC A04/MF A01

Electro-Impulse Delcing (EIDI) was recently developed and tested with very encouraging results. Questions remain, however, regarding the fatigue life and electromagnetic compatibility of the system. Fatigue tests were conducted on two production aluminum wing leading edges and one composite material leading edge. These were done at realistic temperatures and impulse energies for an estimated aircraft lifetime of ice protection. Coil mounting brackets were the main casualties. Wing components did not fail. Tests were also conducted for metal and composite wings of electromagnetic radiation of EIDI over a wide frequency range. The aluminum wing was found to be an excellent shield. All wires external to the aluminum wing were shown to require careful shielding. The composite wing required all wiring and the metal doublers to be shielded and grounded. Author

### 04

### AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

**A89-36592**

#### **AVSAT - THE FIRST DEDICATED AERONAUTICAL SATELLITE COMMUNICATIONS SYSTEM**

D. K. DEMENT (Aeronautical Radio, Inc., Annapolis, MD) IN: International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings. London, Institution of Electrical Engineers, 1988, p. 73-77.

ARINC has taken steps to establish a global aeronautical satellite communication system. Plans call for initiation of thin-route dataoperations in 1989, upgrading to establish voice communications via shared spot-beam transponders carried on other satellites, and deploying a worldwide network using dedicated satellites in the mid 1990's. Spectrum availability and system design considerations are assessed, and AvSat link budgets are examined. B.J.

**A89-36594**

#### **TECHNICAL DESIGN AND PERFORMANCE ANALYSIS OF AERONAUTICAL SATELLITE COMMUNICATION SYSTEMS**

Y. YASUDA, M. OHASHI, F. SUGAYA, and Y. HIRATA (Kokusai Denshin Denwa Co., Ltd., Tokyo, Japan) IN: International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings. London, Institution of Electrical Engineers, 1988, p. 87-91. refs

The technical design aspects of aeronautical satellite communication systems are highlighted, and the system performance is analyzed taking the Inmarsat system parameters into account. The bit interleaving size and the link budget are examined. In addition, the BER improvement by concatenated FEC coding using Reed-Solomon (RS) outer code is evaluated, and the parameters of RS codes, which can markedly reduce the BER without symbol interleaving at the Viterbi decoder output, are proposed. B.J.

**A89-36595**

#### **FIELD TRIALS OF AERONAUTICAL SATELLITE COMMUNICATION SYSTEM**

F. MAKITA, H. NAKAMURA, S. KASHIWABARA (Kokusai Denshin Denwa Co., Ltd., Tokyo, Japan), K. KOSAKA (Ministry of Posts and Telecommunications, Communication Research Laboratory,

Koganei, Japan), K. MAEKITA (Japan Air Line, Co., Ltd. Tokyo) et al. IN: International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings. London, Institution of Electrical Engineers, 1988, p. 92-96. refs

Several field trials and demonstrations of aeronautical satellite communications for aviation authority, airline, and passenger use, employing the Inmarsat space segment, have been conducted and planned in recent years. The experimental system used for the field trials consists of 9.6 kbit/s APC-MLQ, a rate 1/2 FEC codec using Viterbi decoding, and an interleaver. The field tests of the aeronautical satellite communication system were conducted in accordance with Inmarsat specifications, and the feasibility of the system was verified. B.J.

#### A89-36596

##### **COLLABORATIVE EXPERIMENTS INVOLVING A SATELLITE BASED DATA LINK FOR AIR TRAFFIC SERVICES**

G. A. COOKE (Civil Aviation Authority, London, England) and M. E. COX (EUROCONTROL, Brussels, Belgium) IN: International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings. London, Institution of Electrical Engineers, 1988, p. 102-106.

The paper describes experiments devised by the UK Civil Aviation Authority (CAA) and Eurocontrol involving a satellite-based data link for air traffic services. The CAA's main interest is in satellite communications and surveillance to support air traffic services for aircraft flying over the North Atlantic region, while Eurocontrol's main interest is in the transition region between oceanic and continental airspace. B.J.

#### A89-36618

##### **COMMUNICATION AND RANGING SYSTEMS FOR NAVIGATION EXPERIMENT USING ENGINEERING TEST SATELLITE V**

A. ISHIDE (Ministry of Transport, Electronic Navigation Research Institute, Mitaka, Japan) IN: International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings. London, Institution of Electrical Engineers, 1988, p. 222-226.

The communication and ranging systems for a navigation experiment using ETS-V are described. The system equipment was designed to give voice and data communication as well as ranging capabilities using small aircraft antennas. The expected characteristics were obtained in the laboratory test. K.K.

#### A89-38513

##### **FUNDAMENTALS OF THE MAINTENANCE OF THE RADIO-ELECTRONIC EQUIPMENT OF AIRCRAFT [OSNOVY EKSPLOATATSII RADIOELEKTRONNOGO OBOURODOVANIYA LETATEL'NYKH APPARATOV]**

KONSTANTIN I. PAVLENKO Moscow, Voennoe Izdatel'stvo, 1988, 168 p. In Russian. refs

The fundamental principles of the maintenance and repair of the radio-electronic equipment of aircraft are presented in a systematic manner. The discussion covers the concepts and characteristics of the reliability of radio-electronic equipment and factors affecting reliability; analysis of the technical condition of radio-electronic equipment; diagnostics and failure prevention; and technical aspects of flight reliability. Attention is also given to the organization and technical aspects of the maintenance and repair of the radio-electronic equipment of aircraft. V.L.

#### A89-39203

##### **INTERFEROMETRY AGAINST DIFFERENTIAL DOPPLER - PERFORMANCE COMPARISON OF TWO EMITTER LOCATION AIRBORNE SYSTEMS**

N. LEVANON (Tel Aviv University, Israel) IEE Proceedings, Part F: Radar and Signal Processing (ISSN 0143-7070), vol. 136, pt. F, no. 2, April 1989, p. 70-74.

A comparative random error analysis of two airborne systems that provide the location of a stationary emitter is presented. Both systems utilize only two airborne receivers. In the interferometric

system, the separation between the receivers (baseline) is of the order of one wavelength, and the phase measurements yield bearing measurements. In the differential Doppler system, the baseline can extend to the full length of the aircraft, and phase measurements yield accumulated range difference. Both systems employ the Gauss-Newton iterative algorithm to obtain an unbiased least-squares estimate of the emitter location. Simple analytical expressions are obtained for the random error of both systems when the observation section is centered near the point of closest approach. Results of Monte Carlo computer simulations are also presented which confirm the theoretical error expressions.

Author

#### A89-39500#

##### **FORMULATION OF GAIN AND IMPEDANCE RELATIONS FOR CORNER REFLECTORS EMPLOYED IN CONJUNCTION WITH LOCALIZER ANTENNA ARRAYS**

M. C. CHANDRA MOULY, P. S. K. SATYA PRASAD (VRS Engineering College, Vijayawada, India), and V. V. RAM PRASAD Institution of Engineers (India), Journal, Electronics and Telecommunication Engineering Division (ISSN 0251-1096), vol. 68, May 1988, p. 54-58. refs

Equations which can be used to compute the gain, and mutual and effective impedances of 90 and 60 deg conventional corner reflectors and a 60 deg truncated corner reflector are presented. Sine and cosine integrals were used. The values obtained for gain and impedance for 90 deg conventional corner reflectors agreed with published values. K.K.

#### A89-39827

##### **AIRCRAFT AUTOMATIC LANDING SYSTEMS USING GPS**

B. W. PARKINSON and K. T. FITZGIBBON (Stanford University, CA) Journal of Navigation (ISSN 0373-4633), vol. 42, Jan. 1989, p. 47-59. refs

An account is given of the design and simulation of an aircraft automatic landing system employing state-of-the-art carrier-tracking GPS receivers to measure aircraft position and velocity. The capability hypothesized has its basis in measurements taken on a five-channel receiver in an integrated Doppler-aiding mode. In some of the autopilot designs considered, either ground-based GPS transmitters or a radar altimeter was incorporated. The landing simulations encompassed wind shears and a gust model for the sake of realism; lateral and vertical displacement performance figures are presented with their 10 rms estimation errors during the glide-slope and flare phases. O.C.

#### A89-39829

##### **AUTOMATIC CONFLICT DETECTION LOGIC FOR FUTURE AIR TRAFFIC CONTROL**

S. RATCLIFFE Journal of Navigation (ISSN 0373-4633), vol. 42, Jan. 1989, p. 92-106. refs

The development of techniques for the construction of very reliable hardware, as well as of verifiable software, is underway for automatic ATC flight path conflict-resolution detection. A simple, brute-force computer-simulation exploration of trajectories has proven capable of revealing that the worst-case performance of the threat detector can be substantially poorer than would be expected from the values assigned to the logic parameters, or from an analysis that proceeds from the assumption that the threat aircraft is proceeding along a straight-line path. O.C.

#### A89-39830

##### **BENEFITS OF 'AREA NAVIGATION' IN REGIONAL AVIATION**

D. M. WALLACE (U.S. Institute of Navigation, Annual Meeting, Annapolis, MD, June 1988) Journal of Navigation (ISSN 0373-4633), vol. 42, Jan. 1989, p. 124-128.

The present evaluation of the development status of aircraft area-navigation systems, or 'RNAV', as encountered in 'hub and spoke' route operations, notes that such regional carriers as Air Ontario can simultaneously improve service and lower costs by employing RNAV. The bases for these performance improvements are improved cross-track and along-track navigation, less maneuvering in the departure and arrival phases of flights, the



## 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

use of vertical navigation to optimize altitude, and the alternative use of either separate access or simultaneous converging approaches, as well as independent departure profiles. O.C.

**N89-21782#** National Aeronautical Establishment, Ottawa (Ontario).

### **AN INVESTIGATION OF LATERAL TRACKING TECHNIQUES, FLIGHT DIRECTORS AND AUTOMATIC CONTROL COUPLING ON DECELERATING IFR APPROACHES FOR ROTORCRAFT**

S. BAILLIE, S. KERELIUK, and R. HOH Oct. 1988 63 p  
(AD-A202910; NAE-AN-55; NRC-29604) Avail: NTIS HC A04/MF A01 CSCL 01/3

An in-flight simulation experiment was performed to investigate the impact on handling qualities and certification of various issues associated with low minima decelerating flight directed IFR approaches for rotorcraft. These issues were the use of crab versus sideslip techniques to maintain lateral tracking under crosswind conditions, the effects of various methods of vertical axis (glideslope) display, guidance and control, and the benefits of coupling flight director signals directly to the rotorcraft control actuators. The program was performed using the NAE Bell 205 Airborne Simulator and was partially funded by the United States Federal Aviation Administration. Experimental results demonstrated that crab technique approaches were satisfactory for all approach speeds and wind conditions investigated (up to 30-knot crosswinds). A factor not addressed in this study was the visual orientation of the landing pad at breakout to flight with visual references. Sideslipping approaches were also shown to be satisfactory until the steady state lateral acceleration exceeded approximately 0.07 G. While coupling of the collective actuator directly to the flight director provided the best glideslope tracking, evaluations showed that the configuration with A 2-cue (pitch and roll) flight director, using only a raw glideslope presentation, provided satisfactory handling qualities and was considered by FAA single DOT representative to be certifiable for IFR flight. GRA

**N89-21783#** Federal Aviation Administration, Atlantic City, NJ. Technical Center.

### **INSTRUMENT LANDING SYSTEM MATHEMATICAL MODELING STUDY FOR ORLANDO INTERNATIONAL AIRPORT RUNWAY 17R LOCALIZER, ORLANDO, FLORIDA, REVISED AIRSIDE DOCKING PLAN (SCHEME 3A)**

JAMES D. RAMBONE and JOHN E. WALLS Nov. 1988 33 p  
(AD-A204722; DOT/FAA/CT-TN89/1) Avail: NTIS HC A03/MF A01 CSCL 01/5

Upon the completion of a preliminary modeling effort described in Technical Note DOT/FAA/CT-TN88/35, ILS Mathematical Modeling Study for Orlando International Airport Runway 17R, ASO-430 provided a final version of an airside ramp utilization plan (Scheme 3A) for the Orlando Airport. This necessitated an additional modeling effort due to changes in aircraft docking arrangements, the addition of taxiing aircraft, and a Delta ramp operations control tower. Computed data are presented showing the effects of airside terminals with simulated docked and taxiing aircraft on the performance of an ILS localizer proposed for runway 17R at the Orlando International Airport. The Southern Region is concerned that reflections from two proposed airside terminals with docked and taxiing aircraft may degrade the localizer course beyond category 2/3 tolerances. Modeled course structure results indicate that marginal category 2/3 localizer performance should be obtained with the Wilcox Mark 3, 14-element, dual-frequency log periodic antenna and both airside terminals with docked and taxiing aircraft at the currently proposed locations, excluding aircraft taxiing parallel to the runway. Category 2/3 course structure results are not obtained when the parallel taxiing aircraft are included in the reflecting source configuration. Computed clearance orbit results indicate satisfactory linearity, course crossover, and signal clearance levels. GRA

**N89-21784#** Mitre Corp., McLean, VA.

### **A PROCEDURE FOR OPERATING DEPENDENT INSTRUMENT APPROACHES TO CONVERGING RUNWAYS**

BERNARD LISKER Sep. 1988 67 p

(Contract DTFA01-84-C-0001)

(AD-A204723; MTR-88W125; DOT/FAA/DS-88/09) Avail: NTIS HC A04/MF A01 CSCL 17/7

This report introduces an air traffic control procedure that allows two staggered streams of aircraft, flying under Instrument Flight Rules (IFR), to approach and land on converging runways. The staggered arrivals provide adequate separation assurance between aircraft in the event of consecutive missed approaches. Unlike existing converging approach procedures, the new procedure allows Decision Heights (DHs) down to 200 feet, yielding arrival capacity improvements from 4 to 63 percent over single-runway operations. The report discusses currently approved converging approach procedures, their advantages and limitations, as well as the motivation for developing a new procedure. The new procedure is explained in detail and a 17-airport benefit analysis is included. That analysis concludes that the procedure introduced here can be implemented advantageously at several airports. GRA

**N89-21785#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

### **FUNCTIONAL PERFORMANCE SPECIFICATION FOR AN INERTIAL NAVIGATION SYSTEM Final Report**

B. C. MEYERS and NELSON H. WEIDERMAN Oct. 1988 48 p  
(Contract F19628-85-C-0003)  
(AD-A204850; CMU/SEI-88-TR-23; ESD-TR-88-024) Avail: NTIS HC A03/MF A01 CSCL 17/7

This document defines the functional and performance requirements for the inertial navigation system simulator that interfaces with the external computer system (ECS) simulator. Both the INS simulator and the ECS simulator are being developed in Ada by the Real-Time Embedded Systems Testbed Project. The INS simulator is similar to a real-world InS, but has reduced functionality. This document provides specifications for the major functions on the INS simulator. GRA

**N89-22595#** Civil Aeromedical Inst., Oklahoma City, OK.

### **STUDIES OF POSTSTRIKE AIR TRAFFIC CONTROL SPECIALIST TRAINEES. PART 2: SELECTION AND SCREENING PROGRAMS**

CAROL A. MANNING, PAMELA S. KEGG, and WILLIAM E. COLLINS Jul. 1988 25 p  
(AD-A199177; DOT/FAA/AM-88/3) Avail: NTIS HC A03/MF A01

Specific contributions of aviation psychologists to the selection and Academy training of FAA air traffic control specialists are presented in a historical context. Research results which formed the basis for the written aptitude selection tests, The Occupational Knowledge Test (for assessing prior experience), and the pass/fail screens for the Academy's nonradar and radar programs are noted. Results of continuing validation research on all aspects of these selection/screening programs are presented in detail as well as the means by which the results are used to: (1) predict training and performance outcomes; (2) model the impact of program changes; (3) allow the introduction of changes (improvements) without compromising the validity of the programs; and (4) assure compliance with the Uniform Guidelines on Employee Selection Procedures. The application of this line of research has produced considerable cost benefits to the agency. Author

**N89-22596#** Federal Aviation Administration, Washington, DC.

### **NATIONAL AIRSPACE SYSTEM PLAN: FACILITIES, EQUIPMENT, ASSOCIATED DEVELOPMENT AND OTHER CAPITAL NEEDS**

Jun. 1988 364 p  
(AD-A202615; AD-E900870) Avail: NTIS HC A16/MF A01 CSCL 01/4

This is the sixth annual update of the NAS Plan. The Plan addresses the compelling problems of how best to improve safety and efficiency, accommodate spiraling demands for aviation services, deal with the problems of aging or obsolete facilities, recognize and users desires for minimal restrictions on the use of the airspace, allow for a reduced Federal role, and create a foundation for continued evolution which exploits newer tech-

nologies and developments obtained through continuing research. The recurring theme throughout the Plan is that the solution lies in greater use of automation, consolidations of major facilities, and application of cost effective technological solutions. Topics of interest included in this update follow: Demand on the System; Air Traffic Control System - En Route, Terminal, and Flight Service and Weather; Ground-to-Air Systems; Interfacility Communications Systems; Maintenance and Operations Support Systems; Other Capital Needs; and Transition. GRA

**N89-22598#** Service Hydrographique et Oceanographique de la Marine, Paris (France). Section Geodesie-Geophysique.  
**GEODETIC POSITIONING SYSTEM FOR FLYING AIRCRAFT (MAY 1987) [POSITIONNEMENT GPS D'UN AVION EN VOL (MAI 1987)]**

GILDAS COZIAN Nov. 1988 49 p In FRENCH  
(REPT-013/88; ETN-89-94358) Avail: NTIS HC A03/MF A01

Flight tests were performed in on a Caravelle aircraft to evaluate a geodetic positioning system. A Strada laser trajectographic system furnished a precision submetric reference used to evaluate the real time geodetic position values and the same after differential data treatment. The tests show that the receiver allows in real time to determine the position of a flying aircraft with a three-dimensional precision better than 50 m. After differential treatment the precision is 5 m. ESA

## 05

## AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

**A89-36575**  
**V-22 PREPARED FOR FURTHER EXPANSION OF FLIGHT ENVELOPE**

CAROLE A. SHIFRIN Aviation Week and Space Technology (ISSN 0005-2175), vol. 130, April 10, 1989, p. 34-36, 40.

The initial test sequences of the V-22 'Osprey' tilt-rotor VTOL aircraft have been successfully performed in the helicopter-hover mode during nine separate flights totaling 2.3 hours. The flight envelope will now be expanded to a 60-kt airspeed and a ground taxi speed of 40 kt. The first three flights were limited to a speed of 20 kt at 30-ft altitude. The complete process of initial envelope expansion is expected to take 20-40 weeks, while incorporating modifications and revising test instrumentation. The next major step in the process will be the expansion of the 'airplane' operation envelope, with the nacelles pointed fully forward. O.C.

**A89-36899\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.  
**HELICOPTERS AND VTOL. I**

JOHN S. BURKS (NASA, Ames Research Center, Moffett Field, CA) Exxon Air World (ISSN 0014-5068), vol. 41, no. 1, 1989, p. 39-41.

Performance projections into the next half-century of VTOL aircraft design are presently made on the basis of recent design trends. Attention is given to the technology-development and commercial prospects for tilt-rotor, thrust-vectoring hover, lighter-than-air, and speculative electromagnetic-propulsion, remotely-beamed power systems. Highly automated air traffic control systems are envisioned which will incorporate AI, satellite positioning, synthetic vision, obstacle detection/avoidance and fiber-optic transmission to safely manage giant airborne mass-transit commuter systems. It is expected that tilt-rotor aircraft will become the dominant VTOL configuration as time passes. O.C.

**A89-37019#**

**COMPUTER SIMULATION OF THE MOVEMENT OF LOADING DOOR RETRACTION MECHANISM WITH SLIDE TRACKS**  
DEKANG XIE and ZHENGPING WANG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 9, Dec. 1988, p. B645-B647. In Chinese, with abstract in English.

The movement of loading door retraction mechanism with slide track of an airplane is investigated. The mathematical model is established on the basis of selected geometrical parameters of the mechanism. The retracting movement of the loading door is simulated on a digital computer with the coordinates of the moving points computed step by step. The process of retraction is displayed on the screen for the examination of the fulfillment of design requirements. Adjustment of parameters can be made if necessary during the computation. Author

**A89-37650#**

**GUST ANALYSIS OF AN AIRCRAFT WITH HIGHLY NON-LINEAR SYSTEMS INTERACTION**

G. VINNICOMBE (Cambridge University, England), M. HOCKENHULL, and A. E. DUDMAN (British Aerospace, PLC, Civil Aircraft Div., Filton, England) AIAA, ASME, ASCE, AHS, ASC, Structures, Structural Dynamics and Materials Conference, 30th, Mobile, AL, Apr. 3-5, 1989. 8 p. refs  
(AIAA PAPER 89-1377)

A new method of continuous turbulence Design Envelope Analysis is presented which is equivalent to existing techniques for a linear aircraft model but is also appropriate to nonlinear aircraft models. Rice's equation for level exceedence rates of a stationary, Gaussian, stochastic process is used to define a nonlinear aircraft design gust load and a procedure for estimating this load is developed. This method has recently been used for certification of the Airbus A320, which incorporates a nonlinear gust load alleviation system, and some results of this analysis are presented in order to illustrate the technique. Author

**A89-37660**

**PASSENGER SEAT DESIGN COMMERCIAL TRANSPORT AIRCRAFT**

SAE Aerospace Recommended Practice, SAE ARP 750, Nov. 19, 1987, 9 p. refs  
(SAE ARP 750)

Design criteria beyond the minimum standards set down in FAR which are conducive to the formulation of seat structural designs furnishing the greatest safety margins for airliner passengers are discussed. Illustrative of these design practices is the requirement that seats equipped with integral food-tray tables will, during emergency landings, allow such a structure, in fully open position, to fail upon the exertion of a certain amount of loading in a way that does not expose occupants to any sharp points or edges. Underseat baggage restraint systems must prevent baggage from becoming loose articles prone to entering the aisles. O.C.

**A89-38028**

**PREDICTION OF FATIGUE LIFE UNDER AIRCRAFT LOADING WITH AND WITHOUT USE OF MATERIAL MEMORY RULES**

A. BUCH (Technion - Israel Institute of Technology, Haifa) International Journal of Fatigue (ISSN 0142-1123), vol. 11, March 1989, p. 97-105. refs

The use of correction factors in loading distributions to improve the accuracy of fatigue life predictions is described. Consideration is given to aircraft wing maneuver and gust loading programs as well as to the effect of reference stress, notch geometry, loading order, and loading spectrum modifications. It is found that application of conventional material memory rules in LSA1 (cycle-by-cycle calculation) does not reduce the scatter of  $N(\text{pred})/N(\text{exp})$  ratios in comparison to LSA2 (block-by-block counting). K.K.



## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

**A89-38498**

**OPTIMIZATION OF FLIGHT REGIMES ACCORDING TO ECONOMIC CRITERIA (2ND REVISED AND ENLARGED EDITION) [OPTIMIZATSIYA REZHIMOV POLETA PO EKONOMICHEskim KRITERIAM /2ND REVISED AND ENLARGED EDITION/]**

STANISLAV I. SKRIPNICHENKO Moscow, Izdatel'stvo Mashinostroenie, 1988, 153 p. In Russian. refs

The economic foundations of the optimization of flight regimes are presented, and cost criteria are described. The structure of operating costs for different flight regimes (cruising, ascending and descending, and maneuvers) is examined. Algorithms are presented for determining optimal regimes and the influence of various operating and economic factors, including aircraft weight, wind, air temperature, and fuel costs. Calculation examples are presented.

B.J.

**A89-38554\*** Princeton Univ., NJ.

**EXPERIMENTAL STUDIES IN SYSTEM IDENTIFICATION OF HELICOPTER ROTOR DYNAMICS**

ROBERT MCKILLIP, JR. (Princeton University, NJ) Vertica (ISSN 0360-5450), vol. 12, no. 4, 1988, p. 329-336. refs (Contract NAG2-415)

Recent experiments investigating the system identification of helicopter rotor dynamics are described. The identification makes use of a two-pass procedure that estimates the rotor dynamic states prior to estimation of the dynamic equation parameters. Estimation of the rotor states is made possible through use of the predictive information contained in blade-mounted accelerometers combined with a specialized processing scheme utilizing these signals. Descriptions of the experimental hardware and the system identification technique are given, as well as implementation issues for using the procedure on other similarly instrumented rotor blades. Finally, comparisons with other identification techniques using the same data are presented. It is demonstrated that the approach is an attractive one for measurement of a helicopter rotor's dynamic behavior.

Author

**A89-38652**

**EXTENSION OF CLASSICAL TIP LOSS FORMULAS**

DAVID A. PETERS and YIH-WAN CHIU (Georgia Institute of Technology, Atlanta) American Helicopter Society, Journal (ISSN 0002-8711), vol. 34, April 1989, p. 68-71. Research sponsored by the U.S. Army. refs

The differences between various tip loss formulas are examined and a new unified tip loss formula that is reasonable over the entire range of rotor parameters is presented. The assumptions of Prandtl's analytic solution are modified to obtain a more general tip loss formula that includes the effects of wake spacing and aspect ratio in a consistent manner for all values of the normalized wake spacing and normalized chord. The formula can be expressed in two equivalent ways.

K.K.

**A89-39086**

**COMPOSITES - HELICOPTERS LEADING THE WAY**

JAMES H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 9, May 1989, p. 19-26.

Helicopter manufacturers have aggressively developed composite structural components in order to capitalize on the ability to fabricate large, integral components requiring few fasteners, as well as to take advantage of the tailoring of material mechanical property characteristics that different reinforcement types and directions, in conjunction with a variety of matrices, can furnish. Important structural components now widely produced from polymer-matrix composites are primary rotor blades and bearingless hubs, driveshafts, tail rotors, and airframes. Illustrative examples of prepreg tape layup and large structure autoclaving processes are discussed.

O.C.

**A89-39193\*#** Wichita State Univ., KS.

**ELECTROIMPULSE DEICING - ELECTRODYNAMIC SOLUTION BY DISCRETE ELEMENTS**

W. D. BERNHART and R. L. SCHRAG (Wichita State University,

KS) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 547-553. Previously cited in issue 07, p. 945, Accession no. A88-22016. refs (Contract NAG3-284)

**A89-39194\*#** Toledo Univ., OH.

**TWO-DIMENSIONAL SIMULATION OF ELECTROTHERMAL DEICING OF AIRCRAFT COMPONENTS**

W. B. WRIGHT, T. G. KEITH, JR., and K. J. DE WITT (Toledo, University, OH) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 554-562. Previously cited in issue 07, p. 946, Accession no. A88-22208. refs (Contract NAG3-72)

**A89-39198#**

**WING-STORE FLUTTER ANALYSIS OF AN AIRFOIL IN INCOMPRESSIBLE FLOW**

ZHI-CHUN YANG and LING-CHENG ZHAO (Northwestern Polytechnic University, Xian, People's Republic of China) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 583-587. refs

The flutter of two-dimensional airfoil with external store is analyzed to investigate the effects of pylon stiffness on flutter speed. Among the 40 configurations studied, five were tested in the wind tunnel to verify the analytical results. The variations of wing-store flutter speed with the pylon stiffness can basically be divided into three types. The curves of the normal and flutter frequencies vs pylon stiffness have the same pattern. They can be sketched approximately by the aid of the normal frequencies of the two degenerated two-degree-of-freedom systems, i.e., the freely hinged and rigidly connected store cases. A limiting flutter speed for very small pylon stiffness is deduced, which is useful to identify which type of flutter the configuration studied belongs to.

Author

**A89-39199#**

**FLUTTER ANALYSIS OF THE CF-18 AIRCRAFT AT SUPERSONIC SPEEDS**

B. H. K. LEE (National Research Council of Canada, Ottawa) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 588-590. Research supported by DND. refs

The 'harmonic gradient' and 'source distribution' methods for supersonic aircraft aerodynamic computation are presently compared for the cases of an F-18 wing surface pressure distributions and NASTRAN computation-based mode shape flutter behavior. For rigid-body modes, good agreement is obtained in pressure distributions except for high reduced frequencies near the wingtip. Agreement is also established between the two aerodynamic methods' flutter results.

O.C.

**A89-39226**

**GOOD PROSPECTS FOR LET'S 40-SEATER**

BRIAN WANSTALL Interavia (ISSN 0020-5168), vol. 44, April 1989, p. 321-323.

The Czechoslovak commercial aircraft manufacturer LET is scheduled to begin delivering the L-610 twin-turboprop 40-seat commuter airliner in 1991; the 40 new aircraft on order from the Czechoslovak national airline, CSA, will take the place of the current fleet of less fuel-efficient Yak-40 airliners. The L-610 will incorporate air conditioning, cabin pressurization, an APU, and high-pressure hydraulics. The powerplant chosen for the L-610 is the three-spool, two-stage centrifugal compressor Motorlet M602 turboprop, producing 1360 kW. This engine's fuel consumption is 18 percent lower than that of the smaller (19-seat) L-410 airliner.

O.C.

**A89-39234**

**USAF/LOCKHEED F-117A HAS HIGH WING SWEEP BUT LOW WING LOADING**

MICHAEL A. DORNHEIM Aviation Week and Space Technology (ISSN 0005-2175), vol. 130, May 1, 1989, p. 27.

The highly swept F-117A stealth fighter's wing has an aspect ratio of about 1.9 (based on its gross area), which probably penalizes its aerodynamic efficiency but may significantly reduce

radar cross-sections when viewed from some aspects. The extreme sweep angle may also allow the aircraft to be fitted into the C-5 airlifter for overseas deployment. Even though the F-117A is unlikely to have good high-lift performance, its large wing area yields a wing loading of 45 lb/sq ft, for a relatively benign stall speed. The aircraft uses two F404 engines without afterburner, and is estimated to have a thrust/weight ratio of 0.65, assuming a maximum weight of 34,000 lb. O.C.

#### A89-39259

##### **SIMULATION OF OPTIMAL FLIGHT PATHS OF DYNAMICAL SOARING FLIGHT AND THE DESIGN OF A MODEL AIRCRAFT [SIMULATION OPTIMALER FLUGBAHNEN DES DYNAMISCHEN SEGELFLUGS UND AUSLEGUNG EINES MODELLFLUGZEUGS]**

TH. NOTTEBAUM and O. GOEBEL (Aachen, Rheinisch-Westfaelische Technische Hochschule, Federal Republic of Germany) *Zeitschrift fuer Flugwissenschaften und Weltraumforschung* (ISSN 0342-068X), vol. 13, Jan.-Feb. 1989, p. 48-56. In German. refs

In order to assess the possibility of dynamic soaring with modern sailplanes, a computer program has been developed to simulate the flight maneuvers of any sailplane under measured wind shear conditions. The maneuver, an oval circuit inclined to the horizon, is adapted from the dynamic soaring of the albatros. Parameters like maximum load factor, maximum and minimum speed, and other performance data of the sailplane, together with the wind shear data, can be fed into the computer. In order to verify the calculated results, flight tests have been undertaken with a DFVLR sailplane equipped with a data acquisition system. Several examples show that dynamic soaring is theoretically possible with existing sailplanes. With the help of this simulation program, the flight path of a radiocontrolled model glider has been optimized for dynamic soaring in order to prepare for flight tests in boundary layer wind shears near the ground. Author

#### A89-39454#

##### **MULTI-INPUT/MULTI-OUTPUT FREQUENCY DOMAIN MODAL IDENTIFICATION METHOD AND ITS APPLICATION IN GROUND VIBRATION TESTING**

LINGMI ZHANG (Nanjing Aeronautical Institute, People's Republic of China) *Acta Aeronautica et Astronautica Sinica* (ISSN 1000-6893), vol. 10, Jan. 1989, p. A21-A27. In Chinese, with abstract in English. refs

A frequency-domain MIMO modal identification method is presented. Its accuracy, reliability and capability of handling closely-spaced or repeated modes are proved by computer simulation and real structure testing. The application in an aircraft Ground Vibration Test (GVT) of a modern fighter is given. The results show that, compared to traditional multipoint sine-dwell GVT technique, the test operation is easier, the period is shorter, and the accuracy is higher. Therefore, the computation is reduced, and the necessity of distinguishing structural and 'noise' modes is avoided. Author

#### A89-39472#

##### **F.E. SIMULATION OF CRASH FOR HELICOPTERS**

SHOUMEI WANG (Beijing University of Aeronautics and Astronautics, People's Republic of China), XIAOFENG DONG, and MIAN PONG (Helicopter Design and Development Center of China, People's Republic of China) *Acta Aeronautica et Astronautica Sinica* (ISSN 1000-6893), vol. 10, Feb. 1989, p. B27-B35. In Chinese, with abstract in English. refs

The paper summarizes the numerical simulation of crash for helicopters using nonlinear finite element technique. The structures considered include the pilot seat, shock absorber, floor, and skate. The problem is considered as dynamic response of the structure subjected to specified initial velocity or impulse load, with large deformation and plasticity. Special elements are designed to model the absorber and seat trail. Impact effects with ground are represented by gap elements. Author

#### A89-39509

##### **PRELIMINARY RESULTS OF IN-FLIGHT EXPERIMENTS ON THE ACTIVE CONTROL OF PROPELLER-INDUCED CABIN NOISE**

S. J. ELLIOTT, P. A. NELSON, I. M. STOTHERS, and C. C. BOUCHER (Southampton, University, England) *Journal of Sound and Vibration* (ISSN 0022-460X), vol. 128, Jan. 22, 1989, p. 355-357. Research supported by British Aerospace, PLC and Department of Trade and Industry.

The first results are presented of a series of experiments undertaken on the active control of the sound field in the passenger cabin of a 48-seat propeller-driven aircraft. The aircraft used is a BAe 748 twin turboprop which is flown under straight and level cruise conditions. The speed of the engines is nominally 14,200 rpm, producing a blade passage frequency of approximately 88 Hz, although, for some experiments, either one of the two engines is reduced in speed to 12,700 rpm (giving a blade passage frequency of 79 Hz) in order to discriminate between the contributions of the two propellers to the cabin sound field. The cabin sound field is controlled using a system of 16 loudspeakers to minimize the sum of the squared pressures sensed at 32 microphones in a plane at seated passenger head height. Results presented from one control system configuration demonstrate significant reductions in the sound pressure level. S.A.V.

#### A89-39510

##### **A DEMONSTRATION OF ACTIVE NOISE REDUCTION IN AN AIRCRAFT CABIN**

C. M. DORLING, G. P. EATWELL, S. M. HUTCHINS, C. F. ROSS, and S. G. C. SUTCLIFFE (Topexpress, Ltd., Cambridge, England) *Journal of Sound and Vibration* (ISSN 0022-460X), vol. 128, Jan. 22, 1989, p. 358-360. Research supported by British Aerospace, PLC.

Results are presented of an in-flight demonstration of active noise reduction in the cabin of a BAe 748 twin turboprop aircraft. The design of the noise control system is described. The performance of the system shows that active control of propeller noise in an aircraft cabin is feasible, and that substantial reductions in the sound levels can be achieved. The results also show that an active control system with a large number of interacting channels is practicable. The similarity between the predicted and actual reductions suggest that it is possible to make a reasonable assessment of the potential of an active control system by measuring the source and the acoustic environment separately. S.A.V.

#### N89-21786 Maryland Univ., College Park.

##### **GROUND AND AIR RESONANCE OF BEARINGLESS ROTORS IN HOVER AND FORWARD FLIGHT Ph.D. Thesis**

JINSEOK JANG 1988 221 p

Avail: Univ. Microfilms Order No. DA8827086

Ground and air resonances in hover and forward flight are examined for a bearingless rotor using a finite element formulation based on Hamilton's principle. Quasi-steady strip theory is used to evaluate aerodynamic forces, and unsteady aerodynamic effects are introduced approximately through a dynamic inflow mode. For the hover analysis, the nonlinear equations of motion are solved for steady blade deflections through an iterative procedure including the calculation of the pitch link displacement to obtain the desired pitch angle. The equations of motion for the rotor/fuselage dynamics are linearized about the vehicle trim state and the blade steady-state deflected position, and transformed to modal space using coupled vibration modes. These normalized equations consisting of the blade equations of motion, the fuselage equations of motion and the dynamic inflow equations, are then transformed into the nonrotating frame using the multiblade coordinate transformations. The complex eigenvalue analysis is done for the stability. For the analysis of forward flight, the periodic response is calculated using a finite element method in time after the nonlinear finite element equations in space are transformed to normal mode equations. The linearized period perturbation equations in the nonrotating frame are solved for the stability using Floquet transition matrix theory as well as constant coefficient

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

approximation. Satisfactory correlation of predicted ground and air resonance results is carried out with data obtained from the measurements on 1/8th Froude-scaled dynamic model. Systematic parametric studies are carried out to examine the effects of several design parameters on ground and air resonance stabilities. Lag frequencies has a substantial influence on ground resonance stability, whereas pitch-lag coupling (vertical location of cuff restraint), and pitch link stiffness have powerful effects on air resonance stability in hover and forward flight. Dissert. Abstr.

**N89-21787#** Ferranti Defense Systems, Inc., Binghamton, NY. Electro-optics Div.

**AFTI (ADVANCED FIGHTER TECHNOLOGY INTEGRATION)/F-111 MISSION ADAPTIVE WING BRIEFING TO INDUSTRY Final Report, 18 Nov. 1986 - 22 Jul. 1988**

Oct. 1988 427 p

(Contract F33615-78-C-3027)

(AD-A202467; AFWAL-TR-88-3082) Avail: NTIS HC A19/MF A01 CSCL 01/1

The AFTI/F-111 (Advanced Fighter Technology Integration/F-111) Mission Adaptive Wing is a joint USAF and NASA program which is developing and flight demonstrating a smooth variable camber wing and flight control system capable of adjusting the wing's shape in response to flight condition and pilot input in order to maximize aerodynamic efficiency. The program objective is to produce flight substantiated design criteria for a practical wing system that maintains peak aerodynamic efficiency and versatility throughout the broad flight envelopes and diverse mission requirements of future military and civilian aircraft. This document contains illustrations presented at the second AFTI/F-111 Mission Adaptive Wing Briefing to Industry on 21 to 22 July 1988 in Dayton OH. The presentations covered the analysis, design, ground test, and flight test phases of the development of the automatic flight control system for the AFTI/F-111. Flight testing of the AFTI/F-111 Mission Adaptive Wing system was only partially complete at the time these illustrations were prepared for presentation. Data and findings should be considered preliminary.

GRA

**N89-21789#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.

**FLY, GREAT SEA EAGLE**

SHANGFA XU, HONGJIN SUN, and JIWEN DUAN 13 Jan. 1989 9 p Transl. into ENGLISH from Jiefangjun Huabao (Peoples Republic of China), no. 8, 1987 p 18-19

(AD-A203979; FTD-ID(RS)T-0782-88) Avail: NTIS HC A02/MF A01 CSCL 01/3

China's own design and manufacture, the PS-5 seaplane bomber is a success. This achievement fills a gap in the history of the Chinese aviation industry and indicates that the Chinese aviation industry has advanced to a new level. The seaplane is an aircraft and a naval vessel blended into one. It has such features as good performance at low altitude, good concealment ability, good combat radius, and a long cruise duration. It can carry such weapons as air-to-ship missiles, deep-water bombs, torpedoes and mines. It is the ideal set-up for carrying out strikes against enemy naval vessels and submarines. At the same time, it is an effective tool for submarine hunting, anti-submarine, patrol, rescue and transport studies.

GRA

**N89-21790#** Army Aviation Engineering Flight Activity, Edwards AFB, CA.

**EVALUATION OF THE PRODUCTION CH-47D ADVERSE WEATHER COCKPIT (AWC) AERIAL REFUELING SYSTEM Final Report, 17 Jun. - 15 Jul. 1988**

ROBERT D. ROBBINS, MARVIN L. HANKS, and MICHAEL K. HERBST Sep. 1988 79 p

(AD-A204030) Avail: NTIS HC A05/MF A01 CSCL 01/2

For this evaluation, eight flights were conducted for a total of 11.9 flight hours, 8.5 of which were productive, with 106 probe-to-drogue contacts and 18,160 pounds of fuel transferred. Level flight performance tests, aerial refueling tests and aerial refueling system tests were conducted by the contractor and were

witnessed by Army Aviation Engineering Flight Activity (AEFA) personnel. No drag increment determination could be made from the inconclusive level flight test data. The contractor intends to analytically estimate the external drag of the aerial refueling system. The AEFA evaluation included day, night unaided vision and night aided vision aerial refueling operations using Aviator Night Vision Imaging System (ANVIS-6) night vision goggles with U.S.A.F. HC-130P tanker aircraft. Tests included a tanker proximity wake turbulence evaluation of the handling qualities in the refueling environment including off-center disconnects and non-responsive hose operations. One enhancing characteristic, one deficiency and three shortcomings, one of which was identified on a previous evaluation of the standard CH-47D, were noted. The aerial refueling lighting system is an enhancing characteristic. The requirement to have the battery switch ON in order to single-point refuel on the ground is a deficiency. The inability to select anything other than full bright on the refueling probe light and refueling searchlight during initial filament activation is a shortcoming. GRA

**N89-21791#** California Univ., Los Angeles. Dept. of Mechanical Aerospace and Nuclear Engineering.

**CONTROL AUGMENTED STRUCTURAL OPTIMIZATION OF AEROELASTICALLY TAILORED FIBER COMPOSITE WINGS Annual Progress Report, 1 Nov. 1987 - 31 Oct. 1988**

PERETZ FRIEDMANN and LUCIEN A. SCHMIT 30 Nov. 1988 54 p

(Contract F49620-87-K-0003)

(AD-A204534; AFOSR-89-0094TR) Avail: NTIS HC A04/MF A01 CSCL 20/4

A unique capability under development for structure/control synthesis of composite lifting surfaces in subsonic and supersonic flow regimes is described. The constituent modeling concepts for the lifting and control surface structure, the unsteady aerodynamics, and active control feedback laws are described. Sample problems are presented to demonstrate specific features of the capability. Current efforts to extend the capability to handle transonic aeroservoelasticity are described. GRA

**N89-21792#** Army Aviation Engineering Flight Activity, Edwards AFB, CA.

**ARTIFICIAL AND NATURAL ICING TESTS OF THE EH-60A**

**QUICK FIX HELICOPTER Final Report, 24 Feb. - 20 Mar. 1988**

WILLIAM D. LEWIS, MARVIN L. HANKS, and CHRISTOPHER J. YOUNG Jun. 1988 86 p

(AD-A204589) Avail: NTIS HC A05/MF A01 CSCL 08/12

Artificial and natural icing flight tests were conducted on the EH-60A, Quick Fix helicopter (USA SN 84-24019) to establish a moderate icing flight envelope for the helicopter with the AN/ALQ-151(V)2 countermeasures system installed. The tests were conducted at Duluth, Minnesota from 24 February to 20 March 1988. A total of 11.8 flight hours were flown in the icing environment. After damage to an unprotected direction finding (DF) dipole antenna during an icing encounter, the project was terminated. During these tests, two deficiencies and eight shortcomings were noted. The two icing related deficiencies are: Excessive DF dipole antenna element oscillations induced by ice accumulation resulting in damage to the DF antenna element mounts and phenolic blocks, and the ice accretion and shedding characteristics of the EH-60A helicopter forward of the engine inlets resulting in a high probability of engine foreign object damage. The major shortcomings are: The excessive increase in power required with rotor system ice accumulation, the excessive Electronic Countermeasures (ECM) antenna oscillations induced by ice accumulation, the ice accretion and shedding characteristics of the outside air temperature probes, and the inability of the ECM antenna to fully retract following an icing flight. Four additional shortcomings were identified. The EH-60A Quick Fix helicopter, as configured for this test, was not suitable for flight into an icing environment. GRA

**N89-21793#** Naval Postgraduate School, Monterey, CA.  
**A STUDY OF THE EFFECT OF DESIGN PARAMETER VARIATION ON PREDICTED TILT-ROTOR AIRCRAFT PERFORMANCE M.S. Thesis**

MARY COTTRELL DUNSTON Dec. 1988 103 p  
 (AD-A204856) Avail: NTIS HC A06/MF A01 CSCL 01/3

There is currently little data available for trend analyses of tilt-rotor aircraft performance. This study analyzed the sensitivity of predicted tilt-rotor performance to variations in six design parameters: disk loading, tip speed, solidity, download, wing loading, and wing thickness ratio. Two mission profiles were analyzed: A combat search-and-rescue mission and an antisubmarine warfare mission. A tilt-rotor preliminary design code was used to perform computer simulations; and data available from independent tests completed by NASA and the military were encoded in the input data decks. Results were presented as graphs of performance aspects plotted against the parameters varied. Because the study was a trend analysis, no specific conclusions were drawn but a summary was made of the more significant results. It is hoped that the results of this project can serve as a guide to preliminary selection of design parameters for tilt-rotor configurations that would be suitable for a broad range of military and civil applications. GRA

**N89-21794#** Army Aviation Engineering Flight Activity, Edwards AFB, CA.

**ARTIFICIAL AND NATURAL ICING TESTS OF THE UH-60A HELICOPTER CONFIGURED WITH THE XM-139 MULTIPLE MINE DISPENSING SYSTEM (VOLCANO) Final Report, 10 Jan. - 22 Feb. 1988**

DAVID A. DOWNEY, REGINALD C. MURRELL, and CHRISTOPHER J. YOUNG Mar. 1988 56 p  
 (AD-A205031; USAAEFA-85-15) Avail: NTIS HC A04/MF A01 CSCL 01/3

A limited evaluation of the UH-60A helicopter with XM-139 Multiple Delivery Mine Dispensing System (VOLCANO) was conducted to determine the capability to operate safely in a moderate environment. Artificial and natural icing tests were conducted at Duluth, Minnesota from 10 January through 22 February 1988. Testing was conducted by the U.S. Army Aviation Engineering Flight Activity and consisted of 16.4 productive flight hours. One deficiency related to inadequate procedures in the operator's and crewmember's checklist was identified. The checklist does not contain procedures to activate anti-icing systems. Two shortcomings were identified that involved the ice accretion characteristics of the VOLCANO. Ice accretion on the mounting hardware kit interferes with reinstalling the launcher rack jettison safety pins due to ice covering the safety pin holes. Ice accretion on the forward end of the launcher racks interferes with movement of the arming levers and locking levers to the safe and unlocked positions, respectively. The probability of damage to rotating components, due to impact with shed ice particles in descents is increased with the installation of the VOLCANO. The UH-60A helicopter with the VOLCANO system installed can safely operate in moderate icing conditions. GRA

**N89-21795#** Technische Univ., Berlin (Germany, F.R.). Inst. fuer Luft- und Raumfahrt.

**INVESTIGATIONS OF THE PARAMETER REDUCTION IN THE OPTIMIZATION OF AIRCRAFT WING STRUCTURES [UNTERSUCHUNGEN ZUR PARAMETERREDUKTION BEI DER OPTIMIERUNG VON FLUGZEUG-TRAGFLUEGELSTRUKTUREN]**

BERND ZIEGLER 1988 111 p In GERMAN  
 (ILR-MITT-203; ETN-89-93786) Avail: NTIS HC A06/MF A01

The method of optimization parameter reduction in numerical optimization methods, using approach functions, is presented. The suitability of four types of interpolation functions (quadratic/cubic polynomials, splines, Bezier curves, B-splines) was investigated. It is shown that the group of spline interpolations is especially suited for approach functions; they are extremely handy and fast. However, the B-splines allow a better adaptation to the values of the variables which have to be interpolated. The separation of

optimization method and structural analysis is very important. A preliminary optimization using the fully-stressed-design method is required. The correct choice of the penalty factor is essential for the interior penalty function optimization method. The effect of the interpolation time on the total calculation time is negligible. ESA

**N89-21796** Princeton Univ., NJ.  
**A FLIGHT DYNAMIC STUDY OF THE HELICOPTER INCLUDING BLADE DYNAMICS Ph.D. Thesis**

XIN ZHAO 1988 172 p  
 Avail: Univ. Microfilms Order No. DA8827762

A linearized model of rotorcraft dynamics was developed through the use of symbolic automatic equation generating techniques. The dynamic model was formulated in a unique way such that it can be used to analyze a variety of rotor/body coupling problems including a rotor mounted on a flexible shaft with a number of modes as well as free-flight stability and control characteristics. Direct comparison of the time response to longitudinal, lateral and directional control inputs at various trim conditions shows that the linear model yields good to very good correlation with flight test. In particular it is shown that a dynamic inflow model is essential to obtain good time response correlation, especially for the hover trim condition. It also is shown that the main rotor wake interaction with the tail rotor and fixed tail surfaces is a significant contributor to the response at translational flight trim conditions. A relatively simple model for the downwash and sidewash at the tail surfaces based on flat vortex wake theory is shown to produce good agreement. Then, the influence of rotor flap and lag dynamics on automatic control systems feedback gain limitations was investigated with the model. It is shown that the blade dynamics, especially lagging dynamics, can severely limit the useable values of the feedback gain for simple feed-back control and that multivariable optimal control theory is a powerful tool to design high gain augmentation control system. The frequency-shaped optimal control design can offer much better flight dynamic characteristics and a stable margin for the feedback system without need to model the lagging dynamics. Dissert. Abstr.

**N89-22600#** Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.). Unternehmensbereich Transport- und Verkehrsflugzeuge.

**DEVELOPMENT AND TESTING OF CRITICAL COMPONENTS FOR TECHNOLOGICAL PREPARATION OF AN AIRBUS-CFRP-FUSELAGE, PHASE 2 Final Report, 1 May 1986 - 30 Jun. 1987**

M. KOBLAX Nov. 1987 75 p In GERMAN; ENGLISH summary  
 (Contract BMFT-LKF-8652/7)

(MBB-UT-129/87; ETN-89-93769) Avail: NTIS HC A04/MF A01  
 Essential technological premises for the introduction of composite materials into the fuselage structure of future commercial aircraft were prepared. Selected critical as well as production-development components were manufactured, tested and evaluated. Tests were developed and prepared in order to continue post crash fire research. The possibilities to improve materials and processes were analyzed. The structural efficiency of the selected critical components was proved. The development risks are therefore sufficiently minimized. ESA

**N89-22601#** Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

**TRANSONIC AND SUPERSONIC WIND TUNNEL TESTS ON CONTROL EFFECTIVENESS ON SCHEMATIC MISSILE CONFIGURATIONS WITH CANARD CONTROLS**

SVEN ERIK GUDMUNDSON and LARS TORNGREN Dec. 1987 76 p

(Contract FMV-FLYGFL-82223-78-170-21-001)  
 (FFA-TN-1988-11; ETN-89-94314) Avail: NTIS HC A05/MF A01

A wind tunnel investigation of pitch, yaw, and roll control effectiveness was performed at transonic and supersonic speeds for two body-canard-wing cruciform missile configurations. At zero

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

roll angle position the setting angles were varied from 0 to 20 deg in steps of 5 or 10 deg for the two horizontal canard controls for pitch control tests, and for the two vertical canard controls for yaw control tests. At 45 deg roll angle position the setting angles were varied for all controls in both pitch and yaw control tests. At the roll control tests the setting angles were varied from 0 to 5 and 10 deg for all controls at both 0 and 45 deg roll angle position. Pitch control tests were done with the canard controls interdigitated 45 deg in relation to the wing planes. ESA

**N89-22602#** Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

### **PREDICTION OF LOADS ON WING/BODY/EXTERNAL STORE/FINS PYLON-CONFIGURATIONS AT TRANSONIC SPEEDS**

DIEQIAN WANG and SVEN G. HEDMAN 29 Aug. 1988 78 p (Contract FMV-FLYGFL-82260-88-061-73-001) (FFA-TN-1988-44; ETN-89-94547) Avail: NTIS HC A05/MF A01

A computational method for prediction of loads on configurations consisting of wing, body, external store, and pylon at transonic speeds is described. The geometric flexibility required for treatment of underwing pylon-mounted stores is achieved by the embedded grid technique. The store modeling capability permits a body of revolution with multiple aft fins in cruciform positions. The chosen formulation of the small perturbation equation and the selected mass flux boundary condition enhance the numerical stability and the accuracy of the computed store body flow field. Computed pressure distributions at zero angle of attack for two parabolic arc bodies of different thickness ratios were compared with experimental data, and an excellent agreement between calculation and experiment is obtained in a wide range of transonic speed, including Mach number 1 and a Mach number larger than 1. For a complete configuration it is observed that the method predicted the features of the flow. ESA

**N89-22603** Georgia Inst. of Tech., Atlanta.

### **AN EFFICIENT INVERSE METHOD FOR THE DESIGN OF BLENDED WING-BODY CONFIGURATIONS Ph.D. Thesis**

NEEP HAZARIKA 1988 180 p  
Avail: Univ. Microfilms Order No. DA8904811

A numerical inverse design technique was developed for designing body-alone and wing-body configurations directly in the physical plane. Although numerous inverse design techniques exist, they are closely tied to the basic analyses, and can not be upgraded as improved analysis techniques become available. Moreover, many of these tools are configuration-specific, i.e., they are restricted to the design of specific configurations such as airfoils or wings. A general purpose analysis-and configuration-independent design scheme is developed. The present design technique is capable of incorporating a variety of analysis tools and is capable of designing body-alone and wing-body configurations with a minimum of modifications. The present method of designing directly in the physical plane derives its roots from panel methods and was applied to isolated aircraft components such as airfoils and nacelles in transonic flow. The present work avoids chordwise distortions when applied to blended wing-body configuration design, and trailing edge closure is ensured naturally within the solution scheme. The flow solver used to compute pressures over the initial, final and intermediate configurations is a full potential solver. The present work can be used to modify existing configurations to meet certain target requirements. The presence of shock waves and lifting surfaces does not seem to complicate or restrict the design process. Since the analysis is separate from the design, one can substitute Euler or Navier-Stokes solvers as they become more efficient and available. This technique thus provides a methodology for the inverse design of realistic configurations that are typical of high performance transonic aircraft. Dissert. Abstr.

## 06

### AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

**A89-37537**

### **TEST OF A CALIBRATION DEVICE FOR AIRBORNE LYMAN-ALPHA HYGROMETERS**

EDWIN W. ELORANTA, ROLAND B. STULL, and ELIZABETH E. EBERT (Wisconsin, University, Madison) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 6, Feb. 1989, p. 129-139. refs  
(Contract NSF ATM-85-11196)

Results are presented from tests of a calibration device designed to fit over airborne Lyman-alpha probes to allow pure nitrogen, oxygen, and carbon dioxides gases into the probe's radiation path. The presence of these gases made it possible to calculate the path length, reference voltage, and oxygen absorption terms in the Lyman-alpha humidity equation. The tests of the calibration device show that it performs successfully. R.B.

**A89-38949**

### **COLOR DISPLAYS CAN REDUCE WORKLOAD**

Aerospace Engineering (ISSN 0736-2536), vol. 9, April 1989, p. 10-14.

An account is given of the ways in which the A320 airliner's flight-management system (FMS) employs color displays in its Multipurpose Control and Display Unit (MCDU) to furnish perceptually effective flight-planning, navigation, guidance, and aircraft performance information. The FMS allows the flight crew to enter a complete flight plan, including departure and arrival procedures; it provides predictions of time, speed, altitude, fuel, and wind for every waypoint of the flight plan. Six colors are used for presenting data, and any MCDU character can be displayed in one of two available sizes. Illustrative examples of MCDU messages are presented. O.C.

**A89-39227**

### **HUD ON THE HEAD FOR COMBAT PILOTS**

BRIAN WANSTALL Interavia (ISSN 0020-5168), vol. 44, April 1989, p. 334-338.

Helmet-mounted display (HMD) and helmet-mounted sight (HMS) systems fulfilling the role of HUDs are required for the European Fighter Aircraft, Rafale, the USAF's ATF, and the USN's ATA, as well as for retrofitting in some currently operational aircraft. The core component of an HMD or HMS is a helmet-positioning system which may employ electromagnetic, electrooptic, or acoustic sensors to furnish data for the helmet-tracking processor to extrapolate helmet position. Weight constraints motivate designers' current preoccupation with the question of whether a CRT should be mounted directly on the helmet, or whether a coherent fiber-optic cable should instead be used to bring images to the helmet. O.C.

**A89-39587**

### **NEAR-FIELD SCATTERING MEASUREMENTS FOR DETERMINING COMPLEX TARGET RCS**

BARRY J. COWN and CHARLES E. RYAN, JR. (Georgia Institute of Technology, Atlanta) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. 37, May 1989, p. 576-585. refs

The application of near-field scattering measurements for determining the near-zone and far-zone radar cross section (RCS) of complex targets that are both physically and electrically large is reviewed and examined in the light of recent advances in near-field measurement technology and data processing capabilities. I.E.

**A89-39828**

### **AIR NAVIGATION SYSTEMS. I - ASTRONOMICAL**

**NAVIGATION IN THE AIR 1919-1969. PART II - INSTRUMENTS**  
J. E. D. WILLIAMS Journal of Navigation (ISSN 0373-4633), vol. 42, Jan. 1989, p. 73-91. refs

A development history is presented for the optical instruments employed for aeronautical astronomical navigation, giving attention to both the design features of the optics employed and the comparative levels of navigational accuracy achieved. Prominent among the instruments employed from the inception of long-range aircraft navigation, circa 1919, to the achievement of dominance in the field by inertial navigation technologies circa 1969, have been the bubble sextant and the periscopic sextant, 'astrodome' bubbles, astrocompasses, and various clockwork mechanisms.

O.C.

**N89-22604#** SLI Avionic Systems Corp., Grand Rapids, MI.  
**PRE AND POST MODIFICATION ELECTROMAGNETIC COMPATIBILITY TEST REPORT FOR THE C-130H SELF CONTAINED NAVIGATION SYSTEM WITH MLS A-KIT, REVISION**

C. SNIDER 20 Jan. 1989 100 p  
(Contract F09603-85-C-1224)  
(AD-A205167; REPT-6216-055-REV) Avail: NTIS HC A05/MF A01 CSCL 20/14

The specific tests performed on the Self Contained Navigation System (SCNS) with MLS A-Kit, were a Pre-Modification Electromagnetic Interference (EMI) Signature of the aircraft equipment bays, flight deck and connecting wiring, followed by a Post-Modification EMI Signature and a functional compatibility test of the avionic systems with the SCNS system operating. The tests performed were an engineering evaluation of post-installation EMI and Electromagnetic Compatibility (EMC) with existing electronic and avionic systems in the C-130H Aircraft. The test objectives were to verify the proper EMI/EMC design, installation, and operation of the associated C-130H Aircraft subsystems prior to beginning flight test. This determines if the new installation, or the new or modified equipment would emit radiated or conducted EMI, and if emitted, whether the levels would create interference or degradation in existing equipment.

GRA

## 07

### AIRCRAFT PROPULSION AND POWER

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

**A89-36215\*#** Lockheed Aeronautical Systems Co., Marietta, GA.

**NEAR-FIELD ACOUSTIC CHARACTERISTICS OF A SINGLE-ROTOR PROPPAN**

H. W. BARTEL and G. SWIFT (Lockheed Aeronautical Systems Co., Marietta, GA) AIAA, Aeroacoustics Conference, 12th, San Antonio, TX, Apr. 10-12, 1989. 13 p. refs  
(Contract NAS3-24339)  
(AIAA PAPER 89-1055)

The near-field noise characteristics of the SR-7L, an eight-blade, single-rotor, wing-mounted, tractor propfan have been determined. It is found that the noise is dominated by discrete tones, usually at the first order (and occasionally at the second or third order) of the blade-passage frequency. The highest noise levels were noted at conditions of high tip helical speeds and high dynamic pressures.

R.R.

**A89-36397\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**A REVIEW AND FORECAST OF ENGINE SYSTEM RESEARCH AT THE ARMY PROPULSION DIRECTORATE**

GEORGE A. BOBULA (NASA, Lewis Research Center; U.S. Army,

Propulsion Directorate, Cleveland, OH) Vertiflite (ISSN 0042-4455), vol. 35, Mar.-Apr. 1989, p. 12-19.

An account is given of the development status and achievements to date of the U.S. Army Propulsion Directorate's Small Turbine Engine Research (STER) programs, which are experimental investigations of the physics of entire engine systems from the viewpoints of component interactions and/or system dynamics. STER efforts are oriented toward the evaluation of complete turboshaft engine advanced concepts and are conducted at the ECRL-2 indoor, sea-level engine test facility. Attention is given to the results obtained by STER experiments concerned with IR-suppressing engine exhausts, a ceramic turbine-blade shroud, an active shaft-vibration control system, and a ceramic-matrix combustor liner.

O.C.

**A89-36399**  
**T800/A129 FLIGHT PROGRAM**

R. DAVID TOMS, JR. (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) Vertiflite (ISSN 0042-4455), vol. 35, Mar.-Apr. 1989, p. 40-44.

The A129 helicopter has been chosen and used as the testbed aircraft for the state-of-the-art T800-LHT-800 turboshaft engine, since it approximates the primary mission roles for which the engine was developed. The twin-engine installation of the T800 in the A129 has furnished valuable information relative to control and functional interfaces. Systems testing was first conducted off the aircraft in order to reduce risks and provide early problem resolution. Testing of the electronic system was performed sequentially, progressively including additional system components as each test was completed.

O.C.

**A89-36400**  
**T700 - GROWING TO MEET THE CHALLENGE**

H. G. DONOHIE (General Electric Co., Aircraft Engine Business Group, Lynn, MA) Vertiflite (ISSN 0042-4455), vol. 35, Mar.-Apr. 1989, p. 48-52, 54, 55.

A development history is presented for the T700 turboshaft engine employed by U.S. Army helicopters, whose power output has been progressively enhanced in response to new performance requirements. Attention is given to the paths taken to (1) maximize 4000-ft altitude performance at 95 F ambient temperature, (2) minimize weight, and (3) improve levels of reliability and maintainability; this last involved extensive resort to component redundancy and modularity, as well as measures to protect the engine's inlet. A single-engine (one engine out) operational capability was also achieved for the T700 in the case of the AH-64A Apache helicopter.

O.C.

**A89-36473**  
**AIRCRAFT GAS TURBINE BLADE AND VANE REPAIR**

K. C. ANTONY and G. W. GOWARD (Turbine Components Corp., Branford, CT) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 745-754. refs

Some statistics on the needs for blade and vane repair or replacement, coating technology relevant to blade and vane repair, and the types of repair that commonly applied to turbine hardware are reviewed. Predictions are then made concerning the future of repair technology. It is noted that the future of blade and vane repair will be largely determined by replacement part pricing. Repair is expected to become less labor-intensive as automation becomes more feasible.

V.L.

**A89-36474**  
**REJUVENATION OF SERVICE-EXPOSED IN 738 TURBINE BLADES**

A. K. KOUL, J.-P. IMMARIGION (National Aeronautical Establishment Ottawa, Canada), R. CASTILLO (Westinghouse Canada, Inc., Hamilton), P. LOWDEN, and J. LIBURDI (Liburdi Engineering, Burlington, Canada) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA,



## 07 AIRCRAFT PROPULSION AND POWER

Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 755-764. Research supported by DND. refs

A HIP rejuvenation study has been performed on an aluminide-coated internally-cooled IN 738 turbine blade from an aircraft engine. It is found that airfoils have a tendency to lengthen along their longitudinal axis during service, with the rate of lengthening increasing with increasing service life. The design of a HIP rejuvenation/heat treatment cycle to recover microstructures and creep properties is considered, and a rejuvenation cycle incorporating a diffusion treatment for recoating the blades is found to improve the time to rupture by a factor of 3 relative to new blades. R.R.

### A89-36898

#### AIRCRAFT ENGINES. IV

PHILIP C. RUFFLES (Rolls-Royce PLC, London, England) Exxon Air World (ISSN 0014-5068), vol. 41, no. 1, 1989, p. 36-38.

Configurational design and thermodynamic performance gain trends are projected into the next 50 years, in view of the growing interest of aircraft manufacturers in both larger and more efficient high-bypass turbofan engines for subsonic flight and variable cycle engines for supersonic flight. Ceramic- and metal-matrix composites are envisioned as the key to achievement of turbine inlet temperatures 300 C higher than the 1400 C which is characteristic of the state-of-the-art, with the requisite high stiffness, strength, and low density. Such fiber-reinforced materials can be readily tailored to furnish greatest strength in a specific direction of loading. Large, low-density engines are critical elements of future 1000-seat aircraft. O.C.

### A89-37651

#### LEADER - AN AUTOMATIC, REAL-TIME DIAGNOSTIC KNOWLEDGE SYSTEM

J. S. SHURTLEFF (Textron Lycoming, Stratford, CT) SAE, Aerospace Technology Conference and Exposition, Anaheim, CA, Oct. 3-6, 1988. 14 p. (SAE PAPER 881443)

An expert system, LEADER, is implemented that supports acceptance testing of gas turbine engines in four independent test cells. The LEADER system expedites problem diagnosis by automatically analyzing engine parameters for fault identification. The system models the reasoning of an experienced engineer for a specific steady-state testing procedure with several hundred rules controlled by a diagnostic procedure. An overview of the system's objectives and benefits is given, along with its engine testing and diagnostics procedures. A summary of the system's implementation is presented, and the system's operation, user interface, and knowledge base implementation are discussed. The system's evaluation and testing considerations are outlined. S.A.V.

### A89-37654

#### INTERRELATION OF ENGINE DESIGN AND BURNER CONFIGURATION WITH SELECTION AND PERFORMANCE OF ELECTRICAL IGNITION SYSTEMS FOR GAS TURBINE ENGINES

SAE Aerospace Information Report, SAE AIR 784, Oct. 2, 1988, 31 p.

(SAE AIR 784)

An attempt is presently made to furnish gas turbine engine designers with a working knowledge of the role of ignition systems in the achievement of performance objectives. A definitive sampling is accordingly presented of standard references, nomenclature, and descriptive terminology for gas turbine ignition system design. Attention is given to those aspects of combustion chamber structure and aerodynamics that influence the type-selection and performance of ignition systems. Areas for future research in the interest of determining potentially significant effects are noted. O.C.

### A89-37661

#### LEADS, FLEXIBLE, SHIELDED, HIGH ENERGY IGNITION

SAE Aerospace Recommended Practice, SAE ARP 841, Jan. 18,

1988, 4 p.

(SAE ARP 841)

The requirements for shielded, flexible, high-energy ignition leads for use in gas turbine engines are presented. It is noted that the elastomeric materials employed must be resistant to oil, hydraulic fluid, fuel, aging, and weathering; the shielded leads must also furnish suitable EMI suppression levels. Attention is given to the character of the qualification test's resistance, continuity, and inspection requirements, as well as to the electrical test's joint-resistance, shielding-resistance, low voltage continuity, and high potential requirements. O.C.

### A89-37752#

#### ON EVALUATION OF AIRCRAFT PROPULSION SYSTEM PERFORMANCE

ZENGYUAN TAO (Air Force Engineering Institute, People's Republic of China), QISHAN XU, and XIAOXIONG CHEN (Air Force PR China, Beijing, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 7-10, 87. In Chinese, with abstract in English. refs

In order to meet the requirements of performance evaluation for an aircraft propulsion system, the paper elaborates on how to implement the procedures, contents, and methods specified in National Military Standards. The paper can serve as a reference in designing, developing, and testing an aircraft or an engine and as one of the main arguments for checking and accepting the aircraft propulsion system performance in aircraft qualification flight tests. Author

### A89-37753#

#### PERFORMANCE ANALYSIS OF A PROPULSION SYSTEM

ZHANG JING (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 11-16, 86. In Chinese, with abstract in English. refs

Performance analysis programs of a propulsion system are established and recommended as tools for estimating installation penalties. The performance parameters, such as inlet capture area, inlet pressure recovery, inlet drag, nozzle gross thrust coefficient, nozzle/afterbody drag, installed thrust, and specific fuel consumption, can be obtained on condition that the uninstalled engine performance is matched with the inlet/nozzle internal and external performances. The influences of design parameters and operation conditions on the propulsion performance are also discussed. The numerical results obtained show that the installation penalties are 20 to 30 percent at the identical flight conditions and throttling settings. Author

### A89-37754#

#### ADJUSTMENT OF RATIO OF ROTATION SPEED DIFFERENCE IN A TWIN-SPOOL TURBOJET ENGINE

ZIZHONG WU and SHANG YI (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 17-20, 88. In Chinese, with abstract in English.

Analyzing the concept and the function of the ratio of rotation speed difference in a twin-spool turbojet engine indicates that the ratio has an effect on the surge margins of the high and low pressure compressors and on the match between the speed of high pressure compressor and the inlet gas temperature. A procedure for adjusting the ratio of rotation speed difference is proposed. The results of the adjustments are in good agreement with the trial run data. In addition, the effects of the ratio on the thrust, specific fuel consumption, speed of high pressure compressor, and turbine inlet gas temperature are considered. Author

### A89-37757#

#### INVESTIGATION ON SIMULATION OF FOREIGN OBJECT IMPACT DAMAGE TO COMPRESSOR BLADE

ZHENDE SUN (Naval Aeronautical Engineering Institute, People's Republic of China) and QIXIN LU (Nanjing Aeronautical Institute,

People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 30-32, 92. In Chinese, with abstract in English.

An experimental method for the simulation of foreign object impact damage to a compressor blade is investigated. The impact damage mechanism is analyzed by means of a scanning electron microscope. A reasonable experimental method is proposed by comparing bullet damage with pendulum impact damage. Author

#### A89-37759#

##### A STUDY ON EXIT RADIAL TEMPERATURE PROFILE OF 2D EXPERIMENTAL COMBUSTOR

JIBAO LI (Chinese Gas Turbine Establishment, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 37-40, 90. In Chinese, with abstract in English. refs

The exit radial temperature profiles formed by four configurations of a dilution hole have been studied experimentally on a two-dimensional experimental combustor. The effect of different configurations of dilution hole design on the combustor exit radial temperature profile shows certain regularity. A semiempirical and semi-analytical model has been developed for predicting the exit temperature profile of gas turbine combustor. The model can predict the effect of change in dilution zone design or combustion operating conditions on the variation of the combustor exit radial temperature profile based on exit temperatures measured before change.

Author

#### A89-37769#

##### RESEARCH ON TEMPERATURE PROFILE FACTOR AT EXIT IN AN ANNULAR COMBUSTOR

BAOCHENG ZHANG (Shenyang Institute of Aeronautical Engineering, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 70-72, 94. In Chinese, with abstract in English.

The visualized statistics of the temperature profile factors (PF) at exits in an annular combustor and its sectors have been made. The results indicate that the number of heads in a sector has significant effect on PF. The empirical formulas for calculating all-ring combustor PF have been obtained from the fitting of statistical data. The relative errors between the calculations with these formulas and the measurements in tests are less than 0.045.

Author

#### A89-37772#

##### COMPUTATION OF DYNAMIC PROCESS WITH LARGE DISTURBANCE FOR SPLIT-SHAFT GAS TURBINE

ZEHUA LU and BOSHENG YE (Tsinghua University, Beijing, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 79-81, 95. In Chinese, with abstract in English.

The computation of a dynamic process with large disturbance is examined for a split-shaft gas turbine. The Spey core engine used in a gas-stream combined cycle is used as an example.

C.D.

#### A89-37773#

##### OPTIMIZING DESIGN FOR TURBOENGINE DIGITAL SPEED CONTROLLER

SHENGFA YANG (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 82-84, 95. In Chinese, with abstract in English.

A method for optimizing the characteristics of a digital speed controller of a turboengine is presented. A dynamic model of this system has been developed. According to the chosen quadratic property criterion, six characteristic quantities of the digital controller are optimized by system simulation in a digital computer. Author

#### A89-37774#

##### STUDY ON EXCHANGE OPERATION BETWEEN TWO MICROCOMPUTERS IN AEROENGINE DIGITAL CONTROL

QIHUA XU and QIHUA WU (Northwestern Polytechnical University,

Xian, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 85, 86, 95. In Chinese, with abstract in English.

Communication and trouble-self-detection of microcomputers in a dual-computer aeroengine digital control system are considered. Exchange operation between two microcomputers is discussed. Simulation tests of the exchange operation in the dual-computer engine speed control system are performed, and satisfactory results are reported.

C.D.

#### A89-38502

##### NONSTATIONARY THERMAL DUTY OF THE STRUCTURAL ELEMENTS OF FLIGHT VEHICLES [NESTATSIONARNYI TEPLVOI REZHIM ELEMENTOV KONSTRUKTSII DVIGATELEI LETATEL'NYKH APPARATOV]

MARSELII P. KUZ'MIN and IRINA M. LAGUN Moscow, Izdatel'stvo Mashinostroenie, 1988, 240 p. In Russian. refs

Numerical, analytical, and analog methods are presented for calculating the temperature fields, heat fluxes, and heat transfer during nonstationary processes associated with the service of the structural elements of flight vehicles. The discussion covers physical processes occurring in the engines of flight vehicles, classification of cooling devices, mathematical description of heat transfer processes, and thermal operating conditions of short-, medium-, and long-life engines. Attention is also given to the electrical modeling of nonstandard thermal processes in engines.

V.L.

#### A89-38504

##### VIBRATIONS OF THE BLADES OF TURBOMACHINES [KOLEBANIYA LOPATOCHNOGO APPARATA TURBOMASHIN]

IURI S. VOROB'EV Kiev, Izdatel'stvo Naukova Dumka, 1988, 224 p. In Russian. refs

A refined mathematical model of turbine blading is proposed which treats the blades as a unified deformable system with allowance for flow effects. A variational method for calculating the vibrations of the system is developed; the finite element method is used for three-dimensional blade models. Vibration characteristics of blades, blade packets, bladed disks, and rotor-blade systems are discussed. Attention is also given to systems with blade imperfections.

V.L.

#### A89-38510

##### VARIABLE-CYCLE TURBOJET ENGINES FOR MULTIPLE-REGIME AIRCRAFT [AVIATSIONNYE TURBOREAKTIVNYE DVIGATELI S IZMENIAEMYM RABOCHIM PROTSESSOM DLIYA MNOGOREZHIMNYKH SAMOLETOV]

IULIAN N. NECHAEV, VIKTOR N. KOBEL'KOV, and ANATOLII S. POLEV Moscow, Izdatel'stvo Mashinostroenie, 1988, 176 p. In Russian. refs

The general design and operation of variable-cycle turbojet engines based on mixed-flow bypass engines are reviewed. The discussion covers current trends in the development of powerplants; characteristics of the adjustable elements of variable-cycle turbojet engines; the effective thrust of variable-cycle powerplants; and optimization of powerplants using variable-cycle engines. Control laws for the elements of variable-cycle engines are derived.

V.L.

#### A89-38950

##### THE ALL-ELECTRIC (SECONDARY POWER) AIRPLANE

Aerospace Engineering (ISSN 0736-2536), vol. 9, April 1989, p. 17-19.

In all-electric airliner secondary power systems, all aircraft subsystems are directly or indirectly powered by a single, electrical power source and are driven or actuated by high energy density/efficiency low-volume inverters and induction motors. Developmental breakthroughs in power-management ICs, VLSI control electronics, and very compact motors have been the primary drivers in the evolution of all-electric secondary power systems. Novel 'switched-reluctance' motor designs are noted to be much simpler than permanent-magnet motors. The quadruple-redundant



## 07 AIRCRAFT PROPULSION AND POWER

power distribution systems typically employed are designed to operate as a closed ring system, in which the generator can feed all bus-sections in the event of an emergency. O.C.

**A89-39043#**

### **APPLICATION OF A FUZZY CONTROLLER IN THE FUEL SYSTEM OF A TURBOJET ENGINE**

CHI-HUA WU, YUN-HUA XU, and BEN-WEI LI (Northwestern Polytechnical University, Xian, People's Republic of China) (International Symposium on Air Breathing Engines, 8th, Cincinnati, OH, June 14-19, 1987, Proceedings, p. 459-464) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, May-June 1989, p. 373, 374. Previously cited in issue 20, p. 3161, Accession no. A87-46227. refs

**A89-39044#**

### **J85 SURGE TRANSIENT SIMULATION**

Y. SUGIYAMA (Japan Defense Agency, Technical Research and Development Institute, Tokyo), W. TABAKOFF, and A. HAMED (Cincinnati, University, OH) (International Symposium on Air Breathing Engines, 8th, Cincinnati, OH, June 14-19, 1987, Proceedings, p. 568-578) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, May-June 1989, p. 375-381. Previously cited in issue 20, p. 3161, Accession no. A87-46240. refs

**A89-39284**

### **ELECTROMAGNETIC BACKSCATTER FROM OPEN-ENDED CIRCULAR CYLINDER WITH COMPLEX TERMINATION**

J. J. BOONZAAIER and J. A. G. MALHERBE (Pretoria, University, Republic of South Africa) Electronics Letters (ISSN 0013-5194), vol. 25, Feb. 2, 1989, p. 218-220. refs

In this paper, a jet aircraft engine model is proposed that uses a radial blade configuration and a coaxial center rod to describe respectively the engine blades and the axle of the engine. The termination is described using three different waveguides. A circular waveguide describes the intake, a coaxial waveguide the center rod or axle of the engine, and coaxial-sector waveguides describe the engine blades. Comparison of the theory with previous results and with measurement shows that the model has improved realism in approximating the physical construction of a jet engine. C.D.

**A89-39480#**

### **A RESEARCH EXPERIMENT OF DISCRETE FUEL INJECTION IN AERO-ENGINE COMBUSTION CHAMBER**

BAOSEN ZHI (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 10, Feb. 1989, p. B85-B88. In Chinese, with abstract in English.

The importance of research experiments on discrete fuel injection in aero-engine combustion chambers is briefly discussed. The experiment shows that good atomizing quality at different flight conditions and increased combustion efficiency can be maintained by changing fuel supply frequency. At the same time, problems concerning the discrete fuel injection test on the combustion chamber test bed, including the choice of nozzles, the discrete injection quality test, and the test installations, are discussed. Author

**N89-21797** Stanford Univ., CA.

### **THE EFFECT OF EXHAUST PLUME/AFTERBODY ON INSTALLED SCRAMJET PERFORMANCE Ph.D. Thesis**

THOMAS ALAN EDWARDS 1988 130 p  
Avail: Univ. Microfilms Order No. DA8826134

First-generation sustained hypersonic flight vehicles will be driven by air-breathing scramjet (supersonic combustion ramjet) engines. Due to 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. An upwind, implicit Navier-Stokes (UWIN) computer program, is applied to hypersonic exhaust plume/afterbody flow fields. The capability to solve entire

vehicle geometries at hypersonic speeds, including an interacting exhaust plume, is demonstrated. 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. Dissert. Abstr.

**N89-21798\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

### **A PERSPECTIVE ON FUTURE DIRECTIONS IN AEROSPACE PROPULSION SYSTEM SIMULATION**

BRENT A. MILLER, JOHN R. SZUCH, RAYMOND E. GAUGLER, and JERRY R. WOOD 1989 9 p Presented at the 4th International Conference, Santa Clara, CA, 30 Apr. - 5 May 1989; sponsored by the International Supercomputing Inst. (NASA-TM-102038; E-4608; NAS 1.15:102038) Avail: NTIS HC A02/MF A01 CSCL 21/5

The design and development of aircraft engines is a lengthy and costly process using today's methodology. This is due, in large measure, to the fact that present methods rely heavily on experimental testing to verify the operability, performance, and structural integrity of components and systems. The potential exists for achieving significant speedups in the propulsion development process through increased use of computational techniques for simulation, analysis, and optimization. This paper outlines the concept and technology requirements for a Numerical Propulsion Simulation System (NPSS) that would provide capabilities to do interactive, multidisciplinary simulations of complete propulsion systems. By combining high performance computing hardware and software with state-of-the-art propulsion system models, the NPSS will permit the rapid calculation, assessment, and optimization of subcomponent, component, and system performance, durability, reliability and weight-before committing to building hardware. Author

**N89-21799\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

### **AN EXPLICIT RUNGE-KUTTA METHOD FOR TURBULENT REACTING FLOW CALCULATIONS**

A. A. BORETTI (Florence Univ., Italy) Apr. 1989 17 p  
(NASA-TM-101945; E-4635; NAS 1.15:101945) Avail: NTIS HC A03/MF A01 CSCL 21/5

The paper presents a numerical method for the solution of the conservation equations governing steady, reacting, turbulent viscous flow in two-dimensional geometries, in both Cartesian and axisymmetric coordinates. These equations are written in Favre-averaged form and closed with a first order model. A two-equation K-epsilon model, where low Reynolds number and compressibility effects are included, and a modified eddy-break up model are used to simulate fluid mechanics turbulence, chemistry and turbulence-combustion interaction. The solution is obtained by using a pseudo-unsteady method with improved perturbation propagation properties. The equations are discretized in space by using a finite volume formulation. An explicit multi-stage dissipative Runge-Kutta algorithm is then used to advance the flow equations in the pseudo-time. The method is applied to the computation of both diffusion and premixed turbulent reacting flows. The computed temperature distributions compare favorably with experimental data. Author

**N89-21800** Oxford Univ. (England).

**UNSTEADY AERODYNAMICS AND HEAT TRANSFER IN A TRANSONIC TURBINE STAGE Ph.D. Thesis**

D. A. ASHWORTH 1987 277 p

Avail: Univ. Microfilms Order No. BRD83740

Prediction methods for gas turbine flow for both the calculation of surface pressures and heat transfer rates are not available. Such features include the prediction of three-dimensional viscous flowfields, the accurate location and strengths of the secondary flow regimes in a turbine passage, and allowance for time-dependent variations. The time-varying phenomena is studied. Such phenomena occur due to the periodic interaction between stages in a turbine, either that of a nozzle guide vane on a rotor downstream or vice-versa. In most contemporary designs of turbines the effects are due primarily to the wakes from the trailing-edge of the upstream airfoil, and to any associated shock structures resulting from transonic exit flow Mach numbers. These wake and shock interactions were investigated using a simulation method. Measurements of heat transfer rates and pressures for two examples of high-pressure turbine rotor blades are presented and supported by flow visualization methods such as surface oil-dots and schlieren photography. The majority of analysis deals with the first of these (a highly-loaded transonic profile) while the second blade (designed for use in a large civil engine) is included for investigation of the effects of flow unsteadiness on the film cooling process. The transition process is examined in detail by use of wide band-width heat transfer measurements, and a method derived for modelling this process. It was possible to observe the effect of the enhanced turbulence in the simulated nozzle guide vane wake and effects due to a shock-boundary layer interaction. The reaction of the blade boundary layers to these disturbances is identified, and trajectories of disturbed events tracked along the blade surfaces. The measurements which have been taken allow for some aspects of wake and shock interactions to be included in the design process for turbine blading.

Dissert. Abstr.

**N89-21801#** Purdue Univ., West Lafayette, IN. Thermal Sciences and Propulsion Center.

**RESEARCH AS PART OF THE AIR FORCE RESEARCH IN AERO PROPULSION TECHNOLOGY (AFRAPT) PROGRAM**

**Final Technical Report, Aug. 1987 - Aug. 1988**

SANFORD FLEETER Aug. 1988 5 p

(Contract AF-AFOSR-0305-86; AF PROJ. 2308)

(AD-A204968; AFOSR-89-0199TR) Avail: NTIS HC A02/MF A01 CSCL 21/5

Eleven students participated in the Air Force Research in Aero Propulsion Technology (AFRAPT) program during the 1987 to 1988 academic year. During this year: One new Ph.D. candidate completed two qualifying exams and initiated his thesis research; One new Ph.D. candidate withdrew from the program and is now permanently employed at a participating company; four M.S.M.E. candidates completed their thesis and are now permanently employed at a participating company; five M.S.M.E. candidates completed their course work, and are working on their thesis projects.

GRA

**N89-22605\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**ACTIVE VIBRATION CONTROL FOR FLEXIBLE ROTOR BY OPTIMAL DIRECT-OUTPUT FEEDBACK CONTROL**

KENZOU NONAMI, ELISEO DIRUSSO, and DAVID P. FLEMING

1989 9 p Proposed for presentation at the 12th Biennial Conference on Mechanical Vibration and Noise, Montreal, Quebec, 17-20 Sep. 1989; sponsored by ASME

(NASA-TM-101972; E-4672; NAS 1.15:101972) Avail: NTIS HC A02/MF A01 CSCL 21/5

Experimental research tests were performed to actively control the rotor vibrations of a flexible rotor mounted on flexible bearing supports. The active control method used in the tests is called optimal direct-output feedback control. This method uses four electrodynamic actuators to apply control forces directly to the bearing housings in order to achieve effective vibration control of

the rotor. The force actuators are controlled by an analog controller that accepts rotor displacement as input. The controller is programmed with experimentally determined feedback coefficients; the output is a control signal to the force actuators. The tests showed that this active control method reduced the rotor resonance peaks due to unbalance from approximately 250 micrometers down to approximately 25 micrometers (essentially runout level). The tests were conducted over a speed range from 0 to 10,000 rpm; the rotor system had nine critical speeds within this speed range. The method was effective in significantly reducing the rotor vibration for all of the vibration modes and critical speeds.

Author

**N89-22606\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**INVESTIGATION OF LOW NOX STAGED COMBUSTOR CONCEPT IN HIGH-SPEED CIVIL TRANSPORT ENGINES**

HUNG LEE NGUYEN, DAVID A. BITTKER, and RICHARD W. NIEDZWIECKI 1989 23 p Presented at the 25th Joint Propulsion Conference, Monterey, CA, 10-12 Jul. 1989; cosponsored by the AIAA, ASME, SAE, and ASEE

(NASA-TM-101977; E-4071; NAS 1.15:101977; AIAA-89-2942)

Avail: NTIS HC A03/MF A01 CSCL 21/5

Levels of exhaust emissions due to high temperatures in the main combustor of high-speed civil transport (HSCT) engines during supersonic cruise are predicted. These predictions are based on a new combustor design approach: a rich burn/quick quench/lean burn combustor. A two-stage stirred reactor model is used to calculate the combustion efficiency and exhaust emissions of this novel combustor. A propane-air chemical kinetics model is used to simulate the fuel-rich combustion of jet fuel. Predicted engine exhaust emissions are compared with available experimental test data. The effect of HSCT engine operating conditions on the levels of exhaust emissions is also presented. The work described in this paper is a part of the NASA Lewis Research Center High-Speed Civil Transport Low NO(x) Combustor program.

Author

**N89-22607\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**TRANSONIC VISCOUS FLOW CALCULATIONS FOR A TURBINE CASCADE WITH A TWO EQUATION TURBULENCE MODEL**

A. A. BORETTI (Florence Univ., Italy) Apr. 1989 16 p

(NASA-TM-101944; E-4634; NAS 1.15:101944) Avail: NTIS HC A03/MF A01 CSCL 21/5

A numerical method for the study of steady, transonic, turbulent viscous flow through plane turbine cascades is presented. The governing equations are written in Favre-averaged form and closed with a first order model. The turbulent quantities are expressed according to a two-equation kappa-epsilon model where low Reynolds number and compressibility effects are included. The solution is obtained by using a pseudo-unsteady method with improved perturbation propagation properties. The equations are discretized in space by using a finite volume formulation. An explicit multistage dissipative Runge-Kutta algorithm is then used to advance the flow equations in the pseudo-time. First results of calculations compare fairly well with experimental data.

Author

**N89-22608** Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).

**PROPULSION SYSTEMS WITH IMPROVED EFFICIENCY FOR FUTURE PASSENGER AIRCRAFT. MAIN TASK A: CONCEPTUAL INVESTIGATIONS OF FUTURE PROPULSION SYSTEMS WITH ENHANCED PROPULSIVE EFFICIENCY [ANTRIEBE MIT VERBESSERTER WIRTSCHAFTLICHKEIT FUER ZUKUNFTIGE VERKEHRSFLUGZEUGE.]**

**HAUPTAUFGABE A: KONZEPTIONELLE UNTERSUCHUNGEN VON ZUKUNFTIGEN ANTRIEBEN MIT ERHOEHTEM VORTRIEBSWIRKUNGSGRAD**

SCHILL, GUMUCIO, WILDNER, GEIDEL, and TRACKSDORF 30 Jun. 1987 186 p In GERMAN

(Contract BMFT-LFT-8510/4)

(MTU-TB-87/010; ETN-89-93765) Avail:

Fachinformationszentrum Karlsruhe, 7514  
Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

Open counter-rotating propfan propulsion systems as pusher with and without transmission were investigated. The variant with transmission is shown to be the most advantageous concept with respect to specific fuel consumption, weight and noise. The main advantages of the pusher without transmission are (besides the omission of the transmission) the smaller length and the smaller propeller diameter. The concept CRISP (Counter-Rotating Integrated Shrouded Propfan) was selected for further studies. Questions concerning CRISP, such as electrical auxiliary apparatus in samarium-cobalt technology and alternative transmission variants, are discussed. A nuclear propulsion system with single-rotor gas generator and innovative component technology was designed. ESA

**N89-22609** Cincinnati Univ., OH.  
**LDV MEASUREMENTS AND INVESTIGATION OF FLOW FIELD THROUGH RADIAL TURBINE GUIDE VANES** Ph.D. Thesis  
HASAN EROGLU 1988 216 p  
Avail: Univ. Microfilms Order No. DA8903591

The results of laser Doppler velocimeter (LDV) measurements and investigation of detailed flow field through radial inflow turbine guide vanes are presented. A three-component LDV system was used for the velocity measurements. The results are presented as contour plots of mean velocities, flow angles and turbulent stresses. Significant end wall cross flows were observed inside the blade passages close to the trailing edges. However, these cross flows are different from the ones in axial turbines because of the counter effects of the radial pressure gradient, the blade shape, and the high negative incidence angle. The flow field through the blade passages was found to be strongly influenced by the scroll geometry. The lack of periodicity between flow channels and asymmetry with respect to the two end walls were attributed to this upstream influence. The rapid mixing of the free stream flow with the wakes occurred downstream of the trailing edges. The average flow angle at downstream measuring station was found to be lower than the exit blade angle showing flow overturning at this radial location. The turbulence intensity increased in the downstream direction. The turbulent stresses also generally increased in the flow direction, but at different rates. The cross plane contour plots of turbulent stress components indicated that the turbulence is anisotropic. The mass flow rate increase did not change the inlet flow angle, but it decreased the passage averaged exit flow angle. The turbulence intensity and stresses decreased with the increase of the mass flow rate. In addition to the experimental investigation, an analytical study of the flow field through the guide vanes of the experimental radial turbine was performed. The flow field was computed using an inviscid, panel method computer code on the blade-to-blade surface of revolution at midspan position. Dissert. Abstr.

**N89-22659#** Ministry of Defence, London (England).  
**FUTURE ADVANCED AERO-ENGINES: THE MATERIALS CHALLENGE**

D. R. HIGHTON and W. J. CHRISPIN /in AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 10 p Mar. 1989  
Avail: NTIS HC A13/MF A01

A balanced program of aero-engine advanced engineering is pursued in the UK, and an important and growing element of this program is that devoted to materials and processing technology. The quest for more capable materials is an essential element of that program. The powerplant continues to be a critical factor in improving vehicle capability in all military and civil applications. A position has been reached where further improvements in propulsion depend not only on maintaining current effort in aerothermodynamic technology, but also making substantial investments in new high risk materials technology. E.R.

## AIRCRAFT STABILITY AND CONTROL

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

**A89-36927\*#** Kansas Univ., Lawrence.  
**SENSITIVITY ANALYSIS OF DIGITAL FLIGHT CONTROL SYSTEMS USING SINGULAR-VALUE CONCEPTS**  
JAMES D. PADUANO and DAVID R. DOWNING (Kansas, University, Lawrence) (Guidance, Navigation and Control Conference, Williamsburg, VA, Aug. 18-20, 1986, Technical Papers, p. 338-345) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, May-June 1989, p. 297-303. Previously cited in issue 23, p. 3409, Accession no. A86-47437. refs (Contract NCC2-293)

**A89-36928\*#** Virginia Polytechnic Inst. and State Univ., Blacksburg.  
**SINGULAR TRAJECTORIES IN AIRPLANE CRUISE-DASH OPTIMIZATION**  
KARL D. BILIMORIA and EUGENE M. CLIFF (Virginia Polytechnic Institute and State University, Blacksburg) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, May-June 1989, p. 304-310. Research supported by DARPA. Previously cited in issue 22, p. 3540, Accession no. A87-50488. refs (Contract F49620-87-C-0116; NAG1-203)

**A89-36929#**  
**TRAJECTORY OPTIMIZATION WITH RISK MINIMIZATION FOR MILITARY AIRCRAFT**  
JOHN L. VIAN and JOHN R. MOORE (Boeing Military Airplane Co., Wichita, KS) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, May-June 1989, p. 311-317. Previously cited in issue 22, p. 3542, Accession no. A87-50526. refs

**A89-36930\*#** City Coll. of the City Univ. of New York, NY.  
**EIGENSTRUCTURE ASSIGNMENT FOR THE CONTROL OF HIGHLY AUGMENTED AIRCRAFT**  
KENNETH M. SOBEL (City College, New York) and FREDERICK J. LALLMAN (NASA, Langley Research Center, Hampton, VA) (1988 American Control Conference, 7th, Atlanta, GA, June 15-17, 1988, Proceedings. Volume 2, p. 1267-1276) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, May-June 1989, p. 318-324. Previously cited in issue 24, p. 3909, Accession no. A88-54549. refs

**A89-36931\*#** National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.  
**APPLICATION OF PRECOMPUTED CONTROL LAWS IN A RECONFIGURABLE AIRCRAFT FLIGHT CONTROL SYSTEM**  
DANIEL D. MOERDER (NASA, Langley Research Center, Information and Control Systems, Inc., Hampton, VA), NESIM HALYO (Information and Control Systems, Inc., Hampton, VA), JOHN R. BROUSSARD (Texas Instruments, Inc., Lewisville), and ALPER K. CAGLAYAN (Charles River Analytics, Inc., Cambridge, MA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, May-June 1989, p. 325-333. refs (Contract F33615-84-C-3608)

A self-repairing flight control system concept in which the control law is reconfigured after actuator and/or control surface damage to preserve stability and pilot command tracking is described. A key feature of the controller is reconfigurable multivariable feedback. The feedback gains are designed off-line and scheduled as a function of the aircraft control impairment status so that reconfiguration is performed simply by updating the gain schedule after detection of an impairment. A novel aspect of the gain schedule design procedure is that the schedule is calculated using a linear quadratic optimization-based simultaneous stabilization algorithm in which the scheduled gain is constrained to stabilize a collection of plant models representing the aircraft in various control

failure modes. A description and numerical evaluation of a controller design for a model of a statically unstable high-performance aircraft are given. Author

**A89-36932\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**SIMULATION EVALUATION OF AN ADVANCED CONTROL CONCEPT FOR A V/STOL AIRCRAFT**

E. MORALES, V. K. MERRICK, and J. A. SCHROEDER (NASA, Ames Research Center, Moffett Field, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, May-June 1989, p. 334-341. Previously cited in issue 22, p. 3542, Accession no. A87-50536. refs

**A89-36934#**

**FLIGHT CONTROL SYSTEM DESIGN FOR AN IN-FLIGHT SIMULATOR**

F. HENSCHER (DFVLR, Brunswick, Federal Republic of Germany) and S. CHETTY (National Aeronautical Laboratory, Bangalore, India) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, May-June 1989, p. 351-356. Previously cited in issue 22, p. 3541, Accession no. A87-50497. refs

**A89-36998#**

**EQUIVALENT SYSTEMS METHOD TO EVALUATE THE FLIGHT QUALITIES**

FENG LIANG, LINCHANG ZHANG, and CHUNJIN LI (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 9, Nov. 1988, p. A581-A585. In Chinese, with abstract in English.

The determination of equivalent systems both in time domain and frequency domain is discussed. Various matching forms of equivalent systems are studied. In the frequency domain, the nonlinear optimization is used to find the equivalent parameters. In the time domain, the adaptive filtering algorithms with UD decomposition are employed as an identification algorithm to estimate the parameters. Author

**A89-37461**

**FLUTTER OF A WING WITH AN AILERON IN TRANSONIC FLOW [O FLATTERE KRYLA S ELERONOM V OKOLOZVUKOVOM POTOKE]**

IU. P. NUSHTAEV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669), vol. 29, April 1989, p. 598-603. In Russian. refs

The problem of the flutter of an infinite-span wing with an aileron in transonic flow of an ideal gas is solved numerically by linearizing the aerodynamic characteristics, with allowance made for compression shock fluctuations. The nonstationary aerodynamic characteristics are calculated using an implicit finite difference scheme. The effect of inertial and aerodynamic constraints on vibration stability is investigated, and a comparison is made with a solution for systems with a single degree of freedom. V.L.

**A89-37524**

**VALIDATION OF NONSTATIONARY AERODYNAMICS MODELS FOR LONGITUDINAL AEROPLANE MOTION ON THE BASIS OF FLIGHT MEASUREMENTS**

VILEM KOCKA Zprava VZLU, no. Z-56, 1988, p. 1-14. refs

The longitudinal motion of a light transport aircraft is considered as being excited by a pulse deflection of the elevator control surface during slow steady horizontal flight. On the basis of physical analysis, basic and simplified models of nondimensional aerodynamic frequency transfers and related nondimensional aerodynamic step admittances are derived. They comprise separated quasistationary and nonstationary parts. The analysis is useful for didactic purposes in flight mechanics and aerodynamics. An objective means of verifying the validity of aerodynamic models, which is based on flight measurements of an actual airplane, is suggested for use during airplane design. S.A.V.

**A89-39258**

**INTEGRAL RUDDER SYSTEM FOR AIRCRAFT STEERING [INTEGRALES RUDERSYSTEM ZUR STEUERUNG VON FLUGZEUGEN]**

W. HEINRICH Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 13, Jan.-Feb. 1989, p. 42-47. In German.

A control surface system is being developed to reduce maximum wing loads and improve aircraft low-speed maneuverability while still permitting structural amplification relative to conventional systems. The system's greatest advantages pertain to canard or swept-back wing aircraft. The effects of the system on slow-flight characteristics, flight performance, longitudinal stability, curved flight, yawing moment, lateral control, and lateral stability as experimentally verified on a flight model are discussed. The influence of the integral rudder system on the flight structure, including the bending moment, torsion moment, and structural weight, is briefly addressed. C.D.

**A89-39458#**

**ROBUST CONTROL OF AN ACTIVE VIBRATION ISOLATION SYSTEM FOR HELICOPTERS**

QITAI GU (Tsinghua University, Beijing, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 10, Jan. 1989, p. A48-A54. In Chinese, with abstract in English.

The rejection of so-called blade harmonic disturbances generated by the main rotor of helicopters and atmospheric turbulence is an important problem which should be considered in the design of future helicopters. In this paper, robust control theory was applied to the design of an active vibration-isolation system which effectively restricts the influence of blade harmonics on the fuselage at the first and second harmonic frequencies, as well as eliminates the static relative displacement between the main rotor and fuselage under ascent or descent acceleration. Author

**A89-39459#**

**THE ANALYSIS AND PREDICTION OF THE SPIN EQUILIBRIUM POINT OF MODERN AIRCRAFTS**

SHUNDA XIAO and YIN CHENG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 10, Jan. 1989, p. A55-A59. In Chinese, with abstract in English.

Two approximate methods for predicting the equilibrium point of steady-state spin are presented. First, approximate values of state variables during steady-state spin are determined analytically by neglecting certain parameters which have trivial influence on the spin. In the second method, the state variables of the equilibrium point are calculated by a digital computer by using the Davidson-Fletcher-Powell optimization method. In this way, the computing time for digital simulation of spin motions is shortened. Author

**N89-21802\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**LATERAL STABILITY ANALYSIS FOR X-29A DROP MODEL USING SYSTEM IDENTIFICATION METHODOLOGY**

DAVID L. RANEY and JAMES G. BATTERSON Jun. 1989 27 p

(NASA-TM-4108; L-16471; NAS 1.15:4108) Avail: NTIS HC A03/MF A01 CSCL 01/3

A 22-percent dynamically scaled replica of the X-29A forward-swept-wing airplane has been flown in radio-controlled drop tests at the NASA Langley Research Center. A system identification study of the recorded data was undertaken to examine the stability and control derivatives that influence the lateral behavior of this vehicle with particular emphasis on an observed wing rock phenomenon. All major lateral stability derivatives and the damping-in-roll derivative were identified for angles of attack from 5 to 80 degrees by using a data-partitioning methodology and a modified stepwise regression algorithm. Author

## 08 AIRCRAFT STABILITY AND CONTROL

**N89-21803#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

### **MULTIVARIABLE CONTROL LAW DESIGN FOR THE CONTROL RECONFIGURABLE COMBAT AIRCRAFT (CRCA)**

**M.S. Thesis**

DARYL HAMMOND Dec. 1988 422 p

(AD-A202697; AFIT/GE/ENG/88D-14) Avail: NTIS HC A18/MF A01 CSCL 01/4

Typically, control law analysis and design for an aircraft include separating the longitudinal and lateral equations of motion and designing control laws for each separate motion. The simplifying assumptions are often valid and do not adversely affect the analysis and design when aerodynamic cross-coupling is minimal. The Control Reconfigurable Combat Aircraft (CRCA) design includes an all-flying canard with 30 degrees of dihedral angle which prevents the normal separation of lateral and longitudinal equations because of high aerodynamic cross-coupling. The multivariable control law design used in this thesis incorporates the high gain error actuated Proportional plus Integral (PI) controller developed by Professor Brian Porter of the University of Salford, England. Control law development and simulation are performed using the computer aided design program called mat. Two successful fixed gain controller design methods and an adaptive controller design are demonstrated. The three control surfaces on each wing are operated together, so they are treated in this thesis as one control effector. Thus, the five CRCA control inputs for this design consist of two canards, left trailing edge flaperon, right trailing edge flaperon, and rudder. An adaptive controller design, using a recursive least squares (RLS) parameter estimation algorithm, is developed for a self-tuning control system. GRA

**N89-21804#** Massachusetts Inst. of Tech., Cambridge. Lab. for Advanced Composites.

### **STALL FLUTTER OF GRAPHITE/EPOXY WINGS WITH BENDING-TORSION COUPLING Annual Technical Report, 1 Jul. 1987 - 30 Jun. 1988**

PETER DUNN and JOHN DUGUNDJI 25 Oct. 1988 25 p  
(Contract F49620-86-C-0066)

(AD-A203077; TELAC-88-11; AFOSR-88-1289TR) Avail: NTIS HC A03/MF A01 CSCL 01/3

An analytical and experimental investigation is made of the non-linear, large amplitude, high angle of attack, stall flutter behavior of cantilevered graphite/epoxy wings. Ten six-ply graphite/epoxy wings with a wide range of bending-torsion characteristics were constructed and styrofoam fairings epoxied to these to form NACA-0012 airfoil shapes. Wind tunnel tests on these cantilevered wings revealed torsional and bending stall flutter limit cycles, depending on the layup. Reasonable agreement with steady, non-linear theory and with unsteady, linear theory was found. Fourier analysis applied to the ONERA 2-D non-linear, unsteady, aerodynamic model shows reasonable agreement with 2-D experiments on aerodynamic force and moment coefficients. GRA

**N89-21806** Alabama Univ., University.

### **ENERGY CONCEPTS APPLIED TO CONTROL OF AIRPLANE FLIGHT IN WIND SHEAR Ph.D. Thesis**

KALMANJE KRISHNAKUMAR 1988 282 p

Avail: Univ. Microfilms Order No. DA8826950

The principle of inertial energy distribution control for optimal wind shear penetration is developed theoretically, and a controller based on this principle is experimentally tested using a non-linear Boeing 727 math model. A Monte Carlo simulation for take-off, landing, and go-around flight conditions in the presence of microburst wind shear environment, is used to demonstrate the controller's universal application capabilities. The results of the experimental study show excellent height minimization characteristics of the controller based on the inertial energy distribution error performance index. Control of airplane flight in microburst wind shear environments is investigated from the point of view of optimally managing the available airplane energy. An energy analysis was conducted to identify viable energy-related performance indices for optimal control system design. Several

energy related performance indices were evaluated for their relative microburst wind shear penetration characteristics, via an energy-based feedback control system design. The concept and importance of feeding back inertial energy parameters for airplane guidance was introduced. The energy-based controller was tested for its robustness in a realistic microburst environment, using a Monte Carlo simulation of landing, take-off, and go-around flight conditions. Statistical models for the microburst strength, size, and location were used for the Monte Carlo simulation. Results are presented in terms of the probability of hitting an obstacle and in terms of the statistics of maximum deviations of airplane variables of interest. A number of recommendations, based both on the energy analysis and on the results obtained, are included.

Dissert. Abstr.

**N89-21807#** Sparta, Inc., Lexington, MA.

### **STABILITY AND CONTROL OF HYPERVELOCITY VEHICLES**

**Final Report, Apr. 1986 - Dec. 1987**

RUDRAPATNA V. RAMNATH Feb. 1989 155 p

(Contract F33615-86-C-3616)

(AD-A205160; AFWAL-TR-89-3019) Avail: NTIS HC A08/MF A01 CSCL 01/3

This report investigates the general class of problems associated with the flight dynamics of hypervelocity vehicles and their control. After an examination of typical vehicles, flight environment, operating conditions and trajectories, a general analytical theory is developed to solve the significant problems. Based on typical flight scenarios, the dynamics are appropriately formulated to fit the situation in question. Thus the flight dynamics are investigated on a variety of trajectories, including re-entry and flight on constant-latitude minor circles at constant altitude. Re-entry dynamics are analyzed along steep, shallow, and arbitrary trajectories. Asymptotic analytical solutions are developed by the Generalized Multiple Scales method, in which the clock functions are necessarily nonlinear and complex quantities in order to solve the nonlinear and time varying dynamics. GRA

**N89-22610** Purdue Univ., West Lafayette, IN.

### **MODEL-BASED ANALYSIS AND COOPERATIVE SYNTHESIS OF CONTROL AND DISPLAY AUGMENTATION FOR PILOTED FLIGHT VEHICLES Ph.D. Thesis**

SANJAY GARG 1988 281 p

Avail: Univ. Microfilms Order No. DA8825537

The thrust of this research is to develop and validate a systematic technique for pilot-optimal control/display synthesis in complex, closed-loop manual control tasks. The suggested methodology makes extensive use of an Optimal Control Model of human behavior, both for synthesis as well as analysis. The use of the Optimal Control Modeling approach to adequately predict the effects of control/display interaction on human performance and workload, is first validated by performing a detailed model-based study of a set of configurations previously evaluated in an in-flight experimental study. The mathematical formulation of the Cooperative Control Synthesis technique is then extended to allow for simultaneously augmenting the display dynamics as well as plant or controlled element dynamics. The first order necessary conditions for the optimality of the control/display augmentation control laws are derived and a numerical solution algorithm is developed to solve for these control laws. The methodology is exercised to synthesize control and display augmentation in a compensatory tracking task with a generic controlled element. Analytical evaluations of the designs indicate the applicability of the methodology to meet pilot-centered requirements and to provide a task specific, systematic trade-off between control and display augmentation. An extensive real-time man-in-the-loop simulation study is performed to validate the results from the methodology. Finally, the utility of the methodology is demonstrated by synthesizing control-display designs in the longitudinal approach and landing task for a modern, statically unstable fighter-type aircraft. Dissert. Abstr.

## 09 RESEARCH AND SUPPORT FACILITIES (AIR)

**N89-22611#** Aeronautical Research Labs., Melbourne (Australia).

### **SINGLE CHANNEL TEST CONTROLLERS Aircraft Structures Technical Memo.**

I. POWLESLAND and E. S. MOODY Jun. 1988 55 p (AD-A204088; ARL-STRUC-TM-488; DODA-AR-005-525) Avail: NTIS HC A04/MF A01 CSCL 14/2

The stand-alone controllers in single and coupled-channel forms are described. Details of hardware and software are given, and notes on the associated data acquisition system and test boxes are included. A number of appendices provide data for preparation and reading of floppy disks, for cycling and communication rate adjustments and detailed information on other aspects of these units. G.R.A.

## 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.

**A89-37783#**

### **INVESTIGATION FOR VENTING TEST TECHNOLOGY WITH LARGE-SIZED MODEL IN A LARGE WIND TUNNEL**

ZHANA O DONG (Luoyang Dynamics Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 75-80. In Chinese, with abstract in English.

This paper describes briefly the investigation of venting test technology with a large-sized model in a 1.2m x 1.2m wind tunnel. Four main problems are solved as follows: the contradiction between balance rod and venting pipeline simultaneous measurements for both 34 point pressures and six-component balance forces variations in flow and in base pressure. The test results were compared with those obtained in 0.6m x 0.6m wind tunnel. It is shown that the venting test technology applied in both model and wind tunnel with large or small size are quite satisfied. Author

**A89-37786#**

### **THE APPLICATION OF WALL PRESSURE METHOD IN LOW SPEED RETURN WIND TUNNEL WITH CLOSED JET**

MINGYAN CHEN (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 7, March 1989, p. 94-101. In Chinese, with abstract in English.

A wall pressure signature method presented by Hackett has been introduced in order to estimate the wind tunnel corrections at high angles of attack. The tests of four flat plate wing and wing-body models of similar geometry with various sizes have been completed in NH-2 wind tunnel of Nanjing Aeronautical Institute. The results of test and calculation showed that the present method is convenient to use and the results corrected are accurate and reliable. But it is necessary to point out that the satisfactory results can be obtained only if the static pressure obtained from measurement at the surface of wall be corrected properly for closed jet and return wind tunnel with the breather slot aft the jet. Author

**A89-38582**

### **AIRPORT TECHNOLOGY INTERNATIONAL 1988**

MAURICE G. HUDSON, ED. London, Sterling Publications, Ltd., 1988, 252 p. No individual items are abstracted in this volume.

The current status of airport technology is surveyed in reviews and reports by industry experts. Topics addressed include airport policy and management; the planning, design, and construction of airports; passenger handling and commercial operations; cargo handling; and ramp operations and handling. Consideration is given to problems of maintenance, airfield operations, ATC and

navigation, training, and security. Extensive diagrams, drawings, graphs, and photographs are provided. T.K.

**A89-39008**

### **ACOUSTIC EMISSION TESTING THE F-111**

J. M. CARLYLE (Physical Acoustics Corp., Princeton, NJ) NDT International (ISSN 0308-9126), vol. 22, April 1989, p. 67-73. refs

An acoustic emission (AE) test chamber is described for locating sources of failure in the F-111 fighter/bomber D6AC steel structures. The chamber periodically chills the F-111 aircraft to -40 C and stresses them up to +7.3 g and down to -3.0 g. The cold proof test station AE monitoring system includes a color CRT displaying the exact location of AE events in real time on simultaneous overhead and side views of the F-111. The events are colored green, yellow, and red according to their severity, as calculated from their amplitude and energy. A monochromatic CRT is used concurrently with the color CRT to display severity information on AE events which only arrive at one sensor. Audio alarms also alert the operator to crucial events, using two tones to distinguish the degree of severity. S.A.V.

**A89-39469#**

### **DEVELOPMENT OF A SECOND GENERATION INJECTOR DRIVEN TRANSONIC WIND TUNNEL AT BUAA**

YUNPEI LING, HUA ZHANG, and JIAN LIU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 10, Feb. 1989, p. B9-B14. In Chinese, with abstract in English. refs

The development of an injector-driven transonic pilot wind tunnel in BUAA is reported. Improvements are made in dynamic flow quality and mass efficiency. The pressure fluctuation level in the test section meets the advanced world standard and specifically satisfies or approaches Lowson's formula and Mabey's criterion. The mass ratio and free-stream turbulence attain a reasonably good level. Experimental results indicate good prospects for utilizing the injector-driven technique in advanced transonic wind tunnels. C.D.

**A89-39477#**

### **ON THE ACCELERATING AIRFLOW PROBLEM IN THE TEST SECTION OF A TRANSONIC WIND TUNNEL**

GUOFENG ZHENG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 10, Feb. 1989, p. B73-B75. In Chinese, with abstract in English.

The accelerating airflow problem in the transonic test section with perforated wall is investigated from three aspects: (1) the axial distribution of porosity, (2) the determination of design parameters in the front of accelerating section, and (3) the investigation of the region of influence. Assuming that the axial pressure drop and the cross-flow velocity in a mass-flow nozzle is equal to those in the solid wall nozzle, a formula for calculating the open-area ratio of the mass-flow nozzle can be deduced. It is found that the predicted values of the open-area are consistent with the measured ones. Hence, the formula can be utilized to design the open-area ratio distribution of the mass-flow nozzle. Author

**N89-21808#**

Aeronautical Research Labs., Melbourne (Australia).

### **DESCRIPTION OF A SIMPLE ROTOR TEST RIG AND PRELIMINARY WAKE STUDIES Aerodynamics Technical Memo.**

M. J. WILLIAMS and K. R. REDDY May 1988 23 p (AD-A204089; ARL-AERO-TM-397; DODA-AR-005-527) Avail: NTIS HC A03/MF A01 CSCL 01/3

A simple test rig has been constructed, to obtain detailed rotor wake geometry data. The rotor head and blades have been taken from a radio-controlled model and attached to a 1HP 3-phase motor. The rotor and drive system were mounted on a rigid tripod-supported stand, and the rig used to obtain smoke flow visualization photographs of tip vortices within the rotor wake.



## 09 RESEARCH AND SUPPORT FACILITIES (AIR)

These photographs provide vortex trajectories from which axial and radial coordinates of the vortex can be determined. The resulting data can be used to construct prescribed wake models for use in helicopter aerodynamics codes. GRA

**N89-21809#** University of Southern Illinois, Carbondale. Materials Technology Center.

**A PROPOSAL FOR FUNDING TO PURCHASE A HIGH-TEMPERATURE FURNACE TO ENABLE DETERMINATION OF THE HIGH TEMPERATURE MECHANICAL PROPERTIES OF STRUCTURAL CARBON MATERIALS Final Report, 15 Aug. 1987 - 15 Aug. 1988**

MAURICE A. WRIGHT 13 Oct. 1988 5 p  
(Contract AF-AFOSR-0397-87; AF PROJ. 2306)  
(AD-A204103; AFOSR-88-1315TR) Avail: NTIS HC A02/MF A01 CSCL 14/2

This report documents the purchase of a controlled environment furnace, designed for attachment to the MTS and Instron tensile testing machines used by the researchers of the Materials Technology Center at Southern Illinois University at Carbondale. After investigating proper sources for the equipment, a purchase requisition was processed on December 7, 1987 through university procedures and Board of Trustees approval. GRA

**N89-21810#** General Electric Co., Burlington, VT. Armament Systems Dept.

**AEROBALLISTIC RESEARCH FACILITY DATA ANALYSIS SYSTEM (ARFDAS) Final Technical Report, Oct. 1986 - Sep. 1987**

MARK FISCHER and WAYNE HATHAWAY Sep. 1988 144 p  
(Contract F08635-87-C-0005)  
(AD-A204308; AD-E801786; AFATL-TR-88-48) Avail: NTIS HC A07/MF A01 CSCL 19/10

This report documents the computerized analysis programs used to examine free-flight, ballistic trajectory data (spatial position, angular orientation, and time) obtained at the United States Air Force Aeroballistic Research Facility (ARF). The Aeroballistic Research Facility Data Analysis System (ARFDAS) is a set of FORTRAN programs used to extract aerodynamic coefficients from experimental spark range data. This report, essentially a User's Manual, concentrates on how to utilize ARFDAS to conduct the desired analysis. The theory behind derivation of the six degree of freedom equations of motion is fully explained by the references. The purpose of the report is to enable a person, who possesses a good knowledge of aerodynamics, to utilize the ARFDAS computer codes to analyze experimental data to final coefficient form. GRA

**N89-21811#** Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.

**EVALUATION OF BARRIER CABLE IMPACT PAD MATERIALS Final Report, Sep. 1983 - Sep. 1984**

TONY B. HUSBANDS and DENNIS L. BEAN Mar. 1988 94 p  
(Contract MIPR-N-90-29; MIPR-F-83-73; AF PROJ. 2104)  
(AD-A204356; AFESC/ESL-TR-87-33) Avail: NTIS HC A05/MF A01 CSCL 01/5

The U.S. Air Force uses an aircraft arresting system on many of their runways for emergency stopping of aircraft. It consists of a 1- or 1-1/4-inch steel cable stretched across the runway connected to a braking mechanism. When aircraft tires impact the cable, considerable damage occurs to concrete and other materials placed underneath the cable. Materials previously used were not performing satisfactorily for various reasons. A survey was made in 1980 for the Air Force Engineering and Services Center (AFESC) to locate materials for evaluation. Five of these were selected for detailed testing. The materials were tested for gel times, peak exotherms, bond strength, abrasion resistivity, ultraviolet degradation, resiliency, hardness, abrasion-impact resistance, effect of curing temperature, and proportioning errors. GRA

**N89-21812#** Federal Aviation Administration, Washington, DC. Office of Airport Planning and Programming.

**ELIGIBILITY OF NOISE ABATEMENT PROPOSALS FOR GRANTS-IN-AID UNDER THE AIRPORT IMPROVEMENT PROGRAM**

ELLIS OHNSTAD Jan. 1989 26 p  
(AD-A204724; DOT/FAA/PP-89/2) Avail: NTIS HC A03/MF A01 CSCL 14/2

This report summarizes the provisions of existing Federal laws, regulations, administrative policies and grant program procedures which relate to funding of noise abatement projects. The report also presents historical data on Federally assisted noise compatibility projects and funding levels in fiscal years 1982 to 1987. A literature search was conducted and parties involved with airport noise compatibility planning and project implementation were consulted to identify proposals which are currently not eligible for grant assistance and the reasons for their ineligibility. The report concludes with recommendations to make eligibility criteria more flexible and to provide clearer guidance to parties involved with noise compatibility project formulation, evaluation and implementation. GRA

**N89-21813#** Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Software Engineering.

**AN OOD (OBJECT-ORIENTED DESIGN) PARADIGM FOR FLIGHT SIMULATORS, 2ND EDITION Final Report**

KENNETH J. LEE, MICHAEL S. RISSMAN, RICHARD DIPPOLITO, CHARLES PLINTA, and ROGER VANSKOY Sep. 1988 120 p  
(Contract F19628-85-C-0003)  
(AD-A204849; CMU/SEI-88-TR-30; ESD-TR-88-031) Avail: NTIS HC A06/MF A01 CSCL 12/5

This report presents a paradigm for object-oriented implementations of flight simulators. It is a result of work on the Ada Simulator Validation Program (ASVP) carried out by members of the technical staff at the Software Engineering Institute (SEI). Object-oriented design (OOD) predominates discussions about Ada-based software engineering. The identification of objects and the implementation of objects are two separate issues. This paradigm is a model for implementing systems of objects. The objects are described in a form of specification called an object diagram. The paradigm is not about how to create the specification. Although much has been written on object-oriented design, SEI project members could find no examples of object-oriented implementations relevant to flight simulators. Examples were required for two reasons. First, object-orientation was new to both of the contractors on the ASVP. A methodology which leads to a specification of objects is useful only if developers know how to implement what is specified. Second, managers were skeptical about the benefits of object-oriented design. Examples were needed to determine whether benefits outweigh costs. GRA

**N89-22614\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**HARDWARE AND OPERATING FEATURES OF THE ADAPTIVE WALL TEST SECTION FOR THE 0.3-METER TRANSONIC CRYOGENIC TUNNEL**

RAYMOND E. MINECK Jun. 1989 41 p  
(NASA-TM-4114; L-16548; NAS 1.15:4114) Avail: NTIS HC A03/MF A01 CSCL 14/2

A 13- by 13-inch adaptive wall test section was installed in the Langley 0.3-Meter Transonic Cryogenic Tunnel circuit. This test section has four solid walls and is configured for two-dimensional airfoil testing. The top and bottom walls are flexible and movable, whereas the sidewalls are rigid and fixed. The test section has a turntable to support airfoil models, a survey mechanism to probe the model wake, and provisions for a sidewall boundary-layer-control system. Details of the adaptive wall test section, the tunnel circuit modifications, the supporting instrumentation, the monitoring and control hardware, and the wall adaptation strategy are discussed. Sample results of shakedown tests with the test section empty and with an airfoil installed are also included. Author



**N89-22615#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.

**VISTING CHINA'S AERODYNAMICS RESEARCH AND DEVELOPMENT CENTER**

YONGDAI HU and YAPING LI 5 Jan. 1989 12 p Transl. into ENGLISH from Sichuan Huabao (People's Republic of China), no. 5, Iss. 53, Sep. 1987 p 7-9

(AD-A203980; FTD-ID(RS)T-0639-88) Avail: NTIS HC A03/MF A01 CSCL 14/2

A visit of the research and development facility is detailed. The facility was developed to meet the needs of China's aviation and space industry and its peoples' economic development. One highlight of the visit was the wind tunnel. Photographs are presented. E.R.

**N89-22616\*#** Vigyan Research Associates, Inc., Hampton, VA. **MICROCOMPUTER BASED CONTROLLER FOR THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL**

S. BALAKRISHNA and W. ALLEN KILGORE Mar. 1989 149 p (Contract NAS1-17919)

(NASA-CR-181808; NAS 1.26:181808) Avail: NTIS HC A07/MF A01 CSCL 14/2

Flow control of the Langley 0.3-meter Transonic Cryogenic Tunnel (TCT) is a multivariable nonlinear control problem. Globally stable control laws were generated to hold tunnel conditions in the presence of geometrical disturbances in the test section and precisely control the tunnel states for small and large set point changes. The control laws are mechanized as four inner control loops for tunnel pressure, temperature, fan speed, and liquid nitrogen supply pressure, and two outer loops for Mach number and Reynolds number. These integrated control laws have been mechanized on a 16-bit microcomputer working on DOS. This document details the model of the 0.3-m TCT, control laws, microcomputer realization, and its performance. The tunnel closed loop responses to small and large set point changes were presented. The controller incorporates safe thermal management of the tunnel cooldown based on thermal restrictions. The controller was shown to provide control of temperature to  $\pm 0.2$  K, pressure to  $\pm 0.07$  psia, and Mach number to  $\pm 0.002$  of a given set point during aerodynamic data acquisition in the presence of intrusive geometrical changes like flexwall movement, angle-of-attack changes, and drag rake traverse. The controller also provides a new feature of Reynolds number control. The controller provides a safe, reliable, and economical control of the 0.3-m TCT. Author

**N89-22617\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**NEW HYPERSONIC FACILITY CAPABILITY AT NASA LEWIS RESEARCH CENTER**

JEFFREY E. HAAS, ROGER CHAMBERLIN, and JOHN H. DICUS 1989 16 p Presented at the 25th Joint Propulsion Conference, Monterey, CA, 10-12 Jul. 1989; sponsored by AIAA, ASME, SAE and ASEE

(NASA-TM-102028; E-4760; NAS 1.15:102028; AIAA-89-2534) Avail: NTIS HC A03/MF A01 CSCL 14/2

Four facility activities are underway at NASA Lewis Research Center to develop new hypersonic propulsion test capability. Two of these efforts consist of upgrades to existing operational facilities. The other two activities will reactivate facilities that have been in a standby condition for over 15 years. These four activities are discussed and the new test facilities NASA Lewis will have in place to support evolving high speed research programs are described. Author

**N89-22619#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Hauptabteilung Windkanale.

**THE LOW-SPEED WIND TUNNEL AT DVFLR IN BRUNSWICK (FED. REPUBLIC OF GERMANY) Status Report, 1988**

GERHARD KAUSCHE, HORST OTTO, DIETMAR CHRIST, and RUEDIGER SIEBERT Sep. 1988 96 p In GERMAN; ENGLISH summary Original contains color illustrations

(DFVLR-MITT-88-25; ISSN-0176-7739; ETN-89-94371) Avail: NTIS HC A05/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, DM 43

Information for users of the low-speed wind tunnel Braunschweig (NWB) of DFVLR is presented. The wind tunnel has a closed return circuit comprising an open and a closed test section, the cross-section being 3.25 m x 2.80 m. A maximum velocity of 90 m/sec in the closed test section and of 75 m/sec in the open one can be achieved. The information required for the preliminary planning of test programs and for the preliminary layout of models for intended tests is given. ESA

**N89-22620** Council for National Academic Awards (England).

**INVESTIGATION OF THE EFFECTS OF INCREASED SOPHISTICATION OF SIMULATION OF THE ATMOSPHERIC WIND IN WIND TUNNELS Ph.D. Thesis**

ALLAN HODGSON CUSICK 1988 413 p

Avail: Univ. Microfilms Order No. BRD-84076

The influence of the sophistication of the simulation of the natural wind in wind tunnels was investigated upon the correlation of model and full scale ground wind speeds and directions. A model of a section of the Manchester University campus, centered about the Mathematics Tower, was made at a scale of 1:250. It extended, at this scale, for a distance of one meter in all directions. This model was tested in three wind tunnels. Two are of high, one of low, sophistication of simulation of the natural wind. It was found that results in all three wind tunnels were significantly affected by model limitations such as the artificial ending of wind dominant building formations at the edge of the model, and potentially, by mis-positioning of ground wind probes at measuring stations in areas of high horizontal velocity gradient. The least sophisticated simulation produced local defects which were markedly worse than corresponding defects in the other two simulations in one particular wind direction. However, the measurements at points in the least sophisticated simulation, which were free of effects directly related to the limited size of the wind tunnel relative to the model, exhibited a similar level of correlation with full scale results to that in the sophisticated simulations. Following the normal custom in pre-construction environmental wind tunnel testing of large buildings in an urban area, only the buildings and major features were included in the model. In these circumstances the effect of the ground-cover on the completed site is expected to give an extra safety factor over the model ground wind predictions made using the smooth base board. The results in all three wind tunnels indicated conformity with these expectations. Dissert. Abstr.

**N89-22621** Colorado Univ., Boulder.

**NUMERICAL STUDY OF A MULTIPURPOSE TRANSONIC WIND TUNNEL WITH AN ADAPTABLE INJECTION-SUCTION SYSTEM Ph.D. Thesis**

SHING-CHUNG ONN 1988 117 p

Avail: Univ. Microfilms Order No. DA8902928

For the simplicity in installation and operation, an adaptable injection-suction (AIS) system was implemented to see if it can be used to replace the conventional convergent-divergent nozzle in a multipurpose transonic wind tunnel. Results for three different AIS systems indicate that such an idea is feasible. Without viscous effects, an isentropic small-disturbance velocity potential formulation is used to solve this transonic flow problem. Based on the examined cases, it can be found that: (1) before choking, with increasing  $M_{sub}$  infinity, the normal shock can be gradually moved down the channel and the supersonic bubble grows like the flow in a conventional convergent-divergent nozzle, (2) after choking, both the location and shape of the sonic line are invariant with respect to decreased exit pressure, (3) in a subcritical flow, the pressure distribution at the AIS system is approximately symmetric with respect to the center of the AIS system, and the pressure distribution is no longer symmetric in a supercritical flow, (4) the supersonic bubble in a supercritical flow may disappear by reducing the strength of the AIS system, (5) after choking, by lowering the choked exit pressure, the shock can be moved further downstream to become a lambda shock near the exit of the channel, (6) for the case by using an AIS system with injection

only, a sonic flow at the exit section can be obtained by locating the trailing edge of this injection system at the wall exit and specifying the exit Mach number to be unity, and (7) an originally choked flow may not be choked if the AIS system is shifted to a different location. From the first three findings, it can be concluded that the present numerical calculations of this transonic flow problem are fairly reliable. Dissert. Abstr.

## 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.

**A89-36543\*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**IMPACT CRATERING IN LOW-GRAVITY ENVIRONMENTS - RESULTS OF RECONNAISSANCE EXPERIMENTATION ON THE NASA KC-135A REDUCED-GRAVITY AIRCRAFT**

M. J. CINTALA, F. HORZ (NASA, Johnson Space Center, Houston, TX), and T. H. SEE (Lockheed Engineering and Sciences Co., Houston, TX) IN: Lunar and Planetary Science Conference, 19th, Houston, TX, Mar. 14-18, 1988, Proceedings. Cambridge/Houston, TX, Cambridge University Press/Lunar and Planetary Institute, 1989, p. 627-639. refs

A program of flight experimentation was performed on the NASA KC-135A reduced-gravity aircraft to evaluate the potential for conducting impact experiments in reduced-gravity environments and to collect impact-cratering data at gravity levels below 1 g. Lead pellets were launched into coarse-grained sand at velocities of about 65-130 m/sec while the gravitational acceleration was maintained at 0.59-0.05 g. A total of 64 craters were studied and, after allowance is made for the atmospheric pressure over the target (0.83 atm), their diameters are found to have been consistent with scaling predictions made on the basis of ground-based experimentation. Formation times were also obtained for 33 of these craters and constitute a distribution that is somewhat different from that described by the ground-based data. Nevertheless, the KC-135 data set as a whole falls on the trend formed by the ground-based results. The overall agreement between the two data sets attests to the stability of the aircraft as a platform for impact experimentation. Author

**A89-36611**

**COMBINING THE USE OF GEOSTATIONARY AND INCLINED ORBIT SATELLITES FOR INTEGRATED COMMUNICATIONS AND NAVIGATION APPLICATIONS**

G. KINAL and K. HUNGERFORD (International Maritime Satellite Organization, London, England) IN: International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings. London, Institution of Electrical Engineers, 1988, p. 186-189.

The diversity of requirements for mobile communications and position determination suggests a liberal interpretation of 'integration' of communications and navigation. A combination of Inmarsat geostationary and GPS inclined-orbit satellites could be employed in a hybrid mode so as to obtain most of the advantages of both passive navigation and active radiolocation (surveillance). The application of this concept to oceanic air traffic control is used to illustrate how such integration enhances both the communications and navigation functions. Author

**A89-37004#**

**COUPLING FACTOR METHOD FOR STUDYING ELASTIC MOTION OF FLIGHT VEHICLES**

JIANPING YUAN and SHILU CHEN (Northwestern Polytechnical

University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 9, Dec. 1988, p. B555-B560. In Chinese, with abstract in English.

By coupling of elastic motion is meant a process in which the forces resulting from elastic vibration act on the same vehicle, and lead to new elastic motions. It is the coupling that maintains vibration. When the equations of motion are rewritten in matrix, the coupling factor is a bilinear form in modal functions or their derivatives determined at the impelling point and impelled point, respectively, with T-1 M as the coefficient of the form. Aerodynamic force is the most essential and it may give rise to coupling between the distinct vibrations. When the engine is installed on a flexible body, the propulsive force also results in vibration. In the feedback control system, control force will produce vibration that is related to the points of measurement and control. But if an open loop control is used, no coupling exists. At the end, coupling factors are applied to optimizing the positions of engine sensor and actuator. Practical examples are given. Author

**A89-37646**

**VOICE OF AUTHORITY**

PETER DONALDSON Space (ISSN 0267-954X), vol. 5, Mar.-Apr. 1989, p. 13, 14.

The development of voice control systems for use on space vehicles is discussed. French testing of a voice control system on the Mirage III aircraft is examined. Possible applications of the system include the Hermes, EVA on the Space Shuttle, and construction and maintenance on the Space Station. The ways in which voice control technology may be used to reduce astronaut workload are summarized. Issues related to the development of voice control systems are considered, including voice dependency, changes in voice patterns, speed, accuracy, and verifying commands. R.B.

**A89-37659**

**GRAVITY REFUELING NOZZLES AND PORTS INTERFACE STANDARDS FOR CIVIL AIRCRAFT**

SAE Aerospace Standard, SAE AS 1852, Feb. 1988, 4 p. (SAE AS 1852)

The critical interface dimensions for airframe refueling ports and ground refueling nozzles pertinent to gravity fuel-feed civil aircraft servicing are presented. It is the intention of such standardized interface limits to prevent the misfueling of reciprocating-engine aircraft requiring aviation gasoline with turbine fuel. Both English and metric nozzle tip dimensions are given. O.C.

**A89-38234**

**FUNDAMENTAL ASPECTS OF AN AEROSPACEPLANE**

RYOJIRO AKIBA (Institute of Space and Astronautical Science, Sagami-hara, Japan) IN: International Symposium on Space Technology and Science, 16th, Sapporo, Japan, May 22-27, 1988, Proceedings. Volume 2. Tokyo, AGNE Publishing, Inc., 1988, p. 1521-1526.

The aerospaceplane defined in this paper is a single-stage vehicle reaching an orbital speed through an atmospheric flight. General characteristics are clarified for the air breathing engine operating in a wide range of flight velocity on the basis of one dimensional conservation laws. It is pointed out that utilization of the energy carried by the intake air is important as well as utilization of the oxygen. The trajectory analysis shows that the gravity loss is negligible along a constant heating rate trajectory in the range of Mach number from 5 to 25 in which SCRAM operates. Further simplified analyses reveal several features of propulsion utilizing the energy of heat produced by the aerodynamic drag. Author

**A89-39028#**

**INVESTIGATION OF A SMALL SOLID FUEL RAMJET COMBUSTOR**

YESHAYAHOU LEVY, ALON GANY (Technion - Israel Institute of Technology, Haifa), and RONI ZVULONI Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, May-June 1989, p. 269-275. refs

Experimental and analytical investigations of a small solid-fuel ramjet (SFRJ) combustor were conducted. A static test system with a 25-kW electrical air heater simulated the air temperature and pressure encountered in flight at a Mach number of 3 at sea level. The transparent polymethylmethacrylate fuel used in the tests permitted continuous video photography, revealing the local fuel-regression-rate behavior and the instantaneous ignition and combustion phenomena. The results demonstrated high combustion efficiency and indicated peculiar local and average fuel-regression-rate correlations. The analysis indicated that the specific conditions resulting from the low Reynolds number range in small SFRJ motors, in contrast to large combustors, enhance the effect of the sudden-expansion heat-transfer regime relative to the boundary-layer regime. Author

## 11

## CHEMISTRY AND MATERIALS

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

## A89-36335

## POLYMERS FOR ADVANCED STRUCTURES - AN OVERVIEW

DAVID TANNER, JOHN R. SCHAEFGEN (Du Pont de Nemours and Co., Wilmington, DE), and VLODEK GABARA (Du Pont de Nemours and Co., Richmond, VA) IN: IUPAC International Symposium on Polymers for Advanced Technologies, Jerusalem, Israel, Aug. 16-21, 1987, Proceedings. New York, VCH Publishers, Inc., 1988, p. 384-418. refs

This paper reviews advances in polymer science that have enabled development of high-performance materials, describes the systems approach to applications, and previews future trends. The emphasis is on important applications; e.g., in aircraft, aerospace, marine, automobiles, and ballistics where lightweight, energy-efficient structures provide the impetus for radically new designs and performance. Author

## A89-36405

## METALLURGICAL STABILITY OF INCONEL ALLOY 718

J. W. BROOKS and P. J. BRIDGES (Inco Engineered Products, Ltd., Birmingham, England) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 33-42. refs

Extensive heat treatment and forging trials have been carried out on Inconel alloy 718 produced by vacuum melting in order to clarify the time-temperature transformation characteristics of the material. The effect of forging practice on microstructure and mechanical properties has also been determined, together with the long term stability of the alloy. The gamma-star precipitation behavior has been defined for annealing times up to 10,000 hours, and the transformation kinetics have been compared and contrasted with those of conventional gamma-prime-strengthened superalloys. An explanation for the relationship between grain-boundary delta precipitation and creep ductility is presented. Author

## A89-36406

## ON DEVELOPING A MICROSTRUCTURALLY AND THERMALLY STABLE IRON-NICKEL BASE SUPERALLOY

J. P. COLLIER, A. O. SELIUS, and J. K. TIEN (Columbia University, New York) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 43-52. refs

In order to obtain a turbine engine hot-section alloy possessing the excellent fabricability and heat resistance of IN718, but with a temperature ceiling higher than that imposed in that alloy by microstructural instabilities occurring at elevated temperatures,

seven novel Fe-Ni-base superalloy compositions have been formulated. Tests have been conducted to ascertain the effect of systematically changing the Al, Ti, and Nb contents on the microstructural stability and long-term elevated temperature mechanical properties. Increasing the Al+Nb content and the Al/Ti ratio in the alloy was found to yield more of the stable gamma-prime phase and less of the brittle delta phase, while enhancing the mechanical properties of the alloy. O.C.

## A89-36410

## CAUSES AND EFFECTS OF CENTER SEGREGATION IN ELECTRO-SLAG REMELTED ALLOY 718 FOR CRITICAL ROTATING PART APPLICATIONS

M. D. EVANS and G. E. KRUYNSKI (Cytemp, Specialty Steel Div., Titusville, PA) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 91-100. refs

The causes of center segregation in electroslog remelted (ESR) 718 superalloy are investigated in the interest of defining processing parameters yielding consistently segregation-free ESR 718 ingots suitable for gas turbine turbomechanical element applications. Remelt tests gave attention to the effects of melt rate, slag chemistry and volume, and electrode immersion depth; billet-conversion practices were investigated, and macrostructural, microstructural, and associated mechanical properties were characterized. While the greater susceptibility to macrosegregation in ESR than in vacuum-arc remelted material of this composition is confirmed, positive effects on center segregation are indicated. O.C.

## A89-36411

## DEVELOPMENT OF GATORIZED MERL 76 FOR GAS TURBINE DISK APPLICATIONS

R. H. CALESS and D. F. PAULONIS (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 101-110.

The MERL 76 alloy was developed to produce components by hot isostatic pressing (HIP). To provide for enhanced shaping capability, improved material utilization, and to explore potential property benefits, a development program was undertaken to qualify Gatorized MERL 76. The MERL 76 composition was fixed, and billets were consolidated by HIP, followed by Gatorizing into the required component shape. Detailed studies were conducted to define both metal processing (e.g., HIP and forging) and heat treatment parameters. Comprehensive monotonic and fatigue testing of full-size components has demonstrated that Gatorized MERL 76 met all program goals. This material has been used in commercial service since 1983, with excellent experience. Author

## A89-36414

## DEVELOPMENT OF INCONEL ALLOY MA 6000 TURBINE BLADES FOR ADVANCED GAS TURBINE ENGINE DESIGNS

B. A. EWING and S. K. JAIN (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 131-140.

An account is given of development efforts involving the MA 6000 superalloy's near-net-shape forging and thermal protection coating techniques for uncooled turbine blade applications. Attention is given to turbine blade forging accomplishments to date with an oxide dispersion-strengthened MA 6000 alloy version. The stress rupture results obtained are noted to be competitive with single crystal superalloy blades in the high temperature/low stress regime. Oxidation tests have indicated that the new, duplex coating system used is superior to commercially available types. O.C.

## 11 CHEMISTRY AND MATERIALS

**A89-36418**

### **BEYOND SUPERALLOYS - THE GOALS, THE MATERIALS AND SOME REALITY**

CHESTER T. SIMS (Rensselaer Polytechnic Institute, Troy, NY) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 173-182.

Next-generation gas turbine-related applications for superalloys have been envisioned which require a doubling of operating temperature and a reduction of strength/weight to about 5 g/cu cm for highly refractory superalloys in the near future; these requirements are to be satisfied irrespective of turbine blade, vane, and disk operation in atmospheres that may be oxidizing, neutral, or reducing. Turbine-inlet temperatures of the order of 2200 C may thereby be reached, using comparatively little active cooling. 'Oxide/oxide' ceramic fiber-reinforced ceramic matrix composites are recommended as the best development goal in the longer term. O.C.

**A89-36424**

### **SECOND-GENERATION NICKEL-BASE SINGLE CRYSTAL SUPERALLOY**

A. D. CETEL and D. N. DUHL (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 235-244. refs

Significant increases in high temperature strength capability have been achieved in a second-generation nickel-base single crystal alloy designed for advanced military and commercial turbine airfoil applications. This new alloy, designated PWA 1484, offers a 50 F improvement in metal temperature capability (creep-rupture strength, thermal fatigue resistance, and oxidation resistance) over PWA 1480, the first nickel-base single crystal turbine alloy to enter production. PWA 1484 represents the first use of rhenium in a production single crystal superalloy. The alloy properties have been fully characterized and demonstrate an outstanding combination of high-temperature creep and fatigue strength as well as excellent oxidation resistance. Production processing of single crystal PWA 1484 castings has shown that the alloy has good castability and a wide solution heat treatment range. The superior properties of PWA 1484 have been confirmed through extensive engine testing. Author

**A89-36425**

### **ENHANCED RUPTURE PROPERTIES IN ADVANCED SINGLE CRYSTAL ALLOYS**

S. M. FOSTER, T. A. NIELSEN, and P. NAGY (Williams International, Walled Lake, MI) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 245-254. refs

Extended thermal processing has been employed to improve the rupture lives of the single-crystal superalloys CMSX-2 and -4G, whose compositions are similar except for the addition of Re in the latter in the interest of high-temperature stability. The high-temperature aging cycles yielded gamma-prime platelet formation as well as varying degrees of gamma-prime coarsening, whose effect on rupture and tensile properties was then studied. It is found that overaging the gamma-prime in CMSX-2 occurs more easily than in CMSX-4G; mechanical property tests have also demonstrated that extended thermal cycles yield increased rupture lives due to gamma-prime platelet formation and coarsening, with only minor decrease in tensile strength. O.C.

**A89-36435**

### **A HAFNIUM-FREE DIRECTIONALLY SOLIDIFIED NICKEL-BASE SUPERALLOY**

DONGLIANG LIN, SONGHUI HUANG (Jiaotong University, People's Republic of China), and CHUANQI SUN (Institute of Aeronautic Materials, Beijing, People's Republic of China) IN: Superalloys 1988; Proceedings of the Sixth International

Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 345-354. refs

This paper provides a review of current efforts on design of a hafnium-free directionally solidified nickel-base superalloy with good castability, post-casting transverse ductility and improved creep strength. Emphasis is being placed on the effect of alloy modifications on castability and the improvement of creep strength by increasing solid solution temperature. Author

**A89-36440**

### **ELECTRON BEAM COLD HEARTH REFINEMENT PROCESSING OF INCONEL ALLOY 718 AND NIMONIC ALLOY PK50**

S. PATEL, I. C. ELLIOTT (Inco Alloys International, Ltd., Hereford, England), H. RANKE, and H. STUMPP (Leybold AG, Hanau, Federal Republic of Germany) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 397-406.

This paper describes the electron beam (EB) refining of Inconel alloy 718 and Nimonic alloy PK50 in a 250 kW furnace. The EB furnace design is shown and described. The EB melting process performance and the resulting metallurgical structures, chemistry, forgeability, cleanliness levels, and mechanical behavior are reported and discussed. C.D.

**A89-36452**

### **PROPERTY OPTIMIZATION IN SUPERALLOYS THROUGH THE USE OF HEAT TREAT PROCESS MODELLING**

R. A. WALLIS and P. R. BHOWAL (Cameron Forge Co., Houston, TX) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 525-534.

One important variable in maximizing tensile, creep, stress rupture and toughness properties in superalloys is the cooling rate from the alloy solutioning temperature. Correlations between properties and cooling rates may be conveniently developed using small blanks of material. Implementation of the data in complex geometries such as aircraft engine disks, however, is most effectively done through finite element modelling of the heat treatment process. The application of heat treat process modelling to predict the property levels at various locations in parts having relatively complex shapes are discussed. An example of the use of models to obtain the required properties while reducing residual stress levels in the part is given together with an example where the properties are maximized against the tendency of the part to crack during quenching. Author

**A89-36480**

### **DEGRADATION OF ALUMINIDE COATED DIRECTIONALLY SOLIDIFIED SUPERALLOY TURBINE BLADES IN AN AERO GAS TURBINE ENGINE**

P. C. PATNAIK, J. E. ELDER, and R. THAMBURAJ (Hawker Siddeley Canada, Inc., Toronto) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 815-824. Research supported by the National Aeronautical Establishment Ottawa and DND. refs

An experimental study is made of service induced degradation, such as oxidation, thermal fatigue, and interdiffusion, in a directionally solidified Ni-based superalloy, Rene 80H, with a diffusion aluminide coating that is currently used in the high-pressure turbine of an advanced aircraft engine. It is found that the aluminide coating behaves poorly under thermal fatigue. Thermal fatigue cracks initiate in the coating and propagate into the substrate, leading to a catastrophic oxidation of the substrate alloy. The cracks often turn from the radial to the axial direction, which can cause the failure of the entire blade. Interdiffusion of alloying elements between the coating and the substrate leads to the formation of a deleterious sigma phase at the interface, which can cause embrittlement, particularly in thin sections of the blade. V.L.

A89-36484

**INFLUENCE OF THERMAL FATIGUE ON HOT CORROSION OF AN INTERMETALLIC NI-ALUMINIDE COATING**

JOHN W. HOLMES and FRANK A. MCCLINTOCK (MIT, Cambridge, MA) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 855-864. refs (Contract NSF DMR-84-18718)

The hot corrosion of Ni-aluminide coatings, applied by pack aluminization to stepped-disk fatigue specimens machined from a monocrystalline Ni-base alloy (Rene 14), was investigated experimentally in relation to the fatigue strain history of the specimens. After 6000 cycles between peak strains of -0.26 percent at 925 C and 0.03 percent at 650 C, extensive hot corrosion attack occurred, whereas only minor oxidation of the coating was observed after 6000 cycles between lower peak strains of -0.16 percent at 925 C and 0.01 percent at 650 C. The strain history dependence of hot corrosion is attributed to the cracking of the protective surface oxide, resulting in direct interaction between the coating and molten Na<sub>2</sub>SO<sub>4</sub>, which was applied to the specimens during the tests. V.L.

A89-36721#

**TAMING CERAMIC FIBER**

ALAN S. BROWN Aerospace America (ISSN 0740-722X), vol. 27, May 1989, p. 14-17, 20-22.

An evaluation is made of the development status and comparative performance of ceramic fibers applicable to metal-matrix and ceramic-matrix components for gas turbine engine and hypersonic airframe primary structures. Difficulties in fiber producibility, which increase price/lb, and strength-degrading reactions that can occur at fiber/matrix interfaces at the high temperatures encountered during both fiber/matrix consolidation and high-temperature service, remain major obstacles to further implementation. Much research has concentrated on intermetallic Ti and Al matrices, in order to reduce their brittleness. O.C.

A89-36722#

**MATERIALS FOR THE NASP**

NED D. NEWMAN and RICHARD E. PINCKERT (McDonnell Douglas Corp., Saint Louis, MO) Aerospace America (ISSN 0740-722X), vol. 27, May 1989, p. 24-26, 31.

An evaluation is made of experimental results obtained to date concerning the identification of high structural performance/high service temperature/low density materials for use by the National Aerospace Plane's X-30 technology-demonstrator airframe. Refractory composite development encompasses carbon/carbon and ceramic-matrix composites. Metal-matrix composites under intensive study are exemplified by SiC fiber-reinforced Ti alloy matrices; these materials retain high strength to 1800 F; attention has been given to fiber/matrix reaction zone behavior during simulated hypersonic flight conditions. The X-30 will incorporate active cooling of leading edges combustion chamber walls, etc. O.C.

A89-37658

**AIRCRAFT TURBINE FUEL CONTAMINATION HISTORY AND ENDURANCE TEST REQUIREMENTS**

SAE Aerospace Information Report, SAE AIR 4023, March 1, 1988, 26 p. (SAE AIR 4023)

Standard tests have evolved which subject fuel system components to a controlled, severe, contaminated-fuel environment, in order to ascertain a given fuel system design's filtration and contamination-resistant component features. It has been suggested that a slug-type contamination test be used in order to expose fuel-system components to typical fuel tank debris; contaminants such as sealant globs, lockwire, aluminum chips, o-ring slices, reticulated foam, and cotton lintars should be used. The more intensive use of composite materials in airframes could result in novel kinds of contaminants. O.C.

A89-37756#

**A STUDY ON GH169 CRACK PROPAGATION UNDER CREEP-FATIGUE INTERACTION**

YAN LI, WENGLONG JIANG, and HONGFAN ZHOU (Beijing Institute of Aeronautical Materials, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 25-29, 89. In Chinese, with abstract in English.

As a new technique of crack detection at high temperatures, the reversing dc electric potential method is used to study the crack propagation behaviors of an aero-engine turbine disk material, GH169, under creep-fatigue interaction at 650 C and at different hold times. The experimental results indicate that the life prediction model based on the hyperbolic sine function is superior to the life prediction model based on the Paris formulation. Moreover, the former model is more convenient in application. Author

A89-38021

**EFFECT OF CRACK SIZE ON THE TENSILE STRENGTH OF CERAMICS IN A HIGH-TEMPERATURE CORROSIVE ENVIRONMENT**

YOSHIYUKI MUNAKATA and TETSUYA SENDA (Ministry of Transport, Ship Research Institute, Mitaka, Japan) JSME International Journal, Series I (ISSN 0914-8809), vol. 32, April 1989, p. 287-291.

Ceramics with considerable defects in corrosive ash were tested at temperatures of 650 C for PSZ and 900 C for SiC. Corrosive ash containing vanadium pentoxide and sodium sulphate was applied to an artificial flaw produced by a Vickers indentation on the specimen. The surface damage of PSZ in a high-temperature corrosive environment does not significantly influence the tensile strength. The corrosive ash on SiC ceramics with surface flaws contributes little to the strength as compared to that on PSZ ceramics. K.K.

A89-38153

**ANODIZED ALUMINUM AND ALUMINUM ALLOY COATINGS FOR THERMAL CONTROL**

SONG LIN CONG (Chinese Academy of Sciences, Shanghai Institute of Ceramics, People's Republic of China) IN: International Symposium on Space Technology and Science, 16th, Sapporo, Japan, May 22-27, 1988, Proceedings. Volume 1. Tokyo, AGNE Publishing, Inc., 1988, p. 951-955. refs

The characteristics of four types of anodized aluminum and aluminum alloy coatings for thermal control on spacecraft are described. The coatings include the bright anodized aluminum coating, the bright anodized aluminum foil, the anodized aluminum alloy coating, and the black anodized aluminum and aluminum alloy coating. Both of the bright coatings are characterized by low solar absorptance and a wide range of the solar absorptance to emittance ratio. The bright anodized aluminum foil may be adhered to nonaluminum materials. The black coating has high solar absorptance and emittance and is stable to UV-vacuum irradiation. R.B.

A89-38387

**SCRAMJET COMBUSTION WITH AN AID OF SILANE**

KENJI SUGIMOTO IN: International Symposium on Space Technology and Science, 16th, Sapporo, Japan, May 22-27, 1988, Proceedings. Volume 2. Tokyo, AGNE Publishing, Inc., 1988, p. 2595-2600. refs

The effect of substituting 25-percent silane for hydrogen on the combustion of a stoichiometric H<sub>2</sub>-O<sub>2</sub> mixture at 823-1617 K is investigated in shock-tube experiments simulating conditions in a scramjet engine. The ignition delay time is determined on the basis of monochromator/PMT detection of OH emission, and the results are presented in extensive graphs. Silane is found to improve the H<sub>2</sub> combustion, significantly at temperatures up to about 1200 K but only slightly at higher temperatures. The accuracy of theoretical combustion models is shown to be good at low temperatures but only fair at high temperatures. T.K.

## 11 CHEMISTRY AND MATERIALS

**N89-21851#** Naval Postgraduate School, Monterey, CA.  
**COMPOSITE FAILURE CRITERION: PROBABILISTIC FORMULATION AND GEOMETRIC INTERPRETATION M.S. Thesis**

JONG C. LIM Dec. 1988 96 p  
(AD-A205275) Avail: NTIS HC A05/MF A01 CSCL 12/3

The objective of this thesis is to derive the reliability and the associated probabilistic failure criterion for composite materials under combined stress. In the analytical deviation, the concept of joint probability was used and applied to the Weibull distribution function. In applications, given the experimental measurements of the necessary statistical parameters for the specific composite, the probabilistic criterion of the composite failure and the reliability of the specific structure can be predicted. Graphical representations for the joint reliability and joint failure contours were made in two and three dimensional space for the several different sets of statistical strength parameters to illustrate the effect of parameters on reliability. Such understanding will enhance selection of fiber and matrix (which have their own statistical strength parameters) and can lead to improvement in reliability of some composite components in an aircraft structure. These reliability and failure concepts can also be used in repair problems by selecting the proper composite material with the appropriate statistical parameters. GEA

**N89-21873#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.

**THE FATIGUE IN AIRCRAFT CORROSION TESTING (FACT) PROGRAMME**

R. J. H. WANHILL, J. J. DELUCCIA, and M. T. RUSSO (Naval Air Development Center, Warminster, PA.) Feb. 1989 214 p  
(AGARD-R-713; ISBN-92-835-0495-X) Avail: NTIS HC A10/MF A01

In the 1970s the Structures and Materials Panel decided to embark on collaborative research activities in the area of fatigue. One of the first activities was the Corrosion Fatigue Cooperative Testing Programme (CFCTP), the precursor to the Fatigue in Aircraft Corrosion Testing (FACT) program. Both programs are described. Failure by fatigue and degradation by corrosion continue to be major considerations in aircraft design. Environmental effects influence both initiation and propagation of fatigue cracks, and dynamic loading may cause more rapid deterioration of corrosion protection systems. Therefore the conjoint action of dynamic loading and environmental attack, i.e., corrosion fatigue, requires special attention. Many corrosion fatigue tests were done on aluminum alloys. However, few included critical structural details like joints, under realistic cyclic load histories and in service-like environments. Ever fewer used practical corrosion protection systems. These aspects are specifically addressed by the CFCTP and FACT programs. The results provide a significant contribution to the understanding of aircraft corrosion fatigue and should encourage further investigation. Author

**N89-21926#** Central Research Inst. of Electric Power Industry, Tokyo (Japan).

**SIMULATION ANALYSIS ON CERAMIC GAS TURBINE**

TOSHIO MIMAKI, TOSHIO ABE, TORU HISAMATSU, TERUHIRO HAMAMATSU, HIROSHI ISHIKAWA, and KATSUO WADA Aug. 1987 67 p In JAPANESE; ENGLISH summary  
(DE88-756469; CRIE-W-87002) Avail: NTIS (US Sales Only) HC A04/MF A01

In the application of ceramics to gas turbine materials, the analysis and estimation of thermal stress and careful strength verification were required at the trip on a gas turbine subjected to sudden thermal shock, therefore by the simulation on 20 MW class gas turbine for coal gasification, the quantity change of state of gas in a gas turbine inlet at the trip was studied, and an effective operation method to reduce the thermal shock was investigated. Since the smoothing of temperature gradient and the sudden reduction of high temperature gas flow were considered to be most effective for the thermal stress reduction of ceramic materials, the operation methods of a fuel stop valve, blow-off

valve at a compressor outlet and compressor inlet guide vane were investigated. As a result of the simulation, the method to rapidly reduce working gas flow by simultaneous control of the compressor inlet guide vane and blow-off valve was recommended as the most suitable method at present. DOE

**N89-21943#** Geo-Centers, Inc., Newton, MA.

**JET FUEL DEOXYGENATION Interim Report, Mar. 1987 - Jul. 1988**

SHIRLEY DARRAH Oct. 1988 29 p  
(Contract F33615-84-C-2412)

(AD-A205006; GC-TR-88-1416-013; AFWAL-TR-88-2081) Avail: NTIS HC A03/MF A01 CSCL 07/3

This program was initiated to identify and characterize methods of deoxygenating quantities of jet fuel to improve fuel thermal stability. Three methods, chemical getters, molecular sieves and nitrogen sparging, were evaluated in our laboratory. In the case of nitrogen sparging, additional results were obtained by comparing laboratory experimental results with the output from ULLAGE, a computer based mathematical model. Each method was shown to reduce the oxygen content of jet fuel. Economic and system considerations favor nitrogen sparging for large quantities of fuel. GRA

**N89-21983** Centre d'Essais Aeronautique Toulouse (France).

**MATERIALS TESTS: MEANS AND TECHNIQUES [EXPERTISE MATERIAUX - MOYENS ET TECHNIQUES]**

I.-A. PATRICK ARMANDO In CNES, Quality, Components and Technological Analysis p 1159-1225 Aug. 1988 In FRENCH  
Avail: CEPADUES-Editions, 111 Rue Nicolas-Vauquelin, 31100 Toulouse, France

The techniques used to characterize the materials employed in aeronautical construction are reviewed, as well as the desirable properties and specification procedures. Materials discussed include metals, composites, ceramics, sintered powders, refractory materials, and metallic matrix composites. ESA

**N89-22654#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.

**APPLICATION OF ADVANCED MATERIAL FOR TURBOMACHINERY AND ROCKET PROPULSION**

Mar. 1989 282 p In ENGLISH and FRENCH Meeting held in Bath, England, 3-5 Oct. 1988  
(AGARD-CP-449; ISBN-92-835-0498-4) Avail: NTIS HC A13/MF A01

The proceedings of the conference are presented. The specialists' meetings were arranged in the following sessions: Overview and Combined Applications; Gas Turbine Applications; Rocket Applications; and Special Applications. A Technical Evaluation report is included at the beginning of the proceedings. The aim of the specialists' meetings was to review the advances made in the field of materials applicable in the hot parts of aerospace propulsion system during the last few years. The meetings offered a forum for the users of new materials in the fields of turbomachines and rockets to report on recent achievements and to discuss the various applications.

**N89-22655#** Air Force Materials Lab., Wright-Patterson AFB, OH. Metals and Ceramics Div.

**TECHNICAL EVALUATION REPORT**

NORMAN M. TALLAN In AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 11 p Mar. 1989

Avail: NTIS HC A13/MF A01

A technical evaluation is presented of the materials presented at the 72nd Propulsion and Energetics Panel Specialists' Meeting. The objective of the meeting was to bring together the designers, developers and users of aerospace propulsion systems and the developers and producers of aerospace materials to provide a forum in which the material requirements of both current and future propulsion systems and the ability of emerging new materials to meet those requirements could be reviewed. The scope included



the properties and potential applications of superalloys, refractory metals, advanced intermetallic alloys, and metal matrix composites based on them; carbon-carbon and ceramic matrix composites; coatings and the processes used to prepare them; bearing and insulation materials; braze and weld repair methods; innovative design approaches to the use of these new materials; and the damage tolerance and life prediction of these materials and their implications with regard to damage tolerant design and applications to real propulsion systems. E.R.

**N89-22656#** Pratt and Whitney Aircraft, West Palm Beach, FL. Materials Engineering.

**APPLICATION OF ADVANCED MATERIALS FOR TURBOMACHINERY AND ROCKET PROPULSION**

JOSEPH B. MOORE /In AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 5 p Mar. 1989  
 Avail: NTIS HC A13/MF A01

Gas turbine engines of the 1980's and 1990's will require improved nickel and titanium alloys as well as certain intermetallic compounds and low temperature composites. Engines of the 2000's with significantly higher thrust to weight ratios will require lighter weight, higher temperature non-conventional materials including aluminum alloys, titanium metal matrix composites, intermetallic compounds, and ceramic matrix composites. Major concerns once these materials are developed will be the design, manufacture, inspection, and repair of required components at affordable cost. Current or near-term liquid rocket engines having technology levels equivalent to those being studied for the space transportation and advanced launch systems can benefit from improved materials for turbomachinery, high heat flux throat regions of the thrust chamber, high strength, hydrogen resistant materials for cases and ducts, and refractory materials for uncooled or partially cooled nozzle extensions. To meet the far term goals for advanced rocket engines required for single-stage-to-orbit (SSTO) vehicles materials requirements are not unlike those described above for 21st century gas turbine engines. Author

**N89-22657#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (Germany, F.R.). Inst. for Structures and Design.

**MONOLITHIC AND FIBER CERAMIC COMPONENTS FOR TURBOENGINES AND ROCKETS**

R. KOCHENDOERFER /In AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 10 p Mar. 1989

Avail: NTIS HC A13/MF A01

From the design point of view, whether or not the existing experience gained during the automotive ceramic turbine development can be transferred to aero jet engines is reviewed. It is well known that design considerations strongly influence the failure tolerance of ceramic structures. Following material adequate design concepts will increase component reliability. Focussing these topics, the future application of ceramics for thermally and/or mechanically high-loaded structures within the propulsion system are discussed. Actual available data of emerging materials as C/C, C/SiC, SiC/SiC are presented. The material's behavior, their potential for structural applications as well as design consequences are evaluated. Author

**N89-22658#** Royal Aircraft Establishment, Farnborough (England). Space Dept.

**CVD AND DIFFUSION COATINGS FOR HIGH TEMPERATURE APPLICATIONS IN TURBOMACHINERY AND ROCKET MOTORS**

S. P. FIELD, J. E. RESTALL, C. D. CHALK, and C. HAYMAN (Fulmer Research Inst. Ltd., Stoke Poges, England) /In AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 12 p Mar. 1989

Avail: NTIS HC A13/MF A01

A brief but critical review is presented of recent developments in Chemical Vapor Deposition (CVD) metal and ceramic coatings for aerospace applications, covering in addition to standard CVD, activated CVD, diffusion CVD, pressure pulsed CVD and the more

recently explored chemical vapor infiltration (CVI) processing. Fused slurry diffusion coatings are also covered. Important applications of such coatings and free-standing shapes are outlined and illustrated, particularly CVD diffusion aluminizing, chromizing and siliconizing of turbine blades, refractory metal coatings and free-standing components of rocket motors. Future trends in materials technology are also discussed with particular reference to the CVD coating of fibers, including modified carbon-carbon and other ceramic composites for high temperature operation in oxidizing environments. Author

**N89-22660#** Rolls-Royce Ltd., Derby (England). Materials Research.

**NEW METALLIC MATERIALS FOR GAS TURBINES**

M. A. HICKS /In AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 13 p Mar. 1989  
 Avail: NTIS HC A13/MF A01

The mix of properties required for high performance components in the gas turbine will continue to necessitate the use of metallic materials for the foreseeable future. Examples are shown which indicate how a detailed understanding of material/component behavior and a better understanding and control of the manufacturing process are becoming increasingly important in meeting the anticipated design targets. Author

**N89-22661#** Pratt and Whitney Aircraft, West Palm Beach, FL. **DAMAGE TOLERANCE CONCEPTS FOR ADVANCED MATERIALS AND ENGINES**

T. E. FARMER and M. C. VANWANDERHAM /In AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 7 p Mar. 1989  
 Avail: NTIS HC A13/MF A01

Planned increases in thrust to weight for future gas turbine engines require dramatically higher operating temperatures and rotor speeds. This necessitates simpler design, improved materials and sophisticated fabrication techniques. Damage Tolerance Design (DTD) has been established as the basis for gas turbine engine design and maintenance in the U.S. Consideration of damage tolerance has significant influence on configurations and materials. The advanced configurations, bonded structures, composites, anisotropic alloys and less ductile materials required to meet the advanced engine goals challenge the current DTD philosophy. Fortunately, interim plans for incremental increases in performance and engine configuration to meet long-term goals afford the opportunities for developing transition technologies to meet these objectives. Author

**N89-22662#** Rolls-Royce Ltd., Derby (England).

**MATERIAL/MANUFACTURING PROCESS INTERACTION IN ADVANCED MATERIAL TECHNOLOGIES**

G. W. MEETHAM /In AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 7 p Mar. 1989  
 Avail: NTIS HC A13/MF A01

Since the first flight of a gas turbine powered aircraft some forty years ago, tremendous advances in engine performance have been made in terms of thrust, thrust-weight ratio and specific fuel consumption. The performance and efficiency of gas turbine engines is a direct function of the maximum cycle temperature and, throughout the forty years in which the aero gas turbine has existed, this has provided the motivation for the continuous development of materials which are capable of operating at higher temperatures in the turbine section of the engine. Turbine entry temperatures have risen from around 700 C in the Whittle W1 engine in 1941 to around 1350 C in current advanced engines. Author

**N89-22663#** Fiat Aviazione S.p.A., Turin (Italy). Stress Dept. **DEVELOPMENT OF STRESS AND LIFING CRITERIA FOR SINGLE CRYSTAL TURBINE BLADES**

S. SALVANO, M. STANISCI, and E. CAMPO /In AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 9 p Mar. 1989  
 Avail: NTIS HC A13/MF A01



## 11 CHEMISTRY AND MATERIALS

The stress and lifing criteria applied to turbine blades are discussed, by focusing the relevant features which make single crystal materials different from conventional alloys. The discussion basis is provided by the material data and blade finite element analyses, collected for the application of single crystal alloys to advanced aircraft engines. Author

**N89-22665#** Garrett Turbine Engine Co., Phoenix, AZ.

### **THE DEMONSTRATION OF MONOLITHIC AND COMPOSITE CERAMICS IN AIRCRAFT GAS TURBINE COMBUSTORS**

FRANK G. DAVIS and DALE A. HUDSON /in AGARD, Application of Advanced Material for Turbomachinery and Rocket Propulsion 10 p Mar. 1989

Avail: NTIS HC A13/MF A01

Since the mid seventies, the Air Force Wright Aeronautical Laboratories Aero Propulsion Laboratory has been on a course to evaluate and demonstrate the application of advanced non-metallic materials in experimental gas turbine engines. Potential increases of several hundred degrees or more in operating temperature represents a quantum leap in engine capability. Since the seventies, combustion rig tests have been successfully performed at near-stoichiometric conditions on two ceramic combustor configurations. These combustors were annular, through-flow designs similar to the metallic burners used in present-day military propulsion gas turbines. The first configuration used monolithic ceramic segments as a portion of the inner and outer combustor liners. The segments were supported by an external metal structure. These segments were fabricated from silicon carbide material. In the most recent program ceramic composite rings were used to form the inner and outer liners. The rings were composed of silicon carbide fibers and a silicon carbide matrix. The ceramic composite rings required no external support structure. Testing consisted of both steady-state and transient operations. During transient testing, the combustors were subjected to rapid thermal cycling. Testing of silicon carbide and silicon nitride ceramic materials has just begun. Author

**N89-22688#** Naval Air Development Center, Warminster, PA. Aircraft and Crew Systems Technology Directorate.

### **THE EFFECTS OF PLASTIC MEDIA BLASTING PAINT REMOVAL ON THE MICROSTRUCTURE OF GRAPHITE/EPOXY COMPOSITE MATERIALS Final Report, Oct. 1986 - Oct. 1987**

JOSEPH KOZOL, STEVEN THOMAN, and KENNETH CLARK 7 Oct. 1988 45 p (AD-A204801; NADC-88109-60) Avail: NTIS HC A03/MF A01 CSDL 11/4

Plastic media blasting (PMB) was assessed as a paint removal method for AS4/3501-6 and IM6/3501-6 graphite epoxy (Gr/Ep) composite materials. Microstructural effects on these composite materials were evaluated after repeated paint/blast cycles. Polyester (type 1) and urea formaldehyde (type 2) plastic media materials were used in a variety of blast conditions. Ultrasonic inspection, optical microscopy and scanning electron microscopy were used to assess the damage induced during paint removal. After one paint/blast cycle, most of the blast conditions caused little or no visual damage to the composite substrates. After four paint/blast cycles, several of the conditions caused minimal visual damage. Paint removal by sanding caused more visual damage after one paint removal cycle than any of the repeat blast conditions that were evaluated. GRA

**N89-22702#** Aerospatiale, Suresnes (France). Direction Centrale de la Qualite.

### **TESTS OF NEW MATERIALS WITH SECOND GENERATION CARBON FIBERS, TEST REPORT [ESSAIS CSPC 319-20 SONDAGE SUR NOUVEAUX MATERIAUX AVEC FIBRES DE CARBONE DE DEUXIEME GENERATION. PROCES-VERBAL 47-188F]**

J. ODORICO, G. PELLAN, and R. PERRIER 23 Jan. 1987 51 p In FRENCH (Contract STPA-83-96-003) (REPT-47-188/F; ETN-89-94355) Avail: NTIS HC A04/MF A01

Material to implement the mainframe structure of future aircraft were tested. The results presented refer to five carbon-epoxy systems. The tests include tensile tests, interlayer shearing, flexion on unidirectional specimens, tensile on crossed ply specimens, delamination sensitivity, and influence of holes on the mechanical behavior. Improvements of up to 50 pct of the mechanical characteristics are found. ESA

**N89-22703#** Aerospatiale, Suresnes (France). Direction Centrale de la Qualite.

### **CSPC TEST 319.30: STUDY ON IMPACT TOLERANCE OF PREIMPREGNATED CARBON-EPOXY SYSTEMS [ESSAI CSPC 319.30: ETUDE DE LA TOLERANCE AUX CHOCS DES PREIMPREGNES CARBONE-EPOXY. PROCES-VERBAL 47-323/F]**

B. SOULEZELLE and J. ODORICO 21 Dec. 1988 57 p In FRENCH

(REPT-47-323/F; ETN-89-94356) Avail: NTIS HC A04/MF A01

Standard tests aiming to evaluate the impact behavior of carbon epoxy structural aircraft components are described. After impact testing, the specimens are tested in compression or static traction. The method allows to determine the loss of mechanical characteristics due to impact. The designer must then use a maximum admissible stress corresponding to maximum invisible impact damage. ESA

**N89-22707#** Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.

### **A SURVEY OF POLY-ETHER-ETHER-KETONE AND ITS ADVANCED COMPOSITES**

SOREN NILSSON Dec. 1988 55 p (Contract FMV-FFL-82250-86-169-25-001) (FFA-TN-1988-37; ETN-89-94545) Avail: NTIS HC A04/MF A01

The suitability of PEEK for aircraft structures was reviewed. Its major advantages compared to present epoxy matrix systems are: increased toughness; better impact resistance; greater ease of repair; less hygroscopic; infinite shelf-life; some metal forming operations are transferable to thermoplastic forming; and quality of material may be better in terms of less batch-to-batch variation. However, in processing thermoplastics one can encounter; higher pressures and temperatures; and difficulties with fiber-wet-out at the higher molecular weights and consequently higher void contents. ESA

**N89-22718#** Universal Energy Systems, Inc., Dayton, OH. COMBUSTOR FLOW VISUALIZATION USING INNOVATIVE INFRARED THERMOGRAPHICS TECHNIQUES Final Report, 1 Jul. 1986 - 2 Jan. 1987

GARY D. STREBY Mar. 1989 227 p (Contract F33615-86-C-2670) (AD-A205905; WRDC-TR-89-2015) Avail: NTIS HC A11/MF A01 CSDL 21/2

Innovative computational analysis methods and image processing techniques were combined with a commercially available infrared (IR) thermal imaging video system to produce complete surface thermographic data of a ramjet combustor configuration. The components of the data analysis system, the data-reduction procedures, and typical test data are presented. Data precision and the limitations of the infrared system are discussed. Unique capabilities of the system included continuous infrared color or gray-scale video monitoring of a heated test article, full-frame video digitizing and image enhancement of infrared thermal images, and computer processing to produce complete surface 3-dimensional thermal topographic data plots of a heated combustor under actual operating conditions. GRA

**N89-22768#** Army Materials Technology Lab., Watertown, MA. Polymer Research Branch.

### **ENVIRONMENTALLY INDUCED DISCONTINUITIES IN TRANSPARENT POLYMERS Final Report**

JANICE J. VANSELOW, ALEX J. HSIEH, and JENNIE H. BROWN Feb. 1989 13 p Presented at the US Army CRDEC Conference,

Chemical Defense Research, Nov. 1988  
(AD-A205483; MTL-TR-89-11) Avail: NTIS HC A03/MF A01  
CSCS 07/6

Several grades of poly(methyl methacrylate) (PMMA) used in the aircraft industry have been selected for evaluation of their resistance to chemically-induced stress crazing and cracking. Solvents include simulants for CW agents, the decontaminant, DS2, and another surface active agent, o-xylene. Craze initiation due to solvents applied to the surface of these materials is determined, and the improved stress crazing resistance due to biaxial stretching of PMMA is demonstrated. Fracture toughness is determined for all formulations. Crack propagation is measured in the isotropic samples via a static dead-weight loading apparatus while the solvent, o-xylene, is applied. Results demonstrate varying comparative resistances based on the different test methods. GRA

## 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.

## A89-36304

### CONSIDERATION OF ENVIRONMENTAL CONDITIONS FOR THE FATIGUE EVALUATION OF COMPOSITE AIRFRAME STRUCTURE

MATTHIAS BERG, JOHANN J. GERHARZ (Fraunhofer-Institut fuer Betriebsfestigkeit, Darmstadt, Federal Republic of Germany), and OGUZ GOKGOL (Messerschmitt-Boelkow-Blohm GmbH, Hamburg, Federal Republic of Germany) IN: Composite materials: Fatigue and fracture; Proceedings of the Second Symposium, Cincinnati, OH, Apr. 27, 28, 1987. Volume 2. Philadelphia, PA, American Society for Testing and Materials, 1989, p. 29-44. refs

This paper demonstrates the 'compensation factor' approach in fatigue evaluation of large composite airframe structures, which uses the compensation factors to take into account the effects of environmental history (temperature and humidity) expected in service and missing during the testing of large structures. Compensation factors were experimentally derived, using small preconditioned coupon specimens made from carbon/epoxy prepregs; the specimens were subjected to accelerated quasi-realistic mechanical and environmental flight-by-flight loading. In parallel, other specimens were loaded exactly like the composite airframe structure (i.e., with less stimulated environment). It was found that, only at load levels higher than presently necessary for the applied carbon/epoxy systems, fatigue loading with simultaneous quasi-realistic environmental loading did reduce the life to fracture, as compared to samples without simulated environment. I.S.

## A89-36319

### FRACTURE OF PRESSURIZED COMPOSITE CYLINDERS WITH A HIGH STRAIN-TO-FAILURE MATRIX SYSTEM

KEVIN J. SAEGER and PAUL A. LAGACE (MIT, Cambridge, MA) IN: Composite materials: Fatigue and fracture; Proceedings of the Second Symposium, Cincinnati, OH, Apr. 27, 28, 1987. Volume 2. Philadelphia, PA, American Society for Testing and Materials, 1989, p. 326-337. refs

An experimental and analytical investigation was conducted to examine the fracture behavior of pressurized graphite/epoxy cylinders and coupons that utilize a high strain-to-failure matrix system. The material system is a five-harness satin-weave cloth made of AS4 fiber impregnated with Cycom 907 epoxy. Tests were performed on standard tensile coupons to determine the elastic constants of the material and the notched and unnotched

fracture characteristics of a quasi-isotropic (0, 45)s laminate of this material system. Two notch types, holes and slits, were examined, and existing failure criteria were explored as means to extrapolate these coupon data to the prediction of the failure of axially slit cylinders, which were also tested. The fracture characteristics of this composite system were compared to a baseline system with 3501-6 epoxy. In the laminates using the 'tough' matrix system, delamination was not a significant damage mode. Previous work had shown localized delamination in the 3501-6 laminates. However, both the coupon tests and the cylinder tests indicate that this high strain-to-failure matrix system is more notch-sensitive than the baseline epoxy system with the relatively brittle 3501-6 matrix. Author

## A89-36398

### THE TRANSMISSION DEVELOPMENT PROCESS AT LUCAS WESTERN

ROBERT B. BOSSLER, JR. (Lucas Western, Inc., City of Industry, CA) Vertiflite (ISSN 0042-4455), vol. 35, Mar.-Apr. 1989, p. 20-25.

An account is given of the technology development efforts undertaken by a helicopter transmission manufacturer in order to produce hardware to more exacting performance requirements than had been previously considered. The first of the illustrative examples considered is a 5,400 hp propeller drive for a high-speed marine hydrofoil employing a supercavitating rotor. Additional examples are drawn from efforts to develop mechanical drives for hoists deployable aboard helicopters. The technology developments required concerned gear systems, joints, dynamics, component design, and lubrication systems. O.C.

## A89-36436

### THE PROCESSING AND TESTING OF A HOLLOW DS EUTECTIC HIGH PRESSURE TURBINE BLADE

R. G. MENZIES, C. A. BRUCH, J. A. SMITH, R. C. HAUBERT (General Electric Co., Evendale, OH), and M. F. GIGLIOTTI (General Electric Co., Schenectady, NY) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 355-364. refs  
(Contract F33615-77-C-5200)

A program designed to evaluate the feasibility of directionally solidified eutectic high pressure turbine blades is described. The program's objectives are to define the materials, design, and fabrication technology required for the application of eutectic composites in HPT blade components, and to demonstrate their applicability in advance aircraft gas turbine engines. The Rene 150 blade design was successfully modified to incorporate the excellent mechanical properties of NiTaC-14B. The alloy has an approximately 225 deg F superiority over conventionally cast Rene 80. K.K.

## A89-36455

### LASER DRILLING OF A SUPERALLOY COATED WITH CERAMIC

P. FORGET, M. JEANDIN (Paris, Ecole Nationale Supérieure des Mines, Evry, France), P. LECHERVY, and D. VARELA (SNECMA, Moissy-Cramayel, France) IN: Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Warrendale, PA, Metallurgical Society, Inc., 1988, p. 553-562. refs

An Nd:YAG rod laser was used to drill small holes in conventional Hastelloy X sheets coated with yttria-stabilized zirconia plasma sprayed onto an MCrAlY bond coat, also deposited by conventional air plasma spraying. The effects of the principal laser parameters, such as pulse length, pulse rate, and power density are determined, and thermal models are developed. Coupled with the energy-matter balance, the models can be used to optimize the laser drilling parameters. V.L.

A89-36576

**INTERNATIONAL CONFERENCE ON SATELLITE SYSTEMS FOR MOBILE COMMUNICATIONS AND NAVIGATION, 4TH, LONDON, ENGLAND, OCT. 17-19, 1988, PROCEEDINGS**

Conference organized by IEE, London, Institution of Electrical Engineers, 1988, 283 p. For individual items see A89-36577 to A89-36625.

Attention is given to the following topics: antennas and propagation, systems for communication, systems for land mobile communications, systems for aeronautical communications, and system economics, operation, and traffic. Particular papers are presented on tracking receiver design for the electronic beam squint tracking system in the maritime mobile environment, network signalling system design considerations in a multiservice mobile satellite communication systems, Inmarsat's aeronautical satellite communication system, and proposed systems configurations for a satellite-based ISDN. B.J.

A89-36585

**NTT'S PROGRAM OF EXPERIMENTAL MOBILE SATELLITE SYSTEM (EMSS) USING ETS-V AND PRELIMINARY RESULTS**

T. SAKAI, H. MISHIMA, E. HAGIWARA, and K. SATOH (Nippon Telegraph and Telephone Public Corp., Radio Communication Systems Laboratories, Tokyo, Japan) IN: International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings. London, Institution of Electrical Engineers, 1988, p. 38-42. refs

The system configuration of NTT's EMSS program is described. Preliminary results from this program are presented, including data on ship earth station antenna switching, channel performance monitoring, and bit error rate characteristics. B.J.

A89-36593

**INMARSAT'S AERONAUTICAL SATELLITE COMMUNICATION SYSTEM**

P. WOOD (International Maritime Satellite Organization, London, England) IN: International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings. London, Institution of Electrical Engineers, 1988, p. 78-82. refs

The service requirements, system elements, and system design of Inmarsat's aeronautical satellite communication system are discussed. The system design is summarized in terms of modulation and coding, transmission format, data applications, and transmission channel characteristics. B.J.

A89-36655

**GENERALIZED CRITERIA FOR MICROWAVE BREAKDOWN IN AIR-FILLED WAVEGUIDES**

D. ANDERSON, M. LISAK (Chalmers Tekniska Hogskola, Goteborg, Sweden), and T. LEWIN (Ericsson Radio Systems AB, Molndal, Sweden) Journal of Applied Physics (ISSN 0021-8979), vol. 65, April 15, 1989, p. 2935-2945. refs

Generalized threshold conditions were formulated for microwave breakdown in air-filled waveguides, which take into account the temperature-dependent processes that affect the breakdown process. Emphasis is placed on the parameter range characterized by pressures larger than 100 torr and microwave frequencies between 1 and 40 GHz, relevant to the airborne radar application. The analysis showed a significant reduction in the electric field strength required to produce breakdown in hot air, as compared to the breakdown in fields for lower temperature, providing a theoretical explanation of the fact that the breakdown thresholds of microwave devices are observed to be much lower than those predicted by the conventional cold-air theory. I.S.

A89-36723#

**STRUCTURES FOR HYPERVELOCITY FLIGHT**

PETER K. SHIH, ALLEN D. ZWAN, MICHAEL N. KELLEY, and JACK PRUNTY (General Dynamics Corp., Convair Div., San Diego, CA) Aerospace America (ISSN 0740-722X), vol. 27, May 1989, p. 28-31.

Manned transatmospheric hypervelocity vehicles such as that

studied under the aegis of the USAF Wright Aeronautical Laboratories will require the integration of cryogenic tankage, highly aerothermodynamically loaded structures, crew systems, and propulsion; thermophysical analyses have accordingly become essential to the effort of design with the requisite advanced materials. A hybrid outer structure design has been formulated in which slip-joined carbon-carbon cover panels lie over an encapsulated fibrous insulation blanket that in turn protects the underlying metallic primary structure. Cryogenic tankage of lightweight Al-Li alloy is also employed. O.C.

A89-36909#

**MEASUREMENTS IN SEPARATING BOUNDARY LAYERS**

M. DIANAT and I. P. CASTRO (Surrey, University, Guildford, England) (ICAS, Congress, 15th, London, England, Sept. 7-12, 1986, Proceedings. Volume 2, p. 905-910) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 719-724. Research supported by the Ministry of Defence Procurement Executive and SERC. Previously cited in issue 24, p. 3592, Accession no. A86-49073. refs

A89-36916\*# United Technologies Research Center, East Hartford, CT.

**CALCULATION OF UNSTEADY FLOWS IN TURBOMACHINERY USING THE LINEARIZED EULER EQUATIONS**

KENNETH C. HALL (United Technologies Research Center, East Hartford, CT) and EDWARD F. CRAWLEY (MIT, Cambridge, MA) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 777-787. Research supported by the General Electric Co., General Motors Corp., and Fannie and John Hertz Foundation. Previously announced in STAR as N87-22948. refs (Contract NSG-3079)

A method for calculating unsteady flows in cascades is presented. The model, which is based on the linearized unsteady Euler equations, accounts for blade loading shock motion, wake motion, and blade geometry. The mean flow through the cascade is determined by solving the full nonlinear Euler equations. Assuming the unsteadiness in the flow is small, then the Euler equations are linearized about the mean flow to obtain a set of linear variable coefficient equations which describe the small amplitude, harmonic motion of the flow. These equations are discretized on a computational grid via a finite volume operator and solved directly subject to an appropriate set of linearized boundary conditions. The steady flow, which is calculated prior to the unsteady flow, is found via a Newton iteration procedure. An important feature of the analysis is the use of shock fitting to model steady and unsteady shocks. Use of the Euler equations with the unsteady Rankine-Hugoniot shock jump conditions correctly models the generation of steady and unsteady entropy and vorticity at shocks. In particular, the low frequency shock displacement is correctly predicted. Results of this method are presented for a variety of test cases. Predicted unsteady transonic flows in channels are compared to full nonlinear Euler solutions obtained using time-accurate, time-marching methods. The agreement between the two methods is excellent for small to moderate levels of flow unsteadiness. The method is also used to predict unsteady flows in cascades due to blade motion (flutter problem) and incoming disturbances (gust response problem).

Author

A89-36917\*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.

**INTEGRATED APPROACH FOR ACTIVE COUPLING OF STRUCTURES AND FLUIDS**

GURU P. GURUSWAMY (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 788-793. Research supported by USAF. refs

Strong coupling of structure and fluids is common in many engineering environments, particularly when the flow is nonlinear and very sensitive to structural motions. Such coupling can give rise to physically important phenomena, such as a dip in the transonic flutter boundary of a wing. The coupled phenomenon can be analyzed in closed form for simple cases that are defined

by linear structural and fluid equations of motion. However, complex cases defined by nonlinear equations pose a more difficult task for solution. It is important to understand these nonlinear coupled problems, since they may lead to physically important new phenomena. Flow discontinuities, such as a shock wave, and structural discontinuities, such as a hinge line of a control surface of a wing, can magnify the coupled effects and give rise to new phenomena. To study such a strongly coupled phenomenon, an integrated approach is presented in this paper. The aerodynamic and structural equations of motion are simultaneously integrated by a time-accurate numerical scheme. The theoretical simulation is done using the time-accurate unsteady transonic aerodynamic equations coupled with modal structural equations of motion. As an example, the coupled effect of shock waves and hinge-line discontinuities are studied for aeroelastically flexible wings with active control surfaces. The simulation in this study is modeled in the time domain and can be extended to simulate accurately other systems where fluids and structures are strongly coupled.

Author

#### A89-36919#

##### VARIATIONS OF UNDAMPED ROTOR BLADE FREQUENCIES SUBJECTED TO TRANSIENT HEAT FLUX

ANAND M. SHARAN (Newfoundland, Memorial University, Saint John's, Canada) and RAJEEVE BAHREE (AIAA Journal (ISSN 0001-1452), vol. 27, June 1989, p. 802-808. refs (Contract NSERC-A-5549)

In the present work, the variation of rotor blade natural frequencies due to the radiative heat flux has been studied. The dynamic equations of motion have been obtained using curved, 20 node, solid, isoparametric finite elements. The effect of the variation of the pretwist angle on the natural frequencies also has been studied.

Author

#### A89-36966

##### THE OPTICAL BIDIRECTIONAL ACCELEROMETER

O. DUPONT and J. C. LEGROS (Bruxelles, Universite Libre, Brussels, Belgium) (COSPAR, ESA, and International Union of Crystallography, Plenary Meeting, 27th, Topical Meeting on Microgravity, Espoo, Finland, July 18-29, 1988) *Advances in Space Research* (ISSN 0273-1177), vol. 8, no. 12, 1988, p. 147-154.

A new optical bidirectional accelerometer is described with particular reference to applications in a microgravity environment during a parabolic flight experiment. The capability of the instrument to detect the gravity level is demonstrated experimentally. The g resistance of the instrument is at least 5.5 g; the sensitivity of the accelerometer can be adjusted by modifying the mass fixed at the end of the optic guide, the length of the guide, or the diameter of the thin end of the guide.

V.L.

#### A89-37006#

##### EXPERIMENTAL INVESTIGATION ON BUCKLING OF AIRCRAFT SHELL BY THE CURVED GRATING SHADOW MOIRE METHOD

ZHIQIANG TAO, WENKUAN BIAN, and DAZHEN YUN (Dalian Institute of Technology, People's Republic of China) *Acta Aeronautica et Astronautica Sinica* (ISSN 1000-6893), vol. 9, Dec. 1988, p. B568-B573. In Chinese, with abstract in English.

On the basis of the shadow moire method with curved grating, the buckling parameters such as the smallest critical load, ultimate buckling load, and the buckling mode of two kinds of models of aircraft shell under the action of axial compression or uniform internal pressure are given in this paper. The two kinds of models included circular cylindrical and pillow cylindrical shells. There are twenty-eight specimens with different thickness and rib styles.

Author

#### A89-37011#

##### A WAY FOR UPGRADING THE ACCURACY OF FORCE MEASUREMENT

GUANGZHI YU (Beijing University, People's Republic of China) *Acta Aeronautica et Astronautica Sinica* (ISSN 1000-6893), vol. 9, Dec. 1988, p. B609-B613. In Chinese, with abstract in English.

This paper presents a description for studying the balance signals with a dynamic method. The optimum active filter has been developed for the measurement system of the wind tunnel at Beijing University on the basis of simulation using digital filters. The results of the investigation have shown that the accuracy of force measurements can be improved without increasing the running time of the wind tunnel.

Author

#### A89-37421

##### DYNAMICAL CALCULATIONS OF ENGINE COMPONENTS BASED ON ELASTICITY EQUATIONS (O POSTROENII DINAMICHESKIKH RASCHETOV DETALEI DVIGATELEI NA OSNOVE URAVNENII TEORII UPRUGOSTI)

N. D. KUZNETSOV, L. I. FRIDMAN, A. I. ERMAKOV, and V. N. UKHOV (*Problemy Prochnosti* (ISSN 0556-171X), March 1989, p. 3-8. In Russian. refs

An elasticity approach to the vibration analysis of gas turbine engine components of complex configurations is proposed which makes it possible to determine the natural frequencies and modes of structures with a higher accuracy than that obtainable with methods based on kinematic hypotheses. The method consists of the approximation of geometrically complex components by canonic bodies, conjugation of these bodies, and derivation of a frequency equation for the whole system.

V.L.

#### A89-37525

##### CONTRIBUTION TO CENTRIFUGAL IMPELLER DESIGN

VACLAV VANEK (*Zprava VZLU*, no. Z-57, 1989, p. 1-9. refs

A portion of a centrifugal compressor impeller pre-development research program is described. Results of an investigation on a set of radially-bladed impellers, the ARTI 305, are discussed. The impellers are designed for identical initial boundary conditions. The space shapes of the impeller blades are different, and the blading geometry is defined by two deceleration coefficients. An experimental investigation is carried out to verify the impeller design and manufacturing methods and the influence of the space shape of the impeller blading on its performance map.

S.A.V.

#### A89-37627

##### INFRARED THERMOGRAPHY - A QUANTITATIVE TOOL FOR HEAT STUDY [LA THERMOGRAPHIE INFRAROUGE - UN OUTIL QUANTITATIF A LA DISPOSITION DU THERMICIEN]

D. BALAGEAS, D. BOSCHER, A. DEOM, J. FOURNIER, and R. HENRY (ONERA, Chatillon-sous-Bagneux, France) (*Revue Generale Thermique*, Oct. 1988, p. 501-510) ONERA, TP no. 1989-3, 1989, 11 p. In French. Research supported by DRET and Service Technique des Programmes Aeronautiques. refs (ONERA, TP NO. 1989-3)

Three applications of infrared thermography for temperature determination are discussed: (1) the detection, localization, and thermal characterization of delamination in carbon-epoxy composite structures; (2) the determination of the heat transfer coefficients for wind tunnel models; and (3) the measurement of temperature in a helicopter blade section during icing/deicing tests performed in an icing wind tunnel.

R.R.

#### A89-37631#

##### VIBRATIONS IN AEROSPACE STRUCTURES - PREDICTION, PREVENTION AND CONTROL

R. DAT (ONERA, Chatillon-sous-Bagneux, France) (Israel Annual Conference on Aviation and Astronautics, Tel Aviv, Israel, Feb. 2-15, 1989) ONERA, TP no. 1989-9, 1989, 13 p. refs (ONERA, TP NO. 1989-9)

The effects of aerospace vibrations on safety, the crew and passenger comfort, and the stability of structural elements are discussed, together with the ways by which vibrations can be reduced and controlled. Special attention is given to the problem of vibration as part of the structural design. It is shown that the structural modeling techniques differ according to the frequency range and structure size, the configuration of the structure, and the mechanism of vibration generation. It is emphasized that experiments are important not only to validate calculation codes, but also to provide data for model adjustment, to identify the

characteristics of composite materials well as the characteristics of a whole structure, and to provide an evaluation of the excitation loads. I.S.

**A89-37640#**

**NEW POSSIBILITIES OF VISCOUS-INVISCID NUMERICAL TECHNIQUES FOR SOLVING VISCOUS FLOW EQUATIONS WITH MASSIVE SEPARATION**

J. C. LE BALLEUR (ONERA, Chatillon-sous-Bagneux, France) (Symposium on Numerical and Physical Aspects of Aerodynamic Flows, Long Beach, CA, Jan. 16-19, 1989) ONERA, TP no. 1989-24, 1989, 21 p. refs (ONERA, TP NO. 1989-24)

A viscous-inviscid formulation and numerical coupling algorithms for computations in high Reynolds number aerodynamics are presented. The defect formulation Le Balleur (1986) is extended to study thin-layer massive separation with turbulent three-dimensional velocity profiles. Also, two generalizations of Le Balleur's (1985) semiinverse coupling method are presented for massive separations and for coupling with Euler solvers. Numerical results are given for two-dimensional steady separated flows. Also, a computation method is proposed for massively separated steady flows over airfoils at deep stall conditions. R.B.

**A89-37642#**

**APPLICATION OF INFRARED THERMOGRAPHY TO THE INTERPRETATION OF TESTS IN AN ICING WIND TUNNEL [APPLICATION DE LA THERMOGRAPHIE INFRAROUGE A L'INTERPRETATION D'ESSAIS DANS UNE SOUFFLERIE GIVRANTE]**

R. HENRY and D. GUFFOND (ONERA, Chatillon-sous-Bagneux, France) (Societe Francaise des Thermiciens, Journee d'Etude, Paris, France, Jan. 18, 1989) ONERA, TP no. 1989-28, 1989, 11 p. In French. refs (ONERA, TP NO. 1989-28)

Wall temperature measurements were obtained in an icing wind tunnel using infrared thermography in order to validate models for the simulation of electrothermal deicers intended for helicopter blades. The measurement procedure involves adjusting the camera for the temperature range considered, determining the directional emissivity of the profile surface and of the ice, and using Mie theory to determine the atmospheric transmission factor. The present results demonstrate the importance of taking the phase change of the ice into account in deicer modeling. R.R.

**A89-37766#**

**VARIATION OF CRITICAL SPEED OF A ROTOR-BEARING SYSTEM WITH SLIGHT RELOCATION OF BEARING**

YAN LI and ZEYONG YIN (Nanhua Power Plant Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 63, 64, 93. In Chinese, with abstract in English.

A formula has been derived for calculating the variation of critical speeds of a rotor-bearing system with slight change of bearing position. The formula can determine which bearing should change position and in which direction it should move so that the desired critical speeds of the system could be reached. The formula has been applied to rearranging the bearings of a certain aeroengine so successfully that its critical speeds are farther away from the working speed range than before. Author

**A89-37768#**

**EXPERIMENTAL INVESTIGATION OF SUDDEN IMBALANCE RESPONSE ON A FLEXIBLE ROTOR SYSTEM WITH SQUEEZE-FILM DAMPER**

CAIGAO FU and XIFAN LI (Chinese Gas Turbine Establishment, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, Jan. 1989, p. 67-69, 93. In Chinese, with abstract in English.

An experimental method is used to investigate suddenly applied imbalance response of a flexible rotor with an uncentralized squeeze-film damper. The results show that the unstable transient process in this system is very short, and only after a few cycles

the system recovers to steady state on new vibration level. The squeeze-film damper system has a limited capability of sudden subjection to the imbalance load. The limits depend mainly on the oil-film clearances of the damper. This work will be helpful for selecting squeeze-film parameters and experimental method of suddenly applied imbalance. Author

**A89-37847**

**ACTIVE VIBRATION CONTROL OF FLEXIBLE ROTORS - AN EXPERIMENTAL AND THEORETICAL STUDY**

C. R. BURROWS (Bath, University, England), M. N. SAHINKAYA, and S. CLEMENTS (Strathclyde, University, Glasgow, Scotland) Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences (ISSN 0080-4630), vol. 422, no. 1862, March 8, 1989, p. 123-146. Research supported by SERC. refs

The Burrows and Sahinkaya (1983) algorithm for the control of flexible-rotor synchronous vibration is presently extended to the case in which a single magnetic actuator can be used to estimate multimode rotor-bearing system characteristics and apply the optimum control force required for minimization of synchronous vibration. The rotor in question is supported by oil-film bearings; the algorithm used determines the optimum control force without prior knowledge of the bearing or rotor characteristics of the distribution of out-of-balance forces. This theoretical work's application is illustrated by the case of a rig. Excellent control was obtained by measuring midspan rotor stations. O.C.

**A89-37878**

**AERODYNAMIC DEVICE FOR GENERATING MONO-DISPERSE FUEL DROPLETS**

G. J. GREEN, D. E. WALSH (Mobil Research and Development Corp., Princeton, NJ), F. TAKAHASHI, and F. L. DRYER (Princeton University, NJ) Review of Scientific Instruments (ISSN 0034-6748), vol. 60, April 1989, p. 646-652. refs

A device has been developed for generating well-defined, one-dimensional streams of small monosized droplets of a variety of fuels. The droplets produced are well separated, making this technique well suited to experimental combustion studies of unsupported, isolated droplets. This method has been used successfully to generate droplets of light and middistillate petroleum fuels, heavy oils, boron/JP-10 slurries, and coke/oil slurries, for a range of combustion studies. The principle of operation of the device is the aerodynamic stripping of incompletely formed droplets emerging from the tip of a capillary/fine wire which resides in the throat of a venturi or convergent nozzle. Author

**A89-38189**

**CONFIGURATION OF TUNED DRY GYRO REDUNDANT SYSTEM**

HIROKIMI SHINGU (National Aerospace Laboratory, Chofu, Japan) IN: International Symposium on Space Technology and Science, 16th, Sapporo, Japan, May 22-27, 1988, Proceedings. Volume 1. Tokyo, AGNE Publishing, Inc., 1988, p. 1211-1216. refs

The configuration of a redundant attitude reference system using three tuned dry gyros is presented. The system increases the reliability of a strapdown inertial navigator and the failure detection procedure required for system operation. The sensor orientation in the system is modeled and the relationships between navigation reference data and outputs of the tuned dry gyros are obtained. It is shown that sensor failure may be detected using various combinations of gyro outputs. The failure detection procedure is simulated and the speed of failure detection is evaluated. R.B.

**A89-38499**

**HYDRODYNAMICS AND HEAT TRANSFER IN THE POROUS**

**ELEMENTS OF FLIGHT VEHICLE STRUCTURES**

**[GIDRODINAMIKA I TEPLOOBMEN V PORISTYKH**

**ELEMENTAKH KONSTRUKTSII LETATEL'NYKH APPARATOV]**

VLADIMIR M. POLIAEV, VITALII A. MAIOROV, and LEONARD L. VASIL'EV Moscow, Izdatel'stvo Mashinostroenie, 1988, 168 p. In Russian. refs

The physical processes underlying the operation of

high-efficiency porous heat transfer elements used in flight vehicles are examined in the light of current theoretical concepts. In particular, attention is given to the classification, structure and applications of porous heat transfer elements; resistance and heat transfer during the motion of a single-phase coolant in porous matrices; principal problems in transpiration cooling; and intensification of heat transfer in channels with a porous filler. The discussion also covers the liquid evaporative cooling of the porous walls of flight vehicle structures and porous fuel elements.

V.L.

**A89-38500**

**CALCULATION OF THE PRINCIPAL PARAMETERS OF THE ACTUATING MECHANISMS OF AIRCRAFT SLAVE DRIVES**  
**[RASCHET OSNOVNYKH PARAMETROV ISPOLNITEL'NYKH MEKHAIZMOV SLEDIASHCHIKH PRIVODOV LETATEL'NYKH APPARATOV]**

VITALII A. POLKOVNIKOV and ANDREI V. SERGEEV Moscow, Izdatel'stvo Mashinostroenie, 1988, 192 p. In Russian. refs

Problems associated with the synthesis of the principal parameters of slave drive actuators are examined in the context of the theory of dynamic capability limits. The synthesis methods discussed here are based on the use of a computer and take into account the nonlinear properties of the actuating mechanisms, characteristics of the load resistance moments, the laws of drive motion, and the structure of the drive power unit (one-dimensional or multidimensional). Procedures for calculating the principal parameters of the actuating mechanisms are illustrated by examples.

V.L.

**A89-38615**

**THREE COMPONENT LASER DOPPLER ANEMOMETRY IN LARGE WIND TUNNELS**

KARL-ALOYS BUETEFISCH (DFVLR, Institut fuer experimentelle Stroemungsmechanik, Goettingen, Federal Republic of Germany) Progress in Aerospace Sciences (ISSN 0376-0421), vol. 26, no. 1, 1989, p. 79-113. refs

Starting with the physical background of laser Doppler anemometry (LDA), the important parameters influencing the proper operation of such an instrument in large wind tunnels to obtain the flow velocity are discussed. Aspects for designing a three component LDA system to get the time dependent velocity vector are treated. A compact three-component system operated in backscatter and off-axis mode is described. Three component velocity and turbulence results which have been obtained in the 3 sq m subsonic and 1 sq m transonic wind tunnels of the DFVLR are presented.

Author

**A89-38632**

**XRD TECHNIQUES IN AERO ENGINE DEVELOPMENT**

M. PLANT Metals and Materials (ISSN 0266-7185), vol. 5, April 1989, p. 205-209.

State-of-the-art computer-aided data collection and interpretation have been enlisted to extend the role of XRD in novel areas of aircraft engine high-temperature structural material and component characterization. XRD has proved to be an ideal tool for the evaluation of such alternative advanced surface-treatment processes as glass-bead and shot-peening; XRD in these cases establishes the magnitude and direction of residual stresses at different depths from the surface. XRD has also been used to generate data on the interaction between mold material and cast alloys, and to monitor variations in the type and relative quantity of secondary metallic phases in alloys.

O.C.

**A89-38764**

**VISUALIZATION OF AERODYNAMIC FLOW FIELDS USING PHOTOREFRACTIVE CRYSTALS**

A. HAFIZ, R. MAGNUSSON, J. S. BAGBY, D. R. WILSON, and T. D. BLACK (Texas, University, Arlington) Applied Optics (ISSN 0003-6935), vol. 28, April 15, 1989, p. 1521-1524. refs (Contract DAAL03-86-K-0149)

Interferometry based on double exposure Fourier transform holography in photorefractive crystals is applied for visualization

of aerodynamic flow fields. The interferograms obtained are of similar quality as those produced using holographic film but with greatly simplified procedures. The results presented are obtained using a high-power cw argon laser and iron doped lithium niobate crystals. The angular characteristics of the Fourier transform data holograms are studied.

Author

**A89-38874**

**A TWO-SPARK SCHLIEREN SYSTEM FOR VERY-HIGH VELOCITY MEASUREMENT**

D. PAPAMOSCHOU (California Institute of Technology, Pasadena) Experiments in Fluids (ISSN 0723-4864), vol. 7, no. 5, April 1989, p. 354-356. Research supported by the Rockwell International Foundation Trust. (Contract N00014-85-K-0646)

A simple and relatively inexpensive optical method to record the evolution of very rapid events in high-speed flow is described. The method is a two-spark variant of the schlieren system. For each shot, two distinct frames are produced on the same piece of film, each of very short exposure. The timing between the two frames is adjustable and can range anywhere upwards of 1 microsec. The system requires very few additions to an existing schlieren setup and contains no movable parts. It has been successfully applied to a supersonic shear-layer experiment where velocities of turbulent-flow structures were accurately determined.

C.D.

**A89-38951**

**APPLICATION OF NONDESTRUCTIVE INSPECTION METHODS TO COMPOSITES**

THOMAS S. JONES and HAROLD BERGER (Industrial Quality, Inc., Gaithersburg, MD) Materials Evaluation (ISSN 0025-5327), vol. 47, April 1989, p. 390, 391, 393-398, 400. refs

The capabilities and limitations of some typical NDI as applied to composites are examined. The methods considered include: visual inspection, tap test, ultrasonic through-transmission testing, ultrasonic pause-echo testing, ultrasonic polar backscatter, ultrasonic resonance, ultrasonic correlation, X-radiography, X-ray backscatter imaging, neutron radiography, laser holography, thermal infrared inspection, acoustic emission, acoustic ultrasonics, and eddy current testing. An initial sorting approach is given which can be used for the selection of inspection methods for particular composite discontinuities.

C.D.

**A89-38954**

**NONDESTRUCTIVE VOLUMETRIC CT-SCAN EVALUATION OF MONOLITHIC CERAMIC TURBINE COMPONENTS**

M. W. VANNIER, C. J. OFFUTT (Washington University, Medical Center, Saint Louis, MO), and W. A. ELLINGSON (Argonne National Laboratory, IL) Materials Evaluation (ISSN 0025-5327), vol. 47, April 1989, p. 454-459, 465. refs

Contiguous transaxial high-resolution computed tomographic (CT) scans of two green-ceramic turbine rotors were obtained using a medical CT scanner. The CT-scan examinations revealed internal defects in the bladed portion of one of the rotors. The serial section data were reconstructed in a three-dimensional (3D) form with surface and transparent volumetric computer graphics processing techniques. Real-time sequences showing the presence of internal defects and details of the objects were produced and recorded on video tape. Digital radiographs of the rotors were obtained for comparison to the CT reconstructions, using photostimulable phosphor imaging plates as a replacement for film. This study demonstrates the feasibility of 3D volumetric visualization for nondestructive evaluation of advanced ceramic turbine components.

Author

**A89-39037#**

**SWIRLING FLOWS IN AN ANNULAR-TO-RECTANGULAR TRANSITION SECTION**

THOMAS H. SOBOTA and FRANK E. MARBLE (California Institute of Technology, Pasadena) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, May-June 1989, p. 334-340. Previously cited in issue 21, p. 3401, Accession no. A87-48576. refs

A89-39050

**STRESS TENSOR MEASUREMENTS WITHIN THE VANELESS DIFFUSER OF A CENTRIFUGAL COMPRESSOR**

T. M. A. MAKSOUD and M. W. JOHNSON (Liverpool, University, England) Institution of Mechanical Engineers, Proceedings, Part C - Journal of Mechanical Engineering Science (ISSN 0954-4062), vol. 203, no. C1, 1989, p. 51-59. Research supported by SERC. refs

Distributions of normal and shear (Reynolds) stresses inside the vaneless diffuser of a low-speed centrifugal compressor are presented. The measurements were made using a triple hot-wire system and a phase lock loop sampling technique. Results were obtained on cross-sectional planes at eight radial stations between the impeller outlet and the diffuser exit at three different flowrates. The turbulence was highly anisotropic and became more so as the flowrate was increased. The tangential component of turbulent intensity was found to be significantly smaller than either the radial or axial component. The blade wake observed at the diffuser inlet decays very rapidly due to the strong tangential Reynolds stresses generated by the opposed secondary flows on either side of the wake. The passage wake decays very much more slowly and is still identifiable at the diffuser discharge. Author

A89-39076#

**MODERN JOINING METHODS FOR FUTURE AIRCRAFT STRUCTURES**

GUENTER BRODEN Dornier Post (ISSN 0012-5563), no. 1, 1989, p. 10-12.

The results of recent developmental tests of next-generation aircraft metallic structure joining technologies are presented. Superplastic forming/diffusion bonding (SPF/DB) has been employed in the case of a Ti-alloy fin leading edge, which has been realized with two 'skin' and two 'rib' panels; the SPF tool for the leading edge is of symmetrical design, so that two parts may be manufactured in the right-hand and left-hand tool sections in a single SPF/DB cycle. For Al alloys, whose oxide surface film precludes DB, liquid-phase diffusion bonding is illustrated. Temperature, contact pressure, and retention-time parameters have been carefully optimized to minimize structural changes in the superplastic 7475 alloy. O.C.

A89-39186#

**COLOR HELIUM BUBBLE FLOW-VISUALIZATION TECHNIQUE**

DONG ZHAO, ZHONGQI WANG, XIAODI ZHANG, JIALIN QIN, and XIANZHONG LANG (Harbin Aerodynamic Research Institute, People's Republic of China) (ICAS, Congress, 15th, London, England, Sept. 7-12, 1986, Proceedings. Volume 2, p. 900-904) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 499-502. Previously cited in issue 24, p. 3599, Accession no. A86-49072.

A89-39519

**EIGENSOLUTION OF PERIODIC ASSEMBLIES OF MULTI-MODE COMPONENT SYSTEMS**

P. D. CHA and C. PIERRE (Michigan, University, Ann Arbor) Journal of Sound and Vibration (ISSN 0022-460X), vol. 129, Feb. 22, 1989, p. 168-174. refs  
(Contract NSF MSM-87-00820)

The free vibration of a periodic structure made up of identically connected identical components is investigated. An analytical solution for the eigenvalue problem is obtained which, although not completely closed-form, provides information on the sinusoidal variation of the mode shapes in space and the effects of system parameters on mode shapes and natural frequencies. Results for an assembly of three clamped-free Euler-Bernoulli beams are presented and shown to reduce to the closed-form eigensolution of Chen (1971). T.K.

A89-39823

**APPLICATION OF THE THEORY OF FUZZY SETS TO THE TWO-CRITERION STOCHASTIC OPTIMIZATION OF RIBBED SHELLS [PRIMENENIE TEORII NECHETKIKH MNOZHESTV K DVUKHKRITERIAL'NOI STOKHASTICHESKOI OPTIMIZATSII REBRISTYKH OBOLOCHKEK]**

IU. M. POCHTMAN and M. M. FRIDMAN Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), Mar.-Apr. 1989, p. 161-164. In Russian. refs

The paper is concerned with the optimization of hinged closed cylindrical shells cross-reinforced by a system of ribs stochastically loaded by uniform pressure of the white noise type. The treatment allows for the discrete nature of the reinforcement in accordance with the shell model. The analysis presented here is relevant to the loading of aircraft skin panels in an acoustic pressure field. V.L.

N89-21984 Centre d'Essais Aeronautique Toulouse (France).

**FAILURE ANALYSIS: ANALYSIS OF LANDING GEAR FATIGUE TEST RESULTS FOR MECHANICAL AND METALLURGICAL CONSIDERATIONS IN ORDER TO DETERMINE THE AUTHORIZED RUN TIME [ANALYSE DES RESULTATS D'UN ESSAI DE FATIGUE D'ATTERISSEUR, A PARTIR DE CONSIDERATIONS MECANQUES ET METALLURGIQUES, POUR DETERMINER UNE DUREE AUTORISEE D'EXPLOITATION]**

CLAUDE BLEUZEN In CNES, Quality, Components and Technological Analysis p 1229-1246 Aug. 1988 In FRENCH  
Avail: CEPADUES-Editions, 111 Rue Nicolas-Vauquelin, 31100 Toulouse, France

Landing gear fatigue tests carried out over 200,000 cycles detected to find cracks which make safe service life inferior to specifications. The analysis of the case is presented, detailing the reasoning steps and decisions. A reasoning schema and decision tree are presented. Materials science is used to support the analysis. The corrective action taken is described. ESA

N89-21987# Engineering Management Concepts, Camarillo, CA. **PLASTIC MEDIA BLASTING RECYCLING EQUIPMENT STUDY Final Report, Jun. 1987 - Sep. 1988**

Oct. 1988 81 p  
(Contract N00123-85-D-0901)  
(AD-A202463; NCEL-CR-89.001) Avail: NTIS HC A05/MF A01  
CSCL 13/8

Plastic Media Blasting (PMB) is a new technology introduced as a candidate to replace wet chemical paint stripping of airframes and component parts. This report documents the physical testing, observations, and laboratory analyses used to evaluate the effectiveness of plastic media recycling equipment at three PMB sites. Different systems for recycling plastic media were evaluated for operational performance, losses, efficiency, and metal removal. An optimum recycling system was selected which included a cyclone for gross air/media separation, a vibrating screen to remove extra large and extra small particles, and a self-cleaning magnetic separator for ferrous particle removal. GRA

N89-22014# Selenia S.p.A., Naples (Italy).

**DESIGN, IMPLEMENTATION AND COMPUTER AIDED TESTS OF A SHAPED REFLECTOR FOR AN AIR TRAFFIC CONTROL SYSTEM [PROGETTAZIONE, REALIZZAZIONE E TEST ASSISTITI DA CALCOLATORE DI UN RIFLETTORE SHAPED PER UN SISTEMA DI CONTROLLO DEL TRAFICO AEREO]**

G. ASCIONE and U. F. DELIA 1988 5 p In ITALIAN; ENGLISH summary Presented at the 7th Riunione Nazionale di Elettromagnetismo Applicato, Frascati, Italy, 5-8 Sep. 1988 (ETN-89-94229) Avail: NTIS HC A02/MF A01

The use of computer aided methods to perform and optimize a reflector is described. The reflector is to be used in a mobile sheltered system. The description includes characterization of the illuminator, surface synthesis, profile definition, computer aided manufacturing, and measuring techniques. The use of a workstation dedicated to electromagnetic design is allowed to manufacture the reflector without a reduced scale physical model step. ESA



**N89-22016#** China Aeronautical Establishment, Beijing.  
**STUDY OF THE REAL EMULATION OF THE ELECTRONIC INTEGRATED SYSTEM**

ZUNXIAO LIU and JINGCHUN WANG 1988 23 p  
 (PB89-116271; HJB-850281) Avail: NTIS HC A03/MF A01  
 CSDL 09/1

Real time simulation of flight environment for an aeronautical electronic integrated system is discussed. Seven simulation items with two closed-loop modes are included. The navigation-fire control function block for intercept phase has been selected as a typical case. The simulation process is carried out through a series of procedures including the establishment of mathematical model, erecting simulation model, realizing digital simulation and updating mathematical model. The emphasis is laid on the analysis of the pilot's transfer function and the noise model of sensors, and comparison is made to the closed-loop with pilot intervention and the ideal sensor model individually. A satisfactory result is obtained. Author

**N89-22052#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**THE EFFECTS OF INCIDENCE ANGLE AND FREE STREAM TURBULENCE ON THE PERFORMANCE OF A VARIABLE GEOMETRY TWO-DIMENSIONAL COMPRESSOR CASCADE AT HIGH REYNOLDS NUMBERS M.S. Thesis**

EDWARD M. PONIATOWSKI Dec. 1988 321 p  
 (AD-A202650; AD-E900870; AFIT/GAE/AA/88D-31) Avail: NTIS HC A14/MF A01 CSDL 20/4

For this investigation, a seven-blade cascade of NACA 65-A506 airfoils with two inch chord, aspect ratio of one, and solidity of 1.5 was used. This cascade used porous side wall suction to establish two-dimensional flow conditions. Flow Unit Reynolds numbers exceeding 2.5 million foot, and average free stream turbulence levels of 1 pct and 7 pct were used. Cascade geometry was varied in a manner similar to that used in current variable stator designs: maintaining axial direction and blade spacing constant, while varying incidence angle, stagger angle, and angle of attack. Incidence angles of -3, 0, and +3 deg were investigated. Total pressure loss coefficient decreases through the cascade and may increase in the wake as incidence angle or free stream turbulence increase. The change in loss coefficient with increasing incidence was determined to be insignificant when compared with the change as a result of increased free stream turbulence. Blade suction surface pressure coefficients decrease sharply along the first 30 pct chord as incidence increases. The suction surface pressure coefficients show a uniform increase across the blade center span with additional free stream turbulence. Increases in incidence and free stream turbulence result in thicker boundary layers and suggest both earlier transition and intermittent separation on the forward half of the blade. Evidence also suggests that the location of the minimum loss incidence angle may change with additional free stream turbulence. GRA

**N89-22066#** Sverdrup Technology, Inc., Arnold Air Force Station, TN.

**PARC CODE VALIDATION FOR PROPULSION FLOWS Final Report, 1 Oct. 1987 - 30 Sep. 1988**

G. K. COOPER, G. D. GARRARD, and W. J. PHARES Jan. 1989 116 p Prepared in cooperation with Arnold Engineering Development Center, Arnold AFS, TN  
 (AD-A204293; AEDC-TR-88-32) Avail: NTIS HC A06/MF A01 CSDL 21/5

Validation/calibration of the PARC Navier-Stokes computer program for flows typical of turbine engine and rocket motor testing at the Arnold Engineering Development Center has been performed for a number of fundamental test cases. Laminar and turbulent flow simulations for a flat plate with zero pressure gradient have been compared with solutions of the boundary-layer equations with good-to-excellent results. These test cases examined effects of grid spacing in both the streamwise and cross-stream directions, compressibility, and heat transfer. The laminar flow simulations with a new artificial viscosity model were in excellent agreement with the boundary-layer code results; the turbulent simulations with

a Baldwin- and Lomax-style turbulence model compared less favorably with some cases showing a 10-percent error in skin friction. The near wake of turbulent supersonic jet was also simulated and compared very well with experimental data. GRA

**N89-22070#** Rutgers - The State Univ., New Brunswick, NJ. Dept. of Mechanical and Aerospace Engineering.

**THEORETICAL INVESTIGATION OF 3-D SHOCK WAVE-TURBULENT BOUNDARY LAYER INTERACTIONS, PART 7 Annual Report, 1 Oct. 1987 - 30 Sep. 1988**

DOYLE KNIGHT 15 Nov. 1988 76 p  
 (Contract AF-AFOSR-0266-86; AF PROJ. 2307)  
 (AD-A204482; RU-TR-172-MAE-F-PT-7; AFOSR-89-0139TR)  
 Avail: NTIS HC A05/MF A01 CSDL 20/4

This research describes continuing efforts in the analysis of 3-D shock wave turbulent boundary layer interactions. A significant research activity in 3-D hypersonic shock turbulent interactions is initiated to further develop and validate the theoretical model. The quasiconical free interaction principle is examined by simulation of two geometries -17.5 deg sharp fin and (30,60) swept compression corner (Mach 3) - selected to obtain similar shock strengths. The comparison with experimental data is good. It is confirmed that the differences caused by the particular geometry of the model appear only behind the inviscid shock wave. Continuing research on 3-D turbulent interaction control is focused on the effect of bleed and the simulation of flows past the double-fin configuration. The effect of suction is examined on a strong (fin angle = 20 deg, Mach 3) and a weak interaction (8 deg, Mach 3). The overall effect of bleed is remarkably modest. Two double-fin configurations (4 x 4 and 8 x 8, Mach 3) are simulated. A study of the computed flowfield indicates that the first is a weak interaction. In contrast, the 8 x 8 configuration displays an interesting separated flowfield. An analysis of viscous and inviscid effects in a sharp fin and a swept corner flow indicates that the physics of both geometries are governed primarily by inviscid (pressure) effects. Viscous effects are of lower magnitude but are not restricted to the sublayer region. GRA

**N89-22078#** Washington Univ., Seattle. Dept. of Applied Mathematics.

**DEVELOPMENT OF A STREAMLINE METHOD Final Report, 1 Jun. 1987 - 31 Aug. 1988**

CARL E. PEARSON Nov. 1988 3 p  
 (Contract AF-AFOSR-0111-84; AF PROJ. 2307)  
 (AD-A205146; AFOSR-89-0133TR) Avail: NTIS HC A02/MF A01 CSDL 20/4

The research investigated and developed a novel streamline method for the computation of steady state compressible flows in ducts and axial compressors. The method is based on the description of a streamline in terms of axial position and two parameters. A coupled pair of second order differential equation are developed and solved by a relaxing process in the subsonic case, and by downstream marching in the supersonic case. GRA

**N89-22807#** China Aeronautical Establishment, Beijing.

**ACCELERATION TEST FOR AIRCRAFT LOW-PASS FILTER**

ZHUFENG ZHANG 1988 17 p  
 (PB89-116263; HJB-860367) Avail: NTIS HC A03/MF A01 CSDL 09/3

A constant intensive acceleration endurance test method is introduced. Forty paper-capacitor low-pass filters were selected at random sampling for the reliability endurance test at four intensive levels on the increased temperature. According to the measured data during reliability test and using the graphic method, the normal intensive endurance distribution curve can be obtained by extension of the points on the accelerating endurance curve, preliminary judging the filter testing with the distribution tendency, and evaluating the product reliable life-time and the characteristic life-time, the accelerating factor can be calculated. It is to get the theoretical basis to conduct the accelerating endurance test at the increased temperature. Author

**N89-22835#** Naval Postgraduate School, Monterey, CA.  
**CONTROL OF EMBEDDED VORTICES USING WALL JETS**  
**M.S. Thesis**

GEOFFREY E. SCHWARTZ Sep. 1988 291 p  
 (AD-A202606; AD-E900870) Avail: NTIS HC A13/MF A01  
 CSCL 20/11

A wall jet inclined at 30 deg to horizontal was used to alter the structural characteristics of streamwise vortices embedded in a turbulent boundary layer developing in a zero pressure gradient. The vortices were created using a half delta wing attached to the floor of a wind tunnel. With the jet opposing the vortex downwash and blowing ratio increasing from 0 to 4.8, streamwise vorticity decreased from approx. 750 to approx. 150/s while circulation decreased from approx. 0.15 sq m/s. The average vortex core radius increased from approx. 0.9 to approx. 2.4 cm, while the vortex moved approx. 3 cm spanwise toward the jet. With the jet at the vortex upwash and blowing ratio increasing from 0 to 6.7, streamwise vorticity decreased from approx. 860 to approx. 570/s while circulation decreased from approx. 0.17 to approx. 0.15 sq m/s. GRA

**N89-22838\*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.  
**COMPUTATIONAL FLUID DYNAMICS RESEARCH IN THREE-DIMENSIONAL ZONAL TECHNIQUES Final Technical Report**

ROBERT W. WALTERS Apr. 1989 16 p  
 (Contract NAG1-866)  
 (NASA-CR-181406; NAS 1.26:181406) Avail: NTIS HC A03/MF A01 CSCL 20/4

Patched-grid algorithms for the analysis of complex configurations with an implicit, upwind-biased Navier-Stokes solver were investigated. Conservative and non-conservative approaches for performing zonal interpolations were implemented. The latter approach yields the most flexible technique in that it can handle both patched and overlaid grids. Results for a two-dimensional blunt body problem show that either approach yield accurate steady-state shock locations and jump conditions. In addition, calculations of the turbulent flow through a hypersonic inlet on a three-zone grid show that the numerical prediction is in good agreement with the experimental results. Through the use of a generalized coordinate transformation at the zonal interface between two or more blocks, the algorithm can be applied to highly stretched viscous grids and to arbitrarily-shaped zonal boundaries. Applications were made to the F-18 aircraft at subsonic, high-alpha conditions, in support of the NASA High-Alpha Research Program. The calculations were compared to ground-based and flight test experiments and were used as a guide to understanding the ground-based tests, which are laminar and transitional, and their relationship to flight. Calculations about a complete reconnaissance aircraft were also performed in order to further demonstrate the capability of the patched-grid algorithm. Author

**N89-22845#** Sandia National Labs., Albuquerque, NM. Parachute Systems Div.

**A VORTEX PANEL ANALYSIS OF CIRCULAR-ARC BLUFF-BODIES IN UNSTEADY FLOW**

JAMES H. STRICKLAND 1989 28 p Presented at the 10th AIAA Aerodynamic Decelerator Systems Technical Conference, Cocoa Beach, FL, 18 Apr. 1989  
 (Contract DE-AC04-76DP-00789)  
 (DE89-007141; SAND-89-0366C; CONF-8904118-2; AIAA-89-0930) Avail: NTIS HC A03/MF A01

A method which is capable of calculating the unsteady flow field around circular-arc bluff bodies of zero thickness is presented. This method utilizes linear vortex panels to model the body surface and a portion of the wake surfaces. Discrete vortices are used to model the remainder of the wake surfaces. Separation is assumed to occur at the sharp edges of the bodies. Numerical results for circular-arc bodies with included angles of less than 180 degrees are compared with experimental data and found to be in good agreement. DOE

**N89-22866#** Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

**THE STRUCTURE AND CONTROL OF THREE-DIMENSIONAL SHOCK WAVE TURBULENT BOUNDARY LAYER INTERACTIONS Final Report, 15 Jul. 1986 - 30 Sep. 1988**

SEYMOUR M. BOGDONOFF 14 Feb. 1989 39 p  
 (Contract F49620-86-C-0094)  
 (AD-A205923; MAE-1851; AFOSR-89-0285TR) Avail: NTIS HC A03/MF A01 CSCL 20/4

The present report briefly reviews the work accomplished on the study of three-dimensional shock wave turbulent boundary layer interactions at a Mach 3. The work consisted of two major thrusts: (1) Modeling of the complex interaction and detailed experiments coordinated with extensive computations; and (2) Exploratory studies of control concepts for a 20 deg fin and crossing shock configurations. The completed works have been reported and are briefly reviewed. A brief resume is presented of incomplete results on complex interactions, new heat transfer techniques, initial spanwise boundary layer effects, and studies in a new Low Turbulence Variable Geometry facility. GRA

**N89-22868\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**SURFACE TEMPERATURE MEASUREMENTS USING A THIN FILM THERMAL ARRAY**

L. A. DILLON-TOWNES, P. B. JOHNSON, R. L. ASH (Old Dominion Univ., Norfolk, VA.), K. DARYABEIGI, and J. C. WHIPPLE Mar. 1989 22 p  
 (Contract NAS1-17993)  
 (NASA-TM-101549; NAS 1.15:101549) Avail: NTIS HC A03/MF A01 CSCL 14/2

A thin film device was designed and fabricated to measure surface temperatures. An array of eight integrated thermal sensors are mounted on a 0.002 inch (0.05 mm) Kapton film and multiplexed to obtain an area thermal measurement. The device was tested on a flat plate airfoil and demonstrated a temperature variation of 0.55 C maximum and 0.05 C minimum compared to embedded thermocouples. Future improvements are also discussed. Author

**N89-22879#** Centre d'Etudes et de Recherches, Toulouse (France). Dept. d'Etudes et de Recherches en Aerothermodynamique.

**IMPLEMENTATION OF A TWO-COMPONENT LASER ANEMOMETER AT THE T2 WIND TUNNEL**

J. L. BONNET, A. SERAUDIE, J. P. ARCHAMBAUD, and A. MIGNOSI Jul. 1987 123 p In FRENCH Original contains color illustrations  
 (A-501-H; T-114-A) Avail: NTIS HC A06/MF A01

A series of tests for perfecting the velocity measurement with a two-component laser anemometer was carried out on a 180 mm chord RA16SC1 airfoil at the T2 wind tunnel, in September 1986. Measurements were performed on boundary layers, wake, and shock probing on the upper side of the model, mainly for two Mach number values ( $M = 0.6$  and  $0.725$ ) at 2 deg angle of attack, corresponding respectively to a steady shock and to a buffeting configuration. The anemometer system was tested to determine its limitations and practical problems of its use: theoretical limitations due to the filter, to the wall approach, to the density gradients etc. In conclusion, good velocity measurements are reliable with this laser anemometer at the T2 wind tunnel, with respect to the use limitations. Author

**N89-22891\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**ROTORDYNAMIC INSTABILITY PROBLEMS IN HIGH-PERFORMANCE TURBOMACHINERY, 1988**

Washington, DC Feb. 1989 454 p Workshop held in College Station, TX, 16-18 May 1988; sponsored by NASA, Lewis Research Center, Cleveland, OH, Texas A and M Univ., College Station, ARO, Durham, NC, and Aeropropulsion Lab., Wright-Patterson AFB, OH  
 (NASA-CP-3026; E-4227; NAS 1.55:3026) Avail: NTIS HC A20/MF A01 CSCL 13/9

The continuing trend toward a unified view is supported with several developments in the design and manufacture of turbomachines with enhanced stability characteristics along with data and associated numerical/theoretical results. The intent is to provide a continuing impetus for an understanding and resolution of these problems. Topics addressed include: field experience, dampers, seals, impeller forces, bearings, and compressor and rotor modeling.

**N89-22892\*#** Zhejiang Univ. (China).

**SOME FIELD EXPERIENCE WITH SUBSYNCHRONOUS VIBRATION OF CENTRIFUGAL COMPRESSORS**

XI-XUAN WANG, JIN-CHU GU, QIN-GEN SHEN, YONG-LI HUA, LAN-SHENG ZHU, and YUN-TIAN DU (Zhengzhou Polytechnic Inst., Henan, China) / In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 1-18 Feb. 1989  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

A lot of large chemical fertilizer plants producing 1000 ton NH<sub>3</sub>/day and 1700 ton urea/day were constructed in the 1970's in China. During operation, subsynchronous vibration takes place occasionally in some of the large turbine-compressor sets and has resulted in heavy economic losses. Two cases of subsynchronous vibration are described: Self-excited vibration of the low-pressure (LP) cylinder of one kind of N<sub>2</sub>-H<sub>2</sub> multistage compressor; and Forced subsynchronous vibration of the high-pressure (HP) cylinder of the CO<sub>2</sub> compressor. Author

**N89-22894\*#** Cesi, Milan (Italy).

**SOME IN-FIELD EXPERIENCES OF NON-SYNCHRONOUS VIBRATIONS IN LARGE ROTATING MACHINERY**

GIUSEPPE COLNAGO, CLAUDIO FRIGERI, ANDREA VALLINI, and GIAN ANTONIO ZANETTA (Ente Nazionale per l'Energia Elettrica, Rome, Italy) / In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 41-59 Feb. 1989  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

Some problems associated with non-synchronous vibrations are analyzed by describing three cases experienced with fairly large rotating machines in operating conditions. In each case, a brief description is first given of the machine and of the instrumentation used. The experimental results are then presented, with reference to time or frequency domain recordings. The lines followed in diagnosis are then discussed and, lastly, the corrective action undertaken is presented. Author

**N89-22895\*#** Southampton Univ. (England). Dept. of Mechanical Engineering.

**THE SPECTRAL ANALYSIS OF AN AERO-ENGINE ASSEMBLY INCORPORATING A SQUEEZE-FILM DAMPER**

R. HOLMES and M. M. DEDE / In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 61-86 Feb. 1989  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

Aero-engine structures have very low inherent damping and so artificial damping is often introduced by pumping oil into annular gaps between the casings and the outer races of some or all of the rolling-element bearings supporting the rotors. The thin oil films so formed are called squeeze film dampers and they can be beneficial in reducing rotor vibration due to unbalance and keeping to reasonable limits the forces transmitted to the engine casing. However, squeeze-film dampers are notoriously non-linear and as a result can introduce into the assembly such phenomena as subharmonic oscillations, jumps and combination frequencies. The purpose of the research is to investigate such phenomena both theoretically and experimentally on a test facility reproducing the essential features of a medium-size aero engine. The forerunner of this work was published. It was concerned with the examination of a squeeze-film damper in series with housing flexibility when supporting a rotor. The structure represented to a limited extent the essentials of the projected Rolls Royce RB401 engine. That research demonstrated the ability to calculate the oil-film forces arising from the squeeze film from known motions of the bearing

components and showed that the dynamics of a shaft fitted with a squeeze film bearing can be predicted reasonably accurately. An aero-engine will normally have at least two shafts and so in addition to the excitation forces which are synchronous with the rotation of one shaft, there will also be forces at other frequencies from other shafts operating on the squeeze-film damper. Theoretical and experimental work to consider severe loading of squeeze-film dampers and to include these additional effects are examined.

Author

**N89-22897\*#** Texas A&M Univ., College Station. Dept. of Mechanical Engineering.

**CAVITATION EFFECTS ON THE PRESSURE DISTRIBUTION OF A SQUEEZE FILM DAMPER BEARING**

FOUAD Y. ZEIDAN and JOHN M. VANCE / In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 111-132 Feb. 1989  
 Sponsored in part by General Electric Co., Aircraft Engine Business Group  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

High speed motion pictures have revealed several operating regimes in a squeeze film damper. Pressure measurements corresponding to these distinct regimes were made to examine their effect on the performance of such dampers. Visual observation also revealed the means by which the pressure in the feed groove showed higher amplitudes than the theory predicts. Comparison between vapor and gaseous cavitation are made based on their characteristic pressure wave, and the effect this has on the total force and its phase. Author

**N89-22898\*#** Texas A&M Univ., College Station. Dept. of Mechanical Engineering.

**AN ELECTROVISCOUS DAMPER**

JORGEN L. NIKOLAJSEN and M. S. HOQUE / In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 133-141 Feb. 1989  
 Sponsored in part by TAMU Turbomachinery Research Consortium  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

A new type of vibration damper for rotor systems was developed and tested. The damper contains electroviscous fluid which solidifies and provides Coulomb damping when an electric voltage is imposed across the fluid. The damping capacity is controlled by the voltage. The damper was incorporated in a flexible rotor system and found to be able to damp out high levels of unbalanced excitation. Other proven advantages include controllability, simplicity, and no requirement for oil supply. Still unconfirmed are the capabilities to eliminate critical speeds and to suppress rotor instabilities. Author

**N89-22899\*#** Texas A&M Univ., College Station.

**ANNULAR HONEYCOMB SEALS: TEST RESULTS FOR LEAKAGE AND ROTORDYNAMIC COEFFICIENTS; COMPARISONS TO LABYRINTH AND SMOOTH CONFIGURATIONS**

DARA W. CHILDS, DAVID ELROD, and KEITH HALE / In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 143-159 Feb. 1989  
 Previously announced in X89-10207

(Contract NAG3-181; F49620-82-K-0033)

Avail: NTIS HC A20/MF A01 CSCL 11/1

Test results are presented for leakage and rotordynamic coefficients for seven honeycomb seals. All seals have the same radius, length, and clearance; however, the cell depths and diameters are varied. Rotordynamic data, which are presented, consist of the direct and cross-coupled stiffness coefficients and the direct damping coefficients. The rotordynamic-coefficient data show a considerable sensitivity to changes in cell dimensions; however, no clear trends are identifiable. Comparisons of test data for the honeycomb seals with labyrinth and smooth annular seals show the honeycomb seal had the best sealing (minimum leakage) performance, followed in order by the labyrinth and smooth seals. For prerotated fluid entering the seal, in the direction of shaft

rotation, the honeycomb seal has the best rotordynamic stability followed in order by the labyrinth and smooth. For no prerotation, or fluid prerotation against shaft rotation, the labyrinth seal has the best rotordynamic stability followed in order by the smooth and honeycomb seals. Author

**N89-22900\*#** Kaiserslautern Univ. (Germany, F.R.). Dept. of Mechanical Engineering.

**ROTORDYNAMIC COEFFICIENTS FOR LABYRINTH SEALS CALCULATED BY MEANS OF A FINITE DIFFERENCE TECHNIQUE**

R. NORDMANN and P. WEISER /in NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 161-175 Feb. 1989

Avail: NTIS HC A20/MF A01 CSCL 11/1

The compressible, turbulent, time dependent and three dimensional flow in a labyrinth seal can be described by the Navier-Stokes equations in conjunction with a turbulence model. Additionally, equations for mass and energy conservation and an equation of state are required. To solve these equations, a perturbation analysis is performed yielding zeroth order equations for centric shaft position and first order equations describing the flow field for small motions around the seal center. For numerical solution a finite difference method is applied to the zeroth and first order equations resulting in leakage and dynamic seal coefficients respectively. Author

**N89-22901\*#** Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.

**ROTORDYNAMIC COEFFICIENTS FOR STEPPED LABYRINTH GAS SEALS**

JOSEPH K. SCHARRER /in NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 177-195 Feb. 1989

Avail: NTIS HC A20/MF A01 CSCL 11/1

The basic equations are derived for compressible flow in a stepped labyrinth gas seal. The flow is assumed to be completely turbulent in the circumferential direction where the friction factor is determined by the Blasius relation. Linearized zeroth and first-order perturbation equations are developed for small motion about a centered position by an expansion in the eccentricity ratio. The zeroth-order pressure distribution is found by satisfying the leakage equation while the circumferential velocity distribution is determined by satisfying the momentum equations. The first order equations are solved by a separation of variables solution. Integration of the resultant pressure distribution along and around the seal defines the reaction force developed by the seal and the corresponding dynamic coefficients. The results of this analysis are presented in the form of a parametric study, since there are no known experimental data for the rotordynamic coefficients of stepped labyrinth gas seals. The parametric study investigates the relative rotordynamic stability of convergent, straight and divergent stepped labyrinth gas seals. The results show that, generally, the divergent seal is more stable, rotordynamically, than the straight or convergent seals. The results also show that the teeth-on-stator seals are not always more stable, rotordynamically, than the teeth-on-rotor seals as was shown by experiment by Childs and Scharer (1986b) for a 15 tooth seal. Author

**N89-22905\*#** Case Western Reserve Univ., Cleveland, OH.

**A SEAL TEST FACILITY FOR THE MEASUREMENT OF ISOTROPIC AND ANISOTROPIC LINEAR ROTORDYNAMIC CHARACTERISTICS**

M. L. ADAMS, T. YANG, and S. E. PACE (Electric Power Research Inst., Palo Alto, CA.) /in NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 253-267 Feb. 1989

Avail: NTIS HC A20/MF A01 CSCL 11/1

A new seal test facility for measuring high-pressure seal rotor-dynamic characteristics has recently been made operational at Case Western Reserve University (CWRU). This work is being sponsored by the Electric Power Research Institute (EPRI). The fundamental concept embodied in this test apparatus is a

double-spool-shaft spindle which permits independent control over the spin speed and the frequency of an adjustable circular vibration orbit for both forward and backward whirl. Also, the static eccentricity between the rotating and non-rotating test seal parts is easily adjustable to desired values. By accurately measuring both dynamic radial displacement and dynamic radial force signals, over a wide range of circular orbit frequency, one is able to solve for the full linear-anisotropic model's 12 coefficients rather than the 6 coefficients of the more restrictive isotropic linear model. Of course, one may also impose the isotropic assumption in reducing test data, thereby providing a valid qualification of which seal configurations are well represented by the isotropic model and which are not. In fact, as argued in reference (1), the requirement for maintaining a symmetric total system mass matrix means that the resulting isotropic model needs 5 coefficients and the anisotropic model needs 11 coefficients. Author

**N89-22906\*#** Kaiserslautern Univ. (Germany, F.R.). Dept. of Mechanical Engineering.

**FINITE DIFFERENCE ANALYSIS OF ROTORDYNAMIC SEAL COEFFICIENTS FOR AN ECCENTRIC SHAFT POSITION**

R. NORDMANN and F. J. DIETZEN /in NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 269-284 Feb. 1989

Avail: NTIS HC A20/MF A01 CSCL 11/1

The dynamic coefficients of seals are calculated for shaft movements around an eccentric position. The turbulent flow is described by the Navier-Stokes equations in connection with a turbulence model. The equations are solved by a finite-difference procedure. Author

**N89-22909\*#** Textron Bell Helicopter, Fort Worth, TX.

**INFLUENCE OF IMPELLER SHROUD FORCES ON TURBOPUMP ROTOR DYNAMICS**

JIM P. WILLIAMS and DARA W. CHILDS (Texas A&M Univ., College Station.) /in NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 323-339 Feb. 1989 Previously announced as X89-10213

Avail: NTIS HC A20/MF A01 CSCL 13/9

The shrouded-impeller leakage path forces calculated by Childs (1987) have been analyzed to answer two questions. First, because of certain characteristics of the results of Childs, the forces could not be modeled with traditional approaches. Therefore, an approach has been devised to include the forces in conventional rotordynamic analyses. The forces were approximated by traditional stiffness, damping and inertia coefficients with the addition of whirl-frequency-dependent direct and cross-coupled stiffness terms. The forces were found to be well-modeled with this approach. Finally, the effect these forces had on a simple rotor-bearing system was analyzed, and, therefore, they, in addition to seal forces, were applied to a Jeffcott rotor. The traditional methods of dynamic system analysis were modified to incorporate the impeller forces and yielded results for the eigenproblem, frequency response, critical speed, transient response and an iterative technique for finding the frequency of free vibration as well as system stability. All results lead to the conclusion that the forces have little influence on natural frequency but can have appreciable effects on system stability. Specifically, at higher values of fluid swirl at the leakage path entrance, relative stability is reduced. The only unexpected response characteristics that occurred are attributed to the nonlinearity of the model. Author

**N89-22910\*#** Mechanical Technology, Inc., Latham, NY.

**MAGNETIC BEARING STIFFNESS CONTROL USING FREQUENCY BAND FILTERING**

H. MING CHEN /in NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 341-352 Feb. 1989

Avail: NTIS HC A20/MF A01 CSCL 13/9

Active magnetic bearings can be implemented with frequency band-reject filtering that decreases the bearing stiffness and damping at a small bandwidth around a chosen frequency. The control scheme was used for reducing a rotor dynamic force, such

as an imbalance force, transmitted to the bearing stator. The scheme creates additional system vibration modes at the same frequency. It also shows that the amount of force reduction is limited by the stability requirement of these modes. Author

**N89-22911\*#** Rotor Bearing Dynamics, Inc., Wellsville, NY.

**A MAGNETIC DAMPER FOR FIRST MODE VIBRATION REDUCTION IN MULTIMASS FLEXIBLE ROTORS**

M. E. F. KASARDA, P. E. ALLAIRE, R. R. HUMPHRIS, and L. E. BARRETT (Virginia Univ., Charlottesville.) /In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 353-372 Feb. 1989  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

Many rotating machines such as compressors, turbines and pumps have long thin shafts with resulting vibration problems, and would benefit from additional damping near the center of the shaft. Magnetic dampers have the potential to be employed in these machines because they can operate in the working fluid environment unlike conventional bearings. An experimental test rig is described which was set up with a long thin shaft and several masses to represent a flexible shaft machine. An active magnetic damper was placed in three locations: near the midspan, near one end disk, and close to the bearing. With typical control parameter settings, the midspan location reduced the first mode vibration 82 percent, the disk location reduced it 75 percent and the bearing location attained a 74 percent reduction. Magnetic damper stiffness and damping values used to obtain these reductions were only a few percent of the bearing stiffness and damping values. A theoretical model of both the rotor and the damper was developed and compared to the measured results. The agreement was good. Author

**N89-22912\*#** Aerojet TechSystems Co., Sacramento, CA.

**INCORPORATING GENERAL RACE AND HOUSING FLEXIBILITY AND DEADBAND IN ROLLING ELEMENT BEARING ANALYSIS**

R. R. DAVIS and C. S. VALLANCE /In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 373-387 Feb. 1989  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

Methods for including the effects of general race and housing compliance and outer race-to-housing deadband (clearance) in rolling element bearing mechanics analysis is presented. It is shown that these effects can cause significant changes in bearing stiffness characteristics, which are of major importance in rotordynamic response of turbomachinery and other rotating systems. Preloading analysis is demonstrated with the finite element/contact mechanics hybrid method applied to a 45 mm angular contact ball bearing. Author

**N89-22913\*#** Texas A&M Univ., College Station. Dept. of Mechanical Engineering.

**EXPERIMENTAL VERIFICATION OF AN EDDY-CURRENT BEARING**

JORGEN L. NIKOLAJSSEN /In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 389-394 Feb. 1989 Sponsored in part by TAMU Turbomachinery Research Consortium  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

A new type of electromagnetic bearing was built and tested. It consists of fixed AC-electromagnets in a star formation surrounding a conducting rotor. The bearing works by repulsion due to eddy-currents induced in the rotor. A single bearing is able to fully support a short rotor. The rotor support is inherently stable in all five degrees of freedom. No feedback control is needed. The bearing is also able to accelerate the rotor up to speed and decelerate the rotor back to standstill. The bearing design and the experimentation to verify its capabilities are described. Author

**N89-22914\*#** Sulzer-Escher Wyss Ltd., Zurich (Switzerland).  
**ROTORDYNAMIC STABILITY PROBLEMS AND SOLUTIONS IN HIGH PRESSURE TURBOCOMPRESSORS**

J. SCHMIED /In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 395-413 Feb. 1989

Avail: NTIS HC A20/MF A01 CSCL 13/9

The stability of a high pressure compressor is investigated with special regard to the self-exciting effects in oil seals and labyrinths. It is shown how to stabilize a rotor in spite of these effects and even increase its stability with increasing pressure. Author

**N89-22915\*#** Bently Rotor Dynamics Research Corp., Minden, NV.

**ROLE OF CIRCUMFERENTIAL FLOW IN THE STABILITY OF FLUID-HANDLING MACHINE ROTORS**

D. E. BENTLY and A. MUSZYNSKA /In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 415-430 Feb. 1989  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

The recent studies of the dynamic stiffness properties of fluid lubricated bearing and seals by the authors have yielded most of the generalized characteristics discussed and used in this paper. They include bearing and seal nonlinear fluid film properties associated with stiffness, damping, and fluid average circumferential velocity ratio. Analytical relationships yield the rotor system's dynamic stiffness characteristics. This paper shows the combination of these data to provide the fluid-induced rotor stability equations. Author

**N89-22916\*#** Aerojet TechSystems Co., Sacramento, CA.

**ENHANCED ROTOR MODELING TAILORED FOR RUB DYNAMIC STABILITY ANALYSIS AND SIMULATION**

R. R. DAVIS /In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 431-444 Feb. 1989  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

New methods are presented that allow straightforward application of complex nonlinearities to finite element based rotor dynamic analyses. The key features are: (1) the methods can be implemented with existing finite element or dynamic simulation programs, (2) formulation is general for simple application to a wide range of problems, and (3) implementation is simplified because nonlinear aspects are separated from the linear part of the model. The new techniques are illustrated with examples of inertial nonlinearity and torquewhirl which can be important in rubbing turbomachinery. The sample analyses provide new understanding of these nonlinearities which are discussed. Author

**N89-22917\*#** Mitsubishi Heavy-Industries Ltd., Takasago (Japan).

**HIGH STABILITY DESIGN FOR NEW CENTRIFUGAL COMPRESSOR**

H. KANKI, K. KATAYAMA, S. MORII, Y. MOURI, S. UMEMURA, U. OZAWA, and T. ODA /In NASA, Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 445-459 Feb. 1989  
 Avail: NTIS HC A20/MF A01 CSCL 13/9

It is essential that high-performance centrifugal compressors be free of subsynchronous vibrations. A new high-performance centrifugal compressor has been developed by applying the latest rotordynamics knowledge and design techniques: (1) To improve the system damping, a specially designed oil film seal was developed. This seal attained a damping ratio three times that of the conventional design. The oil film seal contains a special damper ring in the seal cartridge. (2) To reduce the destabilizing effect of the labyrinth seal, a special swirl canceler (anti-swirl nozzle) was applied to the balance piston seal. (3) To confirm the system damping margin, the dynamic simulation rotor model test and the full load test applied the vibration exciting test in actual load conditions. Author

## 12 ENGINEERING

**N89-22925\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

### **TRANSMISSION OVERHAUL AND REPLACEMENT PREDICTIONS USING WEIBULL AND RENEWEL THEORY**

M. SAVAGE and D. G. LEWICKI (Army Aviation Systems Command, Cleveland, OH.) 1989 12 p Presented at the 25th Joint Propulsion Conference, Monterey, CA, 10-12 Jul. 1989; cosponsored by the AIAA, ASME, SAE and ASEE (Contract DA PROJ. 1L1-62209-A-47-A) (NASA-TM-102022; E-4756; NAS 1.15:102022; AVSCOM-TR-89-C-007; AIAA-89-2919) Avail: NTIS HC A03/MF A01 CSCL 13/9

A method to estimate the frequency of transmission overhauls is presented. This method is based on the two-parameter Weibull statistical distribution for component life. A second method is presented to estimate the number of replacement components needed to support the transmission overhaul pattern. The second method is based on renewal theory. Confidence statistics are applied with both methods to improve the statistical estimate of sample behavior. A transmission example is also presented to illustrate the use of the methods. Transmission overhaul frequency and component replacement calculations are included in the example. Author

**N89-22939\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

### **STRUCTURAL DYNAMICS BRANCH RESEARCH AND ACCOMPLISHMENTS FOR FY 1988**

Apr. 1989 48 p (NASA-TM-101406; E-4498; NAS 1.15:101406) Avail: NTIS HC A03/MF A01 CSCL 20/11

Fiscal year 1988 research highlights from the Structural Dynamics Branch at NASA Lewis Research Center are described. Highlights from the branch's major work areas -- aeroelasticity, vibration control, dynamic systems, and computational structural methods -- are included as well as a complete listing of the FY 88 branch publications. Author

## 13

## GEOSCIENCES

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

**A89-39647\*** San Jose State Univ., CA.

### **THE USE OF DFDR INFORMATION IN THE ANALYSIS OF A TURBULENCE INCIDENT OVER GREENLAND**

PETER F. LESTER, ORHAN SEN (San Jose State University, CA), and R. E. BACH, JR. (NASA, Ames Research Center, Moffett Field, CA) Monthly Weather Review (ISSN 0027-0644), vol. 117, May 1989, p. 1103-1107. refs (Contract NCC2-315)

Digital flight data recorder (DFDR) tapes from commercial aircraft can provide useful information about the mesoscale environment of severe turbulence incidents. Air motion computations from these data and their errors are briefly described. An example of mesoscale meteorological information available from DFDR tapes is presented for a case of turbulence in mountain waves over the Greenland icecap. Author

**N89-22287** Texas Univ., Arlington.

### **MICROBURST SIMULATION VIA VORTEX-RING AND TURBULENT JET MODELS Ph.D. Thesis**

TUNG WAN 1988 123 p Avail: Univ. Microfilms Order No. DA8901077

Microbursts, suggested as primary causes of many aircraft fatal crashes, are studied. A microburst, or low-level intense wind shear, is generated by a thunderstorm or a small rain cloud, and

presents hazardous conditions for aircraft during takeoff and landing maneuvers. Recently released data show that a microburst resembles a transient vortex ring. Three microburst models were constructed. First, the turbulent jet model encompasses a free jet at high altitude and a wall jet near the ground surface. Second, the vortex ring model is a combination of a primary and an image vortex ring, with an inviscid-viscous interaction at the central axial and surface regions. An unsteady version of this model is also provided by solving the trajectory equation with the Direct Formal Integration (DFI) method or with the Runge-Kutta method. Third and finally, the complete unsteady microburst model equations (conservation of mass, momentum, and energy), or what has been referred to as the Navier-Stokes model formulation, are solved by the successive over relaxation method. Results show that the microburst can be simulated accurately by impulsive turbulent jet at high altitude and a transient vortex ring in mid-air and near the ground surface. In addition to improved understanding of the physical nature of microbursts, the models presented can also be used for flight simulation and the pilot training purposes. Dissert. Abstr.

**N89-23048\*#** National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propulsion Lab.

### **HAZARD INDEX CALCULATION FOR 31 MAY 1984 MICROBURST AT ERIE, COLORADO Final Report**

R. A. KROPFLI Oct. 1988 54 p Sponsored by NASA, Langley Research Center, Hampton, VA (NASA-CR-184968; NAS 1.26:184968; PB89-127831; NOAA-TM-ERL-WPL-155) Avail: NTIS HC A04/MF A01 CSCL 04/2

Two x-band Doppler radars, operated by NOAA, were used to collect high resolution data within a small, benign looking microburst during the PHOENIX II boundary layer experiment. The lowest 2.5 km of the microbursts was observed throughout its development and dissipation over a 15 minute period. These observations presented an excellent opportunity to compute a quantitative threat to a hypothetical aircraft whose flight track would carry it through the microburst. The hazard index is based on the kinetic energy loss to the aircraft that would be produced by the microburst; it is a function of the vertical air motion, horizontal spatial derivatives of the wind field, and the assumed aircraft air speed and direction. Indices were computed and plotted for all 8 volume scans and peak values were observed to be sufficiently high to present a significant hazard to an aircraft. Author

## 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.

**A89-36351#**

### **SOME MATHEMATICAL CONSIDERATIONS ON VIEWS OF THE GROUND SURFACE IN FLIGHT**

YOSHINORI TAKEUCHI Japan Air Self Defense Force, Aeromedical Laboratory, Reports (ISSN 0023-2858), vol. 29, June 1988, p. 61-69. In Japanese, with abstract in English. refs

A mathematical study of the view of the ground surface from an aircraft is presented. A three-dimensional coordinate system is given and definitions are developed for the perspective projection coordinates of a texture element on the ground, the visual angle of a ground element, the angular velocity of a ground element, and the horizontal distance of a ground element from the aircraft. Examples are provided using the definitions to study aircraft takeoff and landing and helicopter flight. Also, consideration is given to the use of motion parallax and optical flowing for altitude and speed estimates. R.B.



A89-36943#

**MEASURES OF MODAL CONTROLLABILITY AND OBSERVABILITY FOR FIRST- AND SECOND-ORDER LINEAR SYSTEMS**

A. M. A. HAMDAN and A. H. NAYFEH (Virginia Polytechnic Institute and State University, Blacksburg) (Dynamics and control of large structures; Proceedings of the Sixth VPI&SU/AIAA Symposium, Blacksburg, VA, June 29-July 1, 1987, p. 453-475) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, May-June 1989, p. 421-428. Previously cited in issue 02, p. 203, Accession no. A89-11680. refs  
(Contract F49620-87-C-0088)

A89-36990#

**SELECTION OF WEIGHTING MATRICES FOR LINEAR OPTIMAL REGULATOR**

JIANHUA ZHAO and ZICAI WANG (Harbin Institute of Technology, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 9, Nov. 1988, p. A534-A539. In Chinese, with abstract in English. refs

A new method is presented for selecting weighting matrices of a linear quadratic regulator. By using the new method, the linear regulator has short setting time, small overshoot, and good robustness; the presented recurrence algorithm is simple. The method is successfully applied to the design of an aircraft control system. Examples show the advantages of the method. Author

A89-37014#

**GDPP - A PRACTICAL CAD SOFTWARE PACKAGE**

XIAORONG CHEN, XIAOMU YE, and YUN HUANG (Chendu Aviation Co., People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 9, Dec. 1988, p. B621-B624. In Chinese, with abstract in English. refs

Rapid and optimum design of aircraft configuration models is examined, and two software packages for engineering analysis of configuration models are introduced. The GDPP software package has been running for two years and good results have been obtained using it in practical design. Together with its common data base, GDPP has become a practical CAD software package shared by many specialist groups. C.D.

A89-37234\* Notre Dame Univ., IN.

**NEURAL COMPUTING FOR NUMERIC-TO-SYMBOLIC CONVERSION IN CONTROL SYSTEMS**

KEVIN M. PASSINO, MICHAEL A. SARTORI, and PANOS J. ANTSAKLIS (Notre Dame, University, IN) IEEE Control Systems Magazine (ISSN 0272-1708), vol. 9, April 1989, p. 44-52. refs  
(Contract JPL-957856; DAAL03-88-K-0144)

A type of neural network, the multilayer perceptron, is used to classify numeric data and assign appropriate symbols to various classes. This numeric-to-symbolic conversion results in a type of information extraction, which is similar to what is called data reduction in pattern recognition. The use of the neural network as a numeric-to-symbolic converter is introduced, its application in autonomous control is discussed, and several applications are studied. The perceptron is used as a numeric-to-symbolic converter for a discrete-event system controller supervising a continuous variable dynamic system. It is also shown how the perceptron can implement fault trees, which provide useful information (alarms) in a biological system and information for failure diagnosis and control purposes in an aircraft example. I.E.

A89-38511

**ADAPTIVE AUTOMATIC CONTROL SYSTEMS FOR FLIGHT VEHICLES [ADAPTIVNYE SISTEMY AVTOMATICHESKOGO UPRAVLENIYA LETATEL'NYMI APPARATAMI]**

NIKOLAI I. SOKOLOV, VLADISLAV I. RUTKOVSKII, and NIKITA B. SUDZILOVSKII Moscow, Izdatel'stvo Mashinostroenie, 1988, 208 p. In Russian. refs

The main principles of the architectural design and performance analysis of fast-response search-free adaptive control systems for flight vehicles are presented. Various methods for the identification of the variables of the controlled process within a nonstationary

system are discussed. Attention is also given to the principles of the design of search-free adaptive systems for the control of systems with slowly variable parameters. V.L.

A89-38512

**SYNTHESIS OF SYSTEMS FOR THE MOTION CONTROL OF NONSTATIONARY OBJECTS [SINTEZ SISTEM UPRAVLENIYA DVIZHENIEM NESTATSIONARNYKH OB'EKTOV]**

GENNADI I. VANIURIKHIN and VIKTOR M. IVANOV Moscow, Izdatel'stvo Mashinostroenie, 1988, 168 p. In Russian. refs

The works presents methods for the synthesis and analysis of optimal control systems for flight vehicles which are characterized by substantial nonstationarity and random scatter of parameters. Attention is given to continuous and discrete models for linear and nonlinear problems of optimal control, including those with adaptation and learning elements. Examples, algorithms, and programs are presented which make it possible to assess the applicability of the proposed methods to the control of nonstationary and unstable objects. B.J.

A89-39777

**INPUT SIGNAL SELECTION IN THE IDENTIFICATION OF LINEAR CONTINUOUS DYNAMIC SYSTEMS FROM DISCRETE OBSERVATIONS [VYBOR VKHODNYKH SIGNALOV PRI IDENTIFIKATSII LINEINYKH NEPRERYVNYKH DINAMICHESKIKH SISTEM PO DISKRETNYM NABLIUDENIYAM]**

V. N. OVCHARENKO Avtomatika i Telemekhanika (ISSN 0005-2310), Feb. 1989, p. 87-95. In Russian. refs

The problem of estimating the parameters of linear continuous dynamic systems from discrete observations is treated simultaneously with the problem of selecting the input signal. The method of selecting the input signal proposed here makes it possible to obtain a control law that ensures the specified level of identification of the unknown parameters. The method is illustrated by a numerical example from aircraft flight dynamics. V.L.

N89-22366# General Electric Co., Cincinnati, OH. Aircraft Engines.

**INTERFACE 2: ADVANCED DIAGNOSTIC SOFTWARE Final Report, Jul. 1985 - Jul. 1988**

LEE R. LAPIERRE, PETER A. COSTEN, DAVID L. DOEL, and RASIK P. SHAH 14 Dec. 1988 168 p

(Contract F33657-85-C-2131)

(AD-A204527; AFWAL-TR-88-2096) Avail: NTIS HC A08/MF A01 CSCL 01/3

JET-X is an expert system for the diagnosis and maintenance of the TF34-100 jet engine as installed on the USAF A-10A aircraft. JET-X uses input supplied by the TEMS (turbine engine monitoring system) installed on the airplane and, in addition, uses data retrieved from the CEMS (comprehensive engine management system) data base that is part of the ground computer support system. Both of these monitoring systems generate alarms which are the starting points for JET-X analyses. As part of an earlier contract, diagnostic troubleshooting procedures had been established for resolving each of these alarms. These diagnostic procedures have been embedded into the JET-X system, generally in a much expanded form. In addition, a number of help facilities have been developed for JET-X to assist the novice diagnostician. JET-X has been designed to be both a flight-line diagnostic tool and a training aid. Although the system is not complete at this point, a first good prototype has been developed, and some field experience has been gained in order to evaluate the system and to guide future enhancements. This report describes the development of the JET-X system, its features and limitations, results of the field trial, and gives conclusions and recommendations for future work. GRA

N89-23213# Swedish Defence Research Establishment, Linköping. Dept. of Information Technology.

**FUSION OF MULTISENSOR DATA: A SUMMARY OF THE JASMIN PROJECT**



## 16 PHYSICS

NILS OLANDER and BENGT ROSEN Jun. 1988 23 p In SWEDEN; ENGLISH summary (FOA-C-30498-3.3; ISSN-0347-3708; ETN-89-94126) Avail: NTIS HC A03/MF A01; Swedish Defence Research Establishment, P.O. Box 1165, S-581 11 Linköping, Sweden, 50 Swedish crowns

The Jasmin project studied how knowledge based techniques could be used to combine symbolic data from different sensors. The application in mind concerned reconnaissance data from an aircraft. The system can also deal with geographical items. To keep the effectiveness of the sensors, various types of automation shall be necessary to interpret the data. ESA

## 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.

**A89-36216\*#** Lockheed Aeronautical Systems Co., Marietta, GA.

#### **INSTALLED PROPFAN (SR-7L) FAR-FIELD NOISE CHARACTERISTICS**

N. N. REDDY, H. W. BARTEL, and M. SALIKUDDIN (Lockheed Aeronautical Systems Co., Marietta, GA) AIAA, Aeroacoustics Conference, 12th, San Antonio, TX, Apr. 10-12, 1989. 7 p. (Contract NAS3-24339) (AIAA PAPER 89-1056)

Far-field noise characteristics of the SR-7L single-rotor propfan were obtained from the Propfan Test Assessment (PTA) aircraft flight tests. The aircraft was flown at low altitudes (about 310m) above the ground at a constant speed of about 92 m/sec. The acoustic data were acquired with an array of ground-flush microphones positioned on both sides of the flight path. Propfan-generated noise levels were extracted from the total aircraft noise, and these data were then used to study the far-field noise characteristics. The directivities at the polar and azimuthal planes, and the variations of the blade-order tone levels with propfan power and blade tip Mach number were derived. The effect of inflow angle was studied by changing the nacelle tilt angle. The levels and the directivity were very sensitive to the nacelle tilt angle (i.e., inflow angle). The noise levels in the aft quadrant were found to be higher than in the forward quadrant. Also, the noise levels on the starboard side of the aircraft were found to be higher than on the port side. The noise levels increase with propfan power and rotational speed. Author

**A89-36217\*#** Lockheed Aeronautical Systems Co., Marietta, GA.

#### **LATERAL NOISE ATTENUATION OF THE ADVANCED PROPELLER OF THE PROPFAN TEST ASSESSMENT AIRCRAFT**

F. W. CHAMBERS, N. N. REDDY, and H. W. BARTEL (Lockheed Aeronautical Systems Co., Marietta, GA) AIAA, Aeroacoustics Conference, 12th, San Antonio, TX, Apr. 10-12, 1989. 9 p. refs (Contract NAS3-24339) (AIAA PAPER 89-1057)

Lateral noise attenuation characteristics of the advanced propeller are determined using the flight test results of the testbed aircraft, Propfan Test Assessment (PTA), with a single, large-scale propfan. The acoustic data were obtained with an array of ground-mounted microphones positioned at distances up to 2.47 km (8100 feet) to the side of the flight path. The aircraft was flown at a Mach number of 0.31 for a variety of operating conditions. The lateral noise attenuation in a frequency range containing the blade passage frequency of the propeller was found to have positive magnitudes on the propfan side and negative magnitudes on the opposite side. The measured attenuation exhibits a strong

dependence upon the elevation angle. The results also display a clear dependence upon the angle at which the propeller and nacelle are mounted on the wing (inflow angle). Author

**A89-36218\*#** Lockheed Aeronautical Systems Co., Marietta, GA.

#### **FLUCTUATING PRESSURES ON WING SURFACES IN THE SLIPSTREAM OF A SINGLE-ROTOR PROPFAN**

G. SWIFT and H. W. BARTEL (Lockheed Aeronautical Systems Co., Marietta, GA) AIAA, Aeroacoustics Conference, 12th, San Antonio, TX, Apr. 10-12, 1989. 12 p. (Contract NAS3-24339) (AIAA PAPER 89-1058)

Measurements of the fluctuating pressure levels (FPLs) induced on a Propfan Test Assessment wing by the SR-7L propfan slipstream within the airplane flight envelope were obtained as a function of propfan operating conditions. It is shown that FPLs were high over most of the flight envelope, and that the spectra were dominated by the propfan first-order blade passage frequency tone. The highest FPLs were found at the lowest aircraft test altitudes and Mach numbers and for propfan conditions of lowest rotational tip speed and highest power. R.R.

**A89-36219#**

#### **REVIEW OF SONIC BOOM THEORY**

KENNETH J. PLOTKIN (Wyle Laboratories, Arlington, VA) AIAA, Aeroacoustics Conference, 12th, San Antonio, TX, Apr. 10-12, 1989. 38 p. refs (AIAA PAPER 89-1105)

A review is presented of sonic boom theory, covering three viewpoints: historical perspective, an exposition of established boom theory and special phenomena, and the theoretical needs of current sonic boom problems. The review is intended to serve as a tutorial for the nonspecialist as well as a review of the current state-of-the-art and open issues. The greatest interest in sonic boom was associated with SST projects of the 1960s, and much of sonic boom theory has been shaped by that influence. Major elements of sonic boom analysis have been well established into what may be called standard theory. Current sonic boom problems require elements beyond standard theory, including the influence of hypersonic speeds, better integration of sonic boom analysis into the aircraft design process, and a more complete understanding of focal zones. Author

**A89-36220\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

#### **A PREDICTION OF HIGH-SPEED ROTOR NOISE**

TIMOTHY W. PURCELL (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) AIAA, Aeroacoustics Conference, 12th, San Antonio, TX, Apr. 10-12, 1989. 12 p. refs (AIAA PAPER 89-1132)

A combined computational (CFD) and integral approach solves the acoustic pressure fields of two high-speed helicopter rotors. A CFD code supplies boundary data to a non-linear type of Kirchhoff integral formulation to find the far-field pressures. Direct calculations of pressures are given by the CFD code up to the sonic cylinder where the Kirchhoff method takes over. This paper shows predictions and measurements of High-Speed Impulsive (HSI) noise in hover for two different rotor geometries. One rotor has a conventional rectangular planform, while the other rotor is highly swept and tapered. The swept rotor analysis forms the majority of this paper. Test data from both rotors are shown and compared with predictions for a range of tip Mach numbers from .85 to .95 (including delocalization). The correlation with the near-field pressures from the straight bladed experiment is excellent and good to excellent correlation is seen for the far-field pressures from both experiments. Author

**A89-36221#**

#### **PREDICTION OF COUNTER-ROTATION PROPELLER NOISE**

A. B. PARRY (Strathclyde, University, Glasgow, Scotland) and D. G. CRIGHTON (Cambridge University, England) AIAA,

Aeroacoustics Conference, 12th, San Antonio, TX, Apr. 10-12, 1989. 27 p. refs  
(AIAA PAPER 89-1141)

Using asymptotic techniques the complex expressions for the sound radiated from a counter-rotation propeller are reduced to provide simple results which do not involve numerical integration or the evaluation of Bessel functions but retain the main parametric dependences. The unsteady loadings on the blades, needed as input to the radiation formulas, are also evaluated asymptotically. Here consideration is given to the effects of both viscous wakes and bound potential fields, the latter resulting in unsteady loads on both blade rows. Comparisons are made with measurements taken from fly-over tests on the Fairey Gannet aircraft. Excellent agreement is obtained between the asymptotic theory and the data in terms of both absolute level and directivity. In addition, for some interaction tones, it is shown that the potential field interactions are much stronger than the viscous wake interactions. Author

**A89-37652#**

**ASYMPTOTIC ANALYSIS OF THE TRANSONIC REGION OF A HIGH-SPEED PROPELLER**

INGEMAR A. A. LINDBLAD (Flygtekniska Forsoksanstalten, Bromma, Sweden) AIAA, Aeroacoustics Conference, 12th, San Antonio, TX, Apr. 10-12, 1989. 15 p. refs  
(AIAA PAPER 89-1077)

A model problem with a moderately swept symmetric rotor blade is considered. It is shown that, for realistic parameter values, the general features of the transonic region of a high-speed propeller can be described by a linear equation of the lowest order. The rotating transonic problem is singular in character; this permits the existence of regions of high disturbance levels in the interior of the flow where nonlinear terms are important. K.K.

**A89-39195\*# Sverdrup Technology, Inc., Cleveland, OH. HIGH-SPEED PROPELLER PERFORMANCE AND NOISE PREDICTIONS AT TAKEOFF/LANDING CONDITIONS**

M. NALLASAMY (Sverdrup Technology, Inc., Cleveland, OH), R. P. WOODWARD, and J. F. GROENEWEG (NASA, Lewis Research Center, Cleveland, OH) Journal of Aircraft (ISSN 0021-8669), vol. 26, June 1989, p. 563-569. Previously cited in issue 07, p. 1088, Accession no. A88-22193. refs

**A89-39506**

**A NOTE ON SOUND FROM THE INTERRUPTION OF A CYLINDRICAL FLOW BY A SEMI-INFINITE AEROFOIL OF SUBSONIC SPEED**

Y. P. GUO (Cambridge, University, England) Journal of Sound and Vibration (ISSN 0022-460X), vol. 128, Jan. 22, 1989, p. 275-286. refs

An analysis is presented of the sound radiated from the interruption of a steady cylindrical flow by a semiinfinite aerofoil that moves subsonically in the plane perpendicular to the flow. The scattered sound energy is found explicitly as a function of the aerofoil Mach number, which is different from the case of supersonic aerofoils where the scattered energy is independent of the speed at which the aerofoil moves. It is shown that the radiated acoustic energy increases from zero to the value for supersonic aerofoils as the aerofoil Mach number increases from zero to unity. The reduction of sound energy at low Mach numbers is shown to be the result of the existence of a second-order suction force at the sharp leading edge which, in the case of subsonic aerofoils, does negative work during the interruption process, and hence causes an energy flow into the leading edge. The energy absorbed by the leading edge is shown to exactly balance the difference between the loss of the kinetic energy of the steady flow and the acoustic energy radiated to infinity. Author

**A89-39514**

**ON SOUND GENERATED WHEN A VORTEX IS CHOPPED BY A CIRCULAR AIRFOIL**

M. S. HOWE (BBN Laboratories, Inc., Cambridge, MA) Journal of Sound and Vibration (ISSN 0022-460X), vol. 128, Feb. 8, 1989, p. 487-503. Research supported by the U.S. Navy. refs

An analysis is made of the sound produced when a rectilinear vortex is cut by a circular airfoil translating at zero angle of attack. The flow Mach number is sufficiently small that the airfoil is acoustically compact, and detailed predictions are given for a vortex whose axis is nearly normal to the plane of the airfoil. The two principal components of the radiation are associated with axial and azimuthal distributions of vorticity, the latter being non-zero when there exists a finite axial velocity defect in the core of the vortex. Comparison is made with similar predictions for a two-dimensional airfoil of infinite span, and the general effects of arbitrary, finite span are briefly discussed. Author

**A89-39515**

**AN APPROXIMATE METHOD FOR SONIC FATIGUE ANALYSIS OF PLATES AND SHELLS**

R. D. BLEVINS (Rohr Industries, Inc., San Diego, CA) Journal of Sound and Vibration (ISSN 0022-460X), vol. 129, Feb. 22, 1989, p. 51-71. refs

Approximate analytical methods are developed for determining the response of plate and shell structures to coherent sound fields. The methods are based on separating the spatial and temporal aspects of the problem and then developing approximations for both. Direct comparison is made with experimental data. Author

**A89-39588**

**SCATTERING FROM THREE-DIMENSIONAL CRACKS**

ALLEN K. DOMINEK, HARRY T. SHAMANSKY, and NAN WANG (Ohio State University, Columbus) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. 37, May 1989, p. 586-591. Research supported by Rockwell International Corp. refs

Scattering from three-dimensional cracks is analyzed and measured. The crack geometry is modeled as a rectangular groove in a perfectly conducting surface. The groove forming the crack may be terminated with an open aperture creating a slit in the conducting surface or with an impedance boundary creating a trough. The scattered fields from a crack are analyzed with two types of scattering mechanisms: a component directly related to the scattered fields from a two-dimensional crack, and a traveling-wave component. I.E.

**A89-39816**

**MOTION OF A THREE-DEGREES-OF-FREEDOM GYROSCOPE WITH A DYNAMICALLY UNBALANCED ROTOR IN THE CASE OF CONTACT BETWEEN THE INTERNAL FRAME AND AN ELASTIC LIMITER [DVIZHENIE TREKHSTEPENNOGO GIROSKOPA S DINAMICHESKI NESBALANSIROVANNYM ROTOROM PRI KONTAKTE VNUTRENNEI RAMKI S UPRUGIM OGRANICHITELEM]**

A. D. VAL'KO, V. A. GARANKIN, V. A. ISAEV, and S. E. KUKHTEVICH Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), Mar.-Apr. 1989, p. 25-29. In Russian.

**A89-39819**

**A METHOD FOR DETERMINING THE INERTIA TENSOR OF A CRAFT IN FLIGHT [OB ODNOM SPOSIBE OPREDELENIIA TENZORA INERTSII APPARATA V POLETE]**

K. B. ALEKSEEV and N. V. NIKOLAEV Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), Mar.-Apr. 1989, p. 60, 61. In Russian. refs

Knowledge of the inertia tensor is essential for controlling the turning maneuvers of flight vehicles. Here, an analytical-experimental method for determining the inertia tensor is proposed which is based on measuring the angular velocity of the vehicle and the counteraction of the jet engines. In contrast to other methods, the approach proposed here does not require that the initial kinetic moment of the flight vehicle equal zero. V.L.

## 16 PHYSICS

**N89-22445#** Max-Planck-Institut fuer Stroemungsforschung, Goettingen (Germany, F.R.).

**THE AEROACOUSTICS OF THE INTERACTION BETWEEN VORTICES AND BODIES IN A TRANSONIC FLOW Thesis [ZUR AEROAKUSTIK DER WECHSELWIRKUNG VON WIRBELN MIT TRANSSONISCH UMSTROEMTEN KOERPERN]**  
KARSTEN LOEHR Feb. 1988 66 p In GERMAN (MPIS-3/1988; ISSN-0436-1199; ETN-89-93811) Avail: NTIS HC A04/MF A01; Max-Planck Inst. fuer Stroemungsforschung, Boettinger Strasse 6-8, 3400 Goettingen, Fed. Republic of Germany, DM 21

Vortex production in the wake of rectangular cylinders, as well as the interaction between vortices and aerodynamic profiles in transonic channel flow were investigated. The vortices are improved if the vortex separation is resonant with the transversal fundamental, acoustic mode of the channel. Using the superimposed acoustic field the vortex separation was synchronized and the separation process stimulated. The synchronization improves the two-dimensionality of the observed flow and provides a good reproducibility of the phenomena. During the interaction with profiles the following accumulating waves were observed the formation of a high-pressure region from the stagnation point upstream of the sound wave, and the formation of shocks in the high-speed region between vortex and fixed surface which leave the profile upstream as shock waves. ESA

## 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.

**A89-38876**

#### **THE CHICAGO CONVENTION - ARTICLE 33 AND THE SFAR 40 EPISODE**

STEPHEN D. MCCREARY Journal of Air Law and Commerce (ISSN 0021-8642), vol. 54, Spring 1989, p. 721-755. refs

Two court cases concerning Special Federal Aviation Regulation (SFAR) No. 40 (1979), which prevented the operation of foreign registered DC-10s in the U.S., are examined. The reciprocal recognition rule of Article 33 of the 1944 Chicago Convention and the minimum airworthiness standards defined in Annex 8 of the Chicago Convention are analyzed. The events leading up to SFAR No. 40, and the cases British Calendonian Airways Ltd. v. Bond and Balair Ltd. v. the United States are discussed. Consideration is given to policy issues that arise regarding the mutual recognition rule when the U.S. is in fundamental disagreement over a safety issue. R.B.

**A89-38877**

#### **PRIVATIZATION OF THE AIR TRAFFIC CONTROL SYSTEM - ITS RATIONALE, IMPLEMENTATION AND IMPLICATIONS**

DAVID DUNCAN Journal of Air Law and Commerce (ISSN 0021-8642), vol. 54, Spring 1989, p. 795-824. refs

The possible privatization of the air traffic control system in the U.S. is examined. A review of attempts to privatize federal government activities during the 1980s is presented. Organized constituencies opposed to privatization and strategies of privatization proponents are discussed. Arguments are given for and against privatization of the air traffic control system and previous efforts to privatize the system are considered, including the original private system, the proposal of Poole (1982) and the recommendations of the President's Commission on Privatization (1988) regarding the air traffic control system. R.B.

**N89-23361#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

#### **CALENDAR OF SELECTED AERONAUTICAL AND SPACE MEETINGS**

Jun. 1988 144 p In ENGLISH and FRENCH (AGARD-CAL-88/2; ISBN-92-835-0470-4) Avail: NTIS HC A07/MF A01

A schedule is presented of some aeronautical and space meetings and workshops which are of interest to the aforementioned community. This calendar is published every six months, in June and December of each year. Details concerning the meetings listed in this particular issue of the calendar were obtained from National and International Organizations which sponsor aeronautical and space meetings and from other sources such as journals and periodicals. E.R.

## 19

### GENERAL

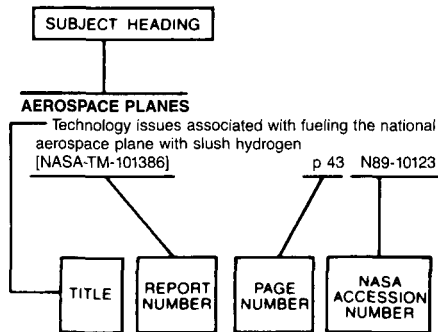
**N89-23403#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

#### **AGARD HIGHLIGHTS 88/2**

Sep. 1988 39 p  
Avail: NTIS HC A03/MF A01

Topics addressed include: a review of fluid dynamics; military pilot ergonomics; and future air operations. The award of the von Karman Medal for 1988 is presented. B.G.

## 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.

## A

### A-320 AIRCRAFT

Color displays can reduce workload p 532 A89-38949

### ACCELERATION (PHYSICS)

On the accelerating airflow problem in the test section of a transonic wind tunnel p 541 A89-39477

Acceleration test for aircraft low-pass filter [PB89-116263] p 557 N89-22807

### ACCELEROMETERS

The optical bidirectional accelerometer --- for microgravity experiments p 553 A89-36966

### ACCIDENT PREVENTION

Safe skies for tomorrow: Aviation safety in a competitive environment [PB89-114318] p 524 N89-22591

### ACOUSTIC ATTENUATION

Lateral noise attenuation of the advanced propeller of the propfan test assessment aircraft [AIAA PAPER 89-1057] p 564 A89-36217

### ACOUSTIC EMISSION

Acoustic emission testing the F-111 p 541 A89-39008

### ACOUSTIC EXCITATION

Separation control on an airfoil by periodic forcing p 509 A89-36922

### ACOUSTIC FATIGUE

An approximate method for sonic fatigue analysis of plates and shells p 565 A89-39515

### ACOUSTIC PROPAGATION

Lateral noise attenuation of the advanced propeller of the propfan test assessment aircraft [AIAA PAPER 89-1057] p 564 A89-36217

### ACRYLIC RESINS

Environmentally induced discontinuities in transparent polymers [AD-A205483] p 550 N89-22768

### ACTIVE CONTROL

Vibrations in aerospace structures - Prediction, prevention and control [ONERA, TP NO. 1989-9] p 553 A89-37631  
Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise p 529 A89-39509

A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510

Active vibration control for flexible rotor by optimal direct-output feedback control [NASA-TM-101972] p 537 N89-22605

### ACTUATORS

Calculation of the principal parameters of the actuating mechanisms of aircraft slave drives --- Russian book p 555 A89-38500

Dynamics and control of truss structures with extending members p 523 N89-21778

### ADAPTIVE CONTROL

Adaptive automatic control systems for flight vehicles --- Russian book p 563 A89-38511

Synthesis of systems for the motion control of nonstationary objects --- Russian book p 563 A89-38512

Multivariable control law design for the Control Reconfigurable Combat Aircraft (CRCA) [AD-A202697] p 540 N89-21803

### AEROACOUSTICS

Installed propfan (SR-7L) far-field noise characteristics [AIAA PAPER 89-1056] p 564 A89-36216

Fluctuating pressures on wing surfaces in the slipstream of a single-rotor propfan [AIAA PAPER 89-1058] p 564 A89-36218

Review of sonic boom theory [AIAA PAPER 89-1105] p 564 A89-36219

A prediction of high-speed rotor noise [AIAA PAPER 89-1132] p 564 A89-36220

Prediction of counter-rotation propeller noise [AIAA PAPER 89-1141] p 564 A89-36221

Asymptotic analysis of the transonic region of a high-speed propeller [AIAA PAPER 89-1077] p 565 A89-37652

A note on sound from the interruption of a cylindrical flow by a semi-infinite aerofoil of subsonic speed p 565 A89-39506

The aeroacoustics of the interaction between vortices and bodies in a transonic flow [MPIS-3/1988] p 566 N89-22445

### AERODYNAMIC CHARACTERISTICS

A method for shock-free wing design p 509 A89-36985

Transfinite interpolation method for 3-D grid generations p 509 A89-36986

Aerodynamic characteristics of arbitrarily rotating bodies in a variable-density gas p 509 A89-37355

A numerical method for the analysis of a flight vehicle with a solid fuselage p 509 A89-37460

Flutter of a wing with an aileron in transonic flow p 539 A89-37461

The effects of vortex breakdown on the aerodynamic properties of a wing and the engineering predicting method p 510 A89-37780

Mach number effects on high-angles-of-attack aerodynamic characteristics of a cone-cylinder with various nose shapes p 511 A89-38122

Consideration of the effect of surface roughness on regime coefficients in local interaction theory p 512 A89-38432

Fundamentals of aviation (4th revised and enlarged edition) --- Russian book p 507 A89-38514

More helicopter aerodynamics --- Book p 513 A89-38578

The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body p 516 N89-21765

A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance [AD-A204856] p 531 N89-21793

Development of a streamline method [AD-A205146] p 557 N89-22078

Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds [AD-A205206] p 519 N89-22575

### AERODYNAMIC COEFFICIENTS

Dependence of regime coefficients on regime parameters in local interaction theory p 512 A89-38435

Effect of spatial wind gradients on airplane aerodynamics p 514 A89-39190

### AERODYNAMIC CONFIGURATIONS

Experimental investigation of applicability of waverider configuration to hypersonic transport and aerospace-plane p 511 A89-38123

### AERODYNAMIC FORCES

Coupling factor method for studying elastic motion of flight vehicles p 544 A89-37004

A way for upgrading the accuracy of force measurement p 553 A89-37011

Aerodynamics of engine-airframe interaction [NASA-CR-184824] p 517 N89-21769

Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 N89-22586

### AERODYNAMIC HEAT TRANSFER

Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating [AD-A205077] p 518 N89-21775

Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800

Control of embedded vortices using wall jets [AD-A202606] p 558 N89-22835

### AERODYNAMIC HEATING

Experimental investigation of aerodynamic heating by flow through control surface gaps p 510 A89-37785

Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating [AD-A205077] p 518 N89-21775

Transition to turbulence in laminar hypersonic flow p 522 N89-22830

### AERODYNAMIC LOADS

A computational method of aerodynamics for subsonic, fully unsteady wings at high angles of attack in time-domain p 515 A89-39462

Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds [FFA-TN-1988-44] p 532 N89-22602

### AERODYNAMIC NOISE

A note on sound from the interruption of a cylindrical flow by a semi-infinite aerofoil of subsonic speed p 565 A89-39506

### AERODYNAMIC STABILITY

Ground and air resonance of bearingless rotors in hover and forward flight p 529 N89-21786

The effect of exhaust plume/afterbody on installed scramjet performance p 536 N89-21797

Aerodynamic detuning of a loaded airfoil cascade in an incompressible flow by a locally analytical method p 521 N89-22588

### AERODYNAMIC STALLING

Wakes of four complex bodies of revolution at zero angle of attack p 508 A89-36907

J85 surge transient simulation p 536 A89-39044

Stall flutter of graphite/epoxy wings with bending-torsion coupling [AD-A203077] p 540 N89-21804

### AERODYNAMICS

Extension and application of flux-vector splitting to calculations on dynamic meshes p 508 A89-36901

Aerodynamic device for generating mono-disperse fuel droplets p 554 A89-37878

Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764

Aeroballistic Research Facility Data Analysis System (ARFAS) [AD-A204308] p 542 N89-21810

Visting China's aerodynamics research and development center [AD-A203980] p 543 N89-22615

A vortex panel analysis of circular-arc bluff-bodies in unsteady flow [DE89-007141] p 558 N89-22845

## AEROELASTICITY

- Integrated approach for active coupling of structures and fluids p 552 A89-36917
- Vibrations in aerospace structures - Prediction, prevention and control [ONERA, TP NO. 1989-9] p 553 A89-37631
- Analytical modeling of helicopter static and dynamic induced velocity in GRASP p 513 A89-38555
- Control augmented structural optimization of aeroelastically tailored fiber composite wings [AD-A204534] p 530 N89-21791
- Aerodynamic detuning of a loaded airfoil cascade in an incompressible flow by a locally analytical method p 521 N89-22588
- Structural dynamics branch research and accomplishments for FY 1988 [NASA-TM-101406] p 562 N89-22939

## AERONAUTICAL ENGINEERING

- Calculation of the principal parameters of the actuating mechanisms of aircraft slave drives --- Russian book p 555 A89-38500
- More helicopter aerodynamics --- Book p 513 A89-38578
- Study of the real emulation of the electronic integrated system [PB89-116271] p 557 N89-22016
- Future advanced aero-engines: The materials challenge p 538 N89-22659

## AERONAUTICAL SATELLITES

- AvSat - The first dedicated aeronautical satellite communications system p 524 A89-36592
- Inmarsat's aeronautical satellite communication system p 552 A89-36593
- Technical design and performance analysis of aeronautical satellite communication systems p 524 A89-36594
- Field trials of aeronautical satellite communication system p 524 A89-36595

## AERONAUTICS

- Calendar of selected aeronautical and space meetings [AGARD-CAL-88/2] p 566 N89-23361

## AEROSPACE MEDICINE

- Sudden inflight incapacitation in general aviation p 522 A89-36117

## AEROSPACE PLANES

- Materials for the NASP p 547 A89-36722
- Experimental investigation of applicability of waverider configuration to hypersonic transport and aerospace plane p 511 A89-38123
- Numerical simulation of supersonic flows past a space-plane p 511 A89-38124
- Fundamental aspects of an aerospaceplane p 544 A89-38234

## AEROSPACE SCIENCES

- Calendar of selected aeronautical and space meetings [AGARD-CAL-88/2] p 566 N89-23361

## AEROTHERMODYNAMICS

- Future advanced aero-engines: The materials challenge p 538 N89-22659

## AFTERBODIES

- The effect of exhaust plume/afterbody on installed scramjet performance p 536 N89-21797

## AILERONS

- Flutter of a wing with an aileron in transonic flow p 539 A89-37461

## AIR BREATHING ENGINES

- Fundamental aspects of an aerospaceplane p 544 A89-38234

## AIR DEFENSE

- AGARD highlights 88/2 p 566 N89-23403

## AIR FLOW

- On the accelerating airflow problem in the test section of a transonic wind tunnel p 541 A89-39477

## AIR LAW

- The Chicago Convention - Article 33 and the SFAR 40 episode p 566 A89-38876

## AIR NAVIGATION

- Accident investigation and the public interest - A pilot's view p 523 A89-39224
- Air navigation systems. I - Astronomical navigation in the air 1919-1969. Part II - Instruments p 532 A89-39828
- Benefits of 'area navigation' in regional aviation p 525 A89-39830
- Study of the real emulation of the electronic integrated system [PB89-116271] p 557 N89-22016

## AIR TO AIR REFUELING

- Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system [AD-A204030] p 530 N89-21790

## AIR TRAFFIC

- The maturing of commercial aviation p 507 A89-36900

## AIR TRAFFIC CONTROL

- Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596
- Combining the use of geostationary and inclined orbit satellites for integrated communications and navigation applications p 544 A89-36611
- Airport technology international 1988 --- Book p 541 A89-38582
- The Chicago Convention - Article 33 and the SFAR 40 episode p 566 A89-38876
- Automatic conflict detection logic for future air traffic control p 525 A89-39829
- Benefits of 'area navigation' in regional aviation p 525 A89-39830
- Description of the derivation of the collision risk model used in the vertical separation simulation risk model [AD-A205109] p 523 N89-21781
- A procedure for operating dependent instrument approaches to converging runways [AD-A204723] p 526 N89-21784
- Design, implementation and computer aided tests of a shaped reflector for an air traffic control system [ETN-89-94229] p 556 N89-22014
- National airspace system plan: Facilities, equipment, associated development and other capital needs [AD-A202615] p 526 N89-22596

## AIR TRAFFIC CONTROLLERS (PERSONNEL)

- Privatization of the air traffic control system - Its rationale, implementation and implications p 566 A89-38877
- Studies of poststrike air traffic control specialist trainees. Part 2: Selection and screening programs [AD-A199177] p 526 N89-22595

## AIR TRANSPORTATION

- Airport technology international 1988 --- Book p 541 A89-38582
- The Chicago Convention - Article 33 and the SFAR 40 episode p 566 A89-38876

## AIRBORNE EQUIPMENT

- Test of a calibration device for airborne Lyman-alpha hygrometers p 532 A89-37537
- Interferometry against differential Doppler - Performance comparison of two emitter location airborne systems p 525 A89-39203

## AIRBORNE/SPACEBORNE COMPUTERS

- Study on exchange operation between two microcomputers in aeroengine digital control p 535 A89-37774
- Study of the real emulation of the electronic integrated system [PB89-116271] p 557 N89-22016

## AIRCRAFT

- Geodetic positioning system for flying aircraft (May 1987) [REPT-013/88] p 527 N89-22598

## AIRCRAFT ACCIDENT INVESTIGATION

- Accident investigation and the public interest - A pilot's view p 523 A89-39224
- The naval aircraft crash environment: Aircrew survivability and aircraft structural response [AD-A204825] p 523 N89-21780
- Aircraft accident report: Trans-Colorado Airlines, Inc., Flight 2286, Fairchild Metro 3, SA227 AC, N68TC Bayfield, Colorado, January 19, 1988 [PB89-910401] p 524 N89-22593

## AIRCRAFT ACCIDENTS

- Human factors in cabin safety p 522 A89-36069
- Sudden inflight incapacitation in general aviation p 522 A89-36117
- F.E. simulation of crash for helicopters p 529 A89-39472

## AIRCRAFT ANTENNAS

- AvSat - The first dedicated aeronautical satellite communications system p 524 A89-36592

## AIRCRAFT BRAKES

- Evaluation of barrier cable impact pad materials [AD-A204356] p 542 N89-21811

## AIRCRAFT COMMUNICATION

- NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results p 552 A89-36585
- Inmarsat's aeronautical satellite communication system p 552 A89-36593
- Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596
- Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

## AIRCRAFT COMPARTMENTS

- A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510
- Evaluation of the ride quality of a light twin engine airplane using a ride quality meter [NASA-TP-2913] p 507 N89-22568

## AIRCRAFT CONFIGURATIONS

- GDPP - A practical CAD software package p 563 A89-37014

## The joined wing - The benefits and drawbacks. I

- p 507 A89-38800
- Unsteady transonic small-disturbance theory including entropy and vorticity effects p 515 A89-39191
- The naval aircraft crash environment: Aircrew survivability and aircraft structural response [AD-A204825] p 523 N89-21780

## AIRCRAFT CONSTRUCTION MATERIALS

- Taming ceramic fiber p 547 A89-36721
- Materials for the NASP p 547 A89-36722
- Composites - Helicopters leading the way p 528 A89-39086
- Materials tests: Means and techniques p 548 N89-21983
- Tests of new materials with second generation carbon fibers, test report [REPT-47-188/F] p 550 N89-22702
- CSPC test 319.30: Study on impact tolerance of prepregged carbon-epoxy systems [REPT-47-323/F] p 550 N89-22703
- A survey of poly-ether-ether-ketone and its advanced composites [FFA-TN-1988-37] p 550 N89-22707

## AIRCRAFT CONTROL

- Sensitivity analysis of digital flight control systems using singular-value concepts p 538 A89-36927
- Singular trajectories in airplane cruise-dash optimization p 538 A89-36928
- Eigenstructure assignment for the control of highly augmented aircraft p 538 A89-36930
- Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931
- Simulation evaluation of an advanced control concept for a V/STOL aircraft p 539 A89-36932
- Flight control system design for an in-flight simulator p 539 A89-36934
- Selection of weighting matrices for linear optimal regulator p 563 A89-36990
- Adaptive automatic control systems for flight vehicles --- Russian book p 563 A89-38511
- Integral rudder system for aircraft steering p 539 A89-39258
- Input signal selection in the identification of linear continuous dynamic systems from discrete observations p 563 A89-39777
- Multivariable control law design for the Control Reconfigurable Combat Aircraft (CRCA) [AD-A202697] p 540 N89-21803

## AIRCRAFT DESIGN

- Review of sonic boom theory [AIAA PAPER 89-1105] p 564 A89-36219
- A method for shock-free wing design p 509 A89-36985
- GDPP - A practical CAD software package p 563 A89-37014
- Gust analysis of an aircraft with highly non-linear systems interaction [AIAA PAPER 89-1377] p 527 A89-37650
- AFTI (Advanced Fighter Technology Integration)/F-111 mission adaptive wing briefing to industry [AD-A202467] p 530 N89-21787
- An efficient inverse method for the design of blended wing-body configurations p 532 N89-22603
- Computational fluid dynamics research in three-dimensional zonal techniques [NASA-CR-181406] p 558 N89-22838

## AIRCRAFT DETECTION

- USAF/Lockheed F-117A has high wing sweep but low wing loading p 528 A89-39234

## AIRCRAFT ENGINES

- Aircraft gas turbine blade and vane repair p 533 A89-36473
- Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474
- Aircraft engines. IV p 534 A89-36898
- Aircraft turbine fuel contamination history and endurance test requirements [SAE AIR 4023] p 547 A89-37658
- On evaluation of aircraft propulsion system performance p 534 A89-37752
- Performance analysis of a propulsion system p 534 A89-37753
- Adjustment of ratio of rotation speed difference in a twin-spool turbojet engine p 534 A89-37754
- A study on GH169 crack propagation under creep-fatigue interaction p 547 A89-37756
- Investigation on simulation of foreign object impact damage to compressor blade p 534 A89-37757
- A study on exit radial temperature profile of 2D experimental combustor p 535 A89-37759
- Variation of critical speed of a rotor-bearing system with slight relocation of bearing p 554 A89-37766
- Research on temperature profile factor at exit in an annular combustor p 535 A89-37769

- Computation of dynamic process with large disturbance for split-shaft gas turbine p 535 A89-37772
- Optimizing design for turboengine digital speed controller p 535 A89-37773
- Study on exchange operation between two microcomputers in aeroengine digital control p 535 A89-37774
- Nonstationary thermal duty of the structural elements of flight vehicles --- Russian book p 535 A89-38502
- Variable-cycle turbojet engines for multiple-regime aircraft --- Russian book p 535 A89-38510
- Fundamentals of aviation (4th revised and enlarged edition) --- Russian book p 507 A89-38514
- XRD techniques in aero engine development --- X-ray diffraction p 555 A89-38632
- A research experiment of discrete fuel injection in aero-engine combustion chamber p 536 A89-39480
- Application of Advanced Material for Turbomachinery and Rocket Propulsion [AGARD-CP-449] p 548 N89-22654
- AIRCRAFT EQUIPMENT**
- Calculation of the principal parameters of the actuating mechanisms of aircraft slave drives --- Russian book p 555 A89-38500
- Electroimpulse deicing - Electrodynamic solution by discrete elements p 528 A89-39193
- AIRCRAFT FUEL SYSTEMS**
- Aircraft turbine fuel contamination history and endurance test requirements [SAE AIR 4023] p 547 A89-37658
- Gravity refueling nozzles and ports interface standards for civil aircraft [SAE AS 1852] p 544 A89-37659
- AIRCRAFT GUIDANCE**
- Formulation of gain and impedance relations for corner reflectors employed in conjunction with localizer antenna arrays p 525 A89-39500
- AIRCRAFT HAZARDS**
- The aviation wire strike problem - The duty to warn of this aerial hazard p 522 A89-38878
- NASA's program on icing research and technology [NASA-TM-101989] p 507 N89-22569
- AIRCRAFT INDUSTRY**
- Fly, great sea eagle [AD-A203979] p 530 N89-21789
- AIRCRAFT LANDING**
- Aircraft automatic landing systems using GPS p 525 A89-39827
- Evaluation of felt pad materials [AD-A204356] p 542 N89-21811
- Aircraft accident report: Trans-Colorado Airlines, Inc., Flight 2286, Fairchild Metro 3, SA227 AC, N68TC Bayfield, Colorado, January 19, 1988 [PB89-910401] p 524 N89-22593
- AIRCRAFT MAINTENANCE**
- Aircraft gas turbine blade and vane repair p 533 A89-36473
- Fundamentals of the maintenance of the radio-electronic equipment of aircraft --- Russian book p 525 A89-38513
- Privatization of the air traffic control system - Its rationale, implementation and implications p 566 A89-38877
- INTERFACE 2: Advanced diagnostic software [AD-A204527] p 563 N89-22366
- AIRCRAFT MANEUVERS**
- Prediction of fatigue life under aircraft loading with and without use of material memory rules p 527 A89-38028
- AIRCRAFT MODELS**
- Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method p 553 A89-37006
- Validation of nonstationary aerodynamics models for longitudinal aeroplane motion on the basis of flight measurements p 539 A89-37524
- Investigation for venting test technology with large-sized model in a large wind tunnel p 541 A89-37783
- Simulation of optimal flight paths of dynamical soaring flight and the design of a model aircraft p 529 A89-39259
- Lateral stability analysis for X-29A drop model using system identification methodology [NASA-TM-4108] p 539 N89-21802
- AIRCRAFT NOISE**
- Near-field acoustic characteristics of a single-rotor propfan [AIAA PAPER 89-1055] p 533 A89-36215
- Installed propfan (SR-7L) far-field noise characteristics [AIAA PAPER 89-1056] p 564 A89-36216
- Lateral noise attenuation of the advanced propeller of the propfan test assessment aircraft [AIAA PAPER 89-1057] p 564 A89-36217
- A prediction of high-speed rotor noise [AIAA PAPER 89-1132] p 564 A89-36220
- Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise p 529 A89-39509
- A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510
- Eligibility of noise abatement proposals for grants-in-aid under the Airport Improvement Program [AD-A204724] p 542 N89-21812
- Evaluation of the ride quality of a light twin engine airplane using a ride quality meter [NASA-TP-2913] p 507 N89-22568
- AIRCRAFT PARTS**
- Computer simulation of the movement of loading door retraction mechanism with slide tracks p 527 A89-37019
- Two-dimensional simulation of electrothermal deicing of aircraft components p 528 A89-39194
- AIRCRAFT PERFORMANCE**
- Fundamentals of aviation (4th revised and enlarged edition) --- Russian book p 507 A89-38514
- Estimation of aircraft aerodynamic parameters from flight data p 513 A89-38614
- Good prospects for LET's 40-seater p 528 A89-39226
- A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance [AD-A204856] p 531 N89-21793
- AIRCRAFT PILOTS**
- Sudden inflight incapacitation in general aviation p 522 A89-36117
- Accident investigation and the public interest - A pilot's view p 523 A89-39224
- HUD on the head for combat pilots p 532 A89-39227
- AIRCRAFT POWER SUPPLIES**
- The all-electric (secondary power) airplane p 535 A89-38950
- AIRCRAFT RELIABILITY**
- Composite failure criterion: Probabilistic formulation and geometric interpretation [AD-A205275] p 548 N89-21851
- AIRCRAFT SAFETY**
- Sudden inflight incapacitation in general aviation p 522 A89-36117
- Passenger seat design commercial transport aircraft [SAE ARP 750] p 527 A89-37660
- Safe skies for tomorrow: Aviation safety in a competitive environment [PB89-114318] p 524 N89-22591
- AIRCRAFT SPECIFICATIONS**
- Testing of a new recovery parachute system for the F111 aircraft crew escape module: An update [DE89-007139] p 524 N89-22592
- AIRCRAFT SPIN**
- The analysis and prediction of the spin equilibrium point of modern aircrafts p 539 A89-39459
- AIRCRAFT STABILITY**
- Effect of spatial wind gradients on airplane aerodynamics p 514 A89-39190
- AIRCRAFT STRUCTURES**
- Polymers for advanced structures - An overview p 545 A89-36335
- Structures for hypervelocity flight p 552 A89-36723
- Vibrations in aerospace structures - Prediction, prevention and control [ONERA, TP NO. 1989-9] p 553 A89-37631
- Acoustic emission testing the F-111 p 541 A89-39008
- Modern joining methods for future aircraft structures p 556 A89-39076
- An approximate method for sonic fatigue analysis of plates and shells p 565 A89-39515
- Eigensolution of periodic assemblies of multi-mode component systems p 556 A89-39519
- Investigations of the parameter reduction in the optimization of aircraft wing structures [ILR-MITT-203] p 531 N89-21795
- Failure analysis: Analysis of landing gear fatigue test results for mechanical and metallurgical considerations in order to determine the authorized run time p 556 N89-21984
- Electro-impulse de-icing research: Fatigue and electromagnetic interference tests [DOT/FAA/CT-88/27] p 524 N89-22594
- An efficient inverse method for the design of blended wing-body configurations p 532 N89-22603
- AIRCRAFT WAKES**
- Prediction of counter-rotation propeller noise [AIAA PAPER 89-1141] p 564 A89-36221
- AIRFOIL OSCILLATIONS**
- Wing-store flutter analysis of an airfoil in incompressible flow p 528 A89-39198
- Flutter analysis of the CF-18 aircraft at supersonic speeds p 528 A89-39199
- AIRFOIL PROFILES**
- Lifetime aerofoil calculations using von Mises variables p 516 A89-39666
- Wind tunnel tests of 16 percent thick airfoil section with spoilers at different chordwise positions --- wind turbines [FFA-TN-1987-39] p 520 N89-22582
- Computational investigation of incompressible airfoil flows at high angles of attack [AD-A205885] p 522 N89-22590
- AIRFOILS**
- Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188
- A study of unsteady turbulent flow past airfoils p 521 N89-22587
- Hardware and operating features of the adaptive wall test section for the 0.3-meter transonic cryogenic tunnel [NASA-TM-4114] p 542 N89-22614
- A vortex panel analysis of circular-arc bluff-bodies in unsteady flow [DE89-007141] p 558 N89-22845
- Surface temperature measurements using a thin film thermal array [NASA-TM-101549] p 558 N89-22868
- AIRFRAME MATERIALS**
- Development and testing of critical components for technological preparation of an Airbus-CFRP-fuselage, phase 2 [MBB-UT-129/87] p 531 N89-22600
- AIRFRAMES**
- Consideration of environmental conditions for the fatigue evaluation of composite airframe structure p 551 A89-36304
- Plastic media blasting recycling equipment study [AD-A202463] p 556 N89-21987
- Tests of new materials with second generation carbon fibers, test report [REPT-47-188/F] p 550 N89-22702
- AIRLINE OPERATIONS**
- The maturing of commercial aviation p 507 A89-36900
- Optimization of flight regimes according to economic criteria (2nd revised and enlarged edition) --- Russian book p 528 A89-38498
- Airport technology international 1988 --- Book p 541 A89-38582
- Benefits of 'area navigation' in regional aviation p 525 A89-39830
- AIRPORT PLANNING**
- Airport technology international 1988 --- Book p 541 A89-38582
- Eligibility of noise abatement proposals for grants-in-aid under the Airport Improvement Program [AD-A204724] p 542 N89-21812
- AIRPORTS**
- The maturing of commercial aviation p 507 A89-36900
- Instrument landing system mathematical modeling study for Orlando International Airport Runway 17R localizer, Orlando, Florida, revised airside docking plan (Scheme 3A) [AD-A204722] p 526 N89-21783
- ALGORITHMS**
- Computational fluid dynamics research in three-dimensional zonal techniques [NASA-CR-181406] p 558 N89-22838
- ALTERNATING DIRECTION IMPLICIT METHODS**
- Primitive numerical simulation of circular Couette flow p 516 N89-21764
- ALTITUDE CONTROL**
- Stability and control of hypervelocity vehicles [AD-A205160] p 540 N89-21807
- ALUMINIDES**
- Degradation of aluminide coated directionally solidified superalloy turbine blades in an aero gas turbine engine p 546 A89-36480
- Influence of thermal fatigue on hot corrosion of an intermetallic Ni-aluminide coating p 547 A89-36484
- ALUMINUM**
- Anodized aluminum and aluminum alloy coatings for thermal control p 547 A89-38153
- ALUMINUM ALLOYS**
- Anodized aluminum and aluminum alloy coatings for thermal control p 547 A89-38153
- Modern joining methods for future aircraft structures p 556 A89-39076
- The fatigue in aircraft corrosion testing (FACT) programme [AGARD-R-713] p 548 N89-21873
- ANGLE OF ATTACK**
- Separation control on an airfoil by periodic forcing p 509 A89-36922
- Pulsating flow over an ellipse at an angle of attack p 513 A89-38620
- A computational method of aerodynamics for subsonic, fully unsteady wings at high angles of attack in time-domain p 515 A89-39462

- Computational investigation of incompressible airfoil flows at high angles of attack  
[AD-A205885] p 522 N89-22590
- ANGULAR VELOCITY**  
Adjustment of ratio of rotation speed difference in a twin-spool turbojet engine p 534 A89-37754  
Variation of critical speed of a rotor-bearing system with slight relocation of bearing p 554 A89-37766
- ANNULAR DUCTS**  
Annular honeycomb seals: Test results for leakage and rotodynamic coefficients: comparisons to labyrinth and smooth configurations p 559 N89-22899
- ANNULAR FLOW**  
Research on temperature profile factor at exit in an annular combustor p 535 A89-37769
- ANTENNA ARRAYS**  
Formulation of gain and impedance relations for corner reflectors employed in conjunction with localizer antenna arrays p 525 A89-39500
- ANTENNA DESIGN**  
Design, implementation and computer aided tests of a shaped reflector for an air traffic control system  
[ETN-89-94229] p 556 N89-22014
- APPROACH CONTROL**  
An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft  
[AD-A202910] p 526 N89-21782
- ARRAYS**  
Surface temperature measurements using a thin film thermal array  
[NASA-TM-101549] p 558 N89-22868
- ARTIFICIAL INTELLIGENCE**  
Fusion of multisensor data: A summary of the JASMIN project  
[FOA-C-30498-3.3] p 563 N89-23213
- ASYMPTOTIC METHODS**  
Asymptotic analysis of the transonic region of a high-speed propeller  
[AIAA PAPER 89-1077] p 565 A89-37652
- ATMOSPHERIC BOUNDARY LAYER**  
Hazard index calculation for 31 May 1984 microburst at Erie, Colorado  
[NASA-CR-184968] p 562 N89-23048
- ATMOSPHERIC CIRCULATION**  
Investigation of the effects of increased sophistication of simulation of the atmospheric wind in wind tunnels p 543 N89-22620  
Hazard index calculation for 31 May 1984 microburst at Erie, Colorado  
[NASA-CR-184968] p 562 N89-23048
- ATMOSPHERIC OPTICS**  
Modeling of density fluctuations in supersonic turbulent boundary layer p 509 A89-36923
- ATMOSPHERIC PRESSURE**  
Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft p 544 A89-36543
- ATMOSPHERIC TEMPERATURE**  
Artificial and natural icing tests of the EH-60A quick fix helicopter  
[AD-A204589] p 530 N89-21792
- ATMOSPHERIC TURBULENCE**  
Aero-optical analysis of compressible flow over an open cavity p 509 A89-36914  
Gust analysis of an aircraft with highly non-linear systems interaction  
[AIAA PAPER 89-1377] p 527 A89-37650  
The use of DFDR information in the analysis of a turbulence incident over Greenland p 562 A89-39647
- ATTACK AIRCRAFT**  
USAF/Lockheed F-117A has high wing sweep but low wing loading p 528 A89-39234
- AUTOMATIC CONTROL**  
Automatic conflict detection logic for future air traffic control p 525 A89-39829  
An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft  
[AD-A202910] p 526 N89-21782
- AUTOMATIC FLIGHT CONTROL**  
Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931  
Adaptive automatic control systems for flight vehicles --- Russian book p 563 A89-38511  
AFTI (Advanced Fighter Technology Integration)/F-111 mission adaptive wing briefing to industry  
[AD-A202467] p 530 N89-21787
- AUTOMATIC LANDING CONTROL**  
Aircraft automatic landing systems using GPS p 525 A89-39827
- AUTOMATIC PILOTS**  
Aircraft automatic landing systems using GPS p 525 A89-39827

- Study of the real emulation of the electronic integrated system  
[PB89-116271] p 557 N89-22016
- AUTOMATION**  
LEADER - An automatic, real-time diagnostic knowledge system  
[SAE PAPER 881443] p 534 A89-37651
- AVIATION METEOROLOGY**  
The use of DFDR information in the analysis of a turbulence incident over Greenland p 562 A89-39647
- AVIONICS**  
Fundamentals of the maintenance of the radio-electronic equipment of aircraft --- Russian book p 525 A89-38513  
Study of the real emulation of the electronic integrated system  
[PB89-116271] p 557 N89-22016
- AXIAL FLOW**  
AF-2 scheme for solution of axial symmetric transonic inlet-flowfield p 511 A89-37791
- AXISYMMETRIC BODIES**  
Potential flow over bodies of revolution in unsteady motion p 508 A89-36910
- AXISYMMETRIC FLOW**  
Inviscid, unsteady, transonic axisymmetric flow with shock waves - Response to time and space-time dependent perturbations p 512 A89-38129  
The inviscid axisymmetric stability of the supersonic flow along a circular cylinder  
[NASA-CR-181816] p 519 N89-22574

## B

- B-70 AIRCRAFT**  
Experimental investigation of dynamic ground effect p 514 A89-39185
- BACKSCATTERING**  
Electromagnetic backscatter from open-ended circular cylinder with complex termination p 536 A89-39284  
Scattering from three-dimensional cracks p 565 A89-39588
- BALLISTIC TRAJECTORIES**  
Aeroballistic Research Facility Data Analysis System (ARFDAS)  
[AD-A204308] p 542 N89-21810
- BALLISTICS**  
Aeroballistic Research Facility Data Analysis System (ARFDAS)  
[AD-A204308] p 542 N89-21810
- BANDPASS FILTERS**  
Magnetic bearing stiffness control using frequency band filtering p 560 N89-22910
- BANDSTOP FILTERS**  
Magnetic bearing stiffness control using frequency band filtering p 560 N89-22910
- BEARINGLESS ROTORS**  
Ground and air resonance of bearingless rotors in hover and forward flight p 529 N89-21786
- BEARINGS**  
Variation of critical speed of a rotor-bearing system with slight relocation of bearing p 554 A89-37766  
Rotodynamic Instability Problems in High-Performance Turbomachinery, 1988 p 558 N89-22891  
[NASA-CP-3026] p 558 N89-22891  
Cavitation effects on the pressure distribution of a squeeze film damper bearing p 559 N89-22897  
Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 N89-22912  
Experimental verification of an eddy-current bearing p 561 N89-22913
- BIT ERROR RATE**  
Technical design and performance analysis of aeronautical satellite communication systems p 524 A89-36594
- BLADE SLAP NOISE**  
Near-field acoustic characteristics of a single-rotor propfan  
[AIAA PAPER 89-1055] p 533 A89-36215  
On sound generated when a vortex is chopped by a circular airfoil p 565 A89-39514
- BLADE TIPS**  
An experimental and computational study of rotor-vortex interactions p 513 A89-38553
- BLADE-VORTEX INTERACTION**  
Blade-vortex interaction p 508 A89-36905  
Rotor vortex wake distortion and its induced velocity in ground effect at low speed p 510 A89-37779  
The constraint wake analysis for hovering rotors p 511 A89-37790  
An experimental and computational study of rotor-vortex interactions p 513 A89-38553  
Extension of classical tip loss formulas --- for rotorcraft design p 528 A89-38652

- On sound generated when a vortex is chopped by a circular airfoil p 565 A89-39514
- BLOWING**  
Unsteady force calculations on circular cylinders and elliptical airfoils with circulation control p 516 N89-21766  
Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows  
[AD-A204364] p 518 N89-21774
- BLUFF BODIES**  
Flow past bluff bodies p 517 N89-21770  
A vortex panel analysis of circular-arc bluff-bodies in unsteady flow  
[DE89-007141] p 558 N89-22845
- BLUNT BODIES**  
Wakes of four complex bodies of revolution at zero angle of attack p 508 A89-36907  
Numerical calculations of hypersonic nonequilibrium flow over a blunt wedge p 515 A89-39461
- BLUNT LEADING EDGES**  
The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack  
[FFA-141] p 520 N89-22583
- BODIES OF REVOLUTION**  
Wakes of four complex bodies of revolution at zero angle of attack p 508 A89-36907  
Approximate calculation of supersonic flow past bodies of revolution with a front separation zone at a small angle of attack p 512 A89-38427
- BODY-WING AND TAIL CONFIGURATIONS**  
Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow  
[PB89-111470] p 518 N89-22571  
Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds  
[FFA-TN-1988-44] p 532 N89-22602
- BODY-WING CONFIGURATIONS**  
Transfinite interpolation method for 3-D grid generations p 509 A89-36986  
A numerical method for the analysis of a flight vehicle with a solid fuselage p 509 A89-37460  
The joined wing - The benefits and drawbacks. I p 507 A89-38800  
Buffeting criteria for a systematic series of wings p 515 A89-39197  
Transonic and supersonic wind tunnel tests on control effectiveness on schematic missile configurations with canard controls  
[FFA-TN-1988-11] p 531 N89-22601  
An efficient inverse method for the design of blended wing-body configurations p 532 N89-22603
- BOILERS**  
Some in-field experiences of non-synchronous vibrations in large rotating machinery p 559 N89-22894
- BOMBER AIRCRAFT**  
Fly, great sea eagle  
[AD-A203979] p 530 N89-21789
- BOUNDARY INTEGRAL METHOD**  
Flow past bluff bodies p 517 N89-21770
- BOUNDARY LAYER CONTROL**  
Separation control on an airfoil by periodic forcing p 509 A89-36922  
The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration  
[NASA-TM-4100] p 516 N89-21762  
Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds  
[AD-A205206] p 519 N89-22575  
Wind tunnel tests of 16 percent thick airfoil section with spoilers at different chordwise positions --- wind turbines  
[FFA-TN-1987-39] p 520 N89-22582
- BOUNDARY LAYER FLOW**  
The inviscid axisymmetric stability of the supersonic flow along a circular cylinder  
[NASA-CR-181816] p 519 N89-22574  
Flow over a leading edge with distributed roughness  
[DFVLR-FB-88-45] p 520 N89-22581  
Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel p 520 N89-22584  
Transition to turbulence in laminar hypersonic flow p 522 N89-22830
- BOUNDARY LAYER SEPARATION**  
Wakes of four complex bodies of revolution at zero angle of attack p 508 A89-36907  
Measurements in separating boundary layers p 552 A89-36909  
Separation shock motion in fin, cylinder, and compression ramp - Induced turbulent interactions p 509 A89-36911  
Separation control on an airfoil by periodic forcing p 509 A89-36922



- Computational investigation of incompressible airfoil flows at high angles of attack  
[AD-A205885] p 522 N89-22590
- BOUNDARY LAYER STABILITY**  
Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186  
The inviscid axisymmetric stability of the supersonic flow along a circular cylinder  
[NASA-CR-181816] p 519 N89-22574
- BOUNDARY LAYER TRANSITION**  
Boundary-layer transition on a cone and flat plate at Mach 3.5 p 508 A89-36904  
Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds  
[AD-A205206] p 519 N89-22575  
Transition to turbulence in laminar hypersonic flow p 522 N89-22830
- BOUNDARY LAYERS**  
Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements  
[NASA-CR-184896] p 517 N89-21772
- BUBBLES**  
Color helium bubble flow-visualization technique p 556 A89-39186
- BUCKLING**  
Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method p 553 A89-37006
- BUFFETING**  
Buffeting criteria for a systematic series of wings p 515 A89-39197
- BUILDINGS**  
Investigation of the effects of increased sophistication of simulation of the atmospheric wind in wind tunnels p 543 N89-22620
- BURNERS**  
Interrelation of engine design and burner configuration with selection and performance of electrical ignition systems for gas turbine engines  
[SAE AIR 784] p 534 A89-37654

## C

- C-130 AIRCRAFT**  
Pre and post modification electromagnetic compatibility test report for the C-130H self contained navigation system with MLS A-kit, revision  
[AD-A205167] p 533 N89-22604
- CABLES**  
Evaluation of barrier cable impact pad materials  
[AD-A204356] p 542 N89-21811
- CALENDARS**  
Calendar of selected aeronautical and space meetings  
[AGARD-CAL-88/2] p 566 N89-23361
- CANARD CONFIGURATIONS**  
Multivariable control law design for the Control Reconfigurable Combat Aircraft (CRCA)  
[AD-A202697] p 540 N89-21803  
Compressible Euler solution around a wing canard sting configuration  
[FFA-TN-1988-62] p 519 N89-22578  
Transonic and supersonic wind tunnel tests on control effectiveness on schematic missile configurations with canard controls  
[FFA-TN-1988-11] p 531 N89-22601
- CANOPES**  
Calculated and experimental stresses in solid and ring slot parachutes p 523 A89-39200
- CARBON FIBER REINFORCED PLASTICS**  
Development and testing of critical components for technological preparation of an Airbus-CFRP-fuselage, phase 2  
[MBB-UT-129/87] p 531 N89-22600  
Tests of new materials with second generation carbon fibers, test report  
[REPT-47-188/F] p 550 N89-22702  
CSPC test 319.30: Study on impact tolerance of preimpregnated carbon-epoxy systems  
[REPT-47-323/F] p 550 N89-22703
- CARBONACEOUS MATERIALS**  
A proposal for funding to purchase a high-temperature furnace to enable determination of the high temperature mechanical properties of structural carbon materials  
[AD-A204103] p 542 N89-21809
- CASCADE FLOW**  
Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186  
Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916  
Navier-Stokes computations of two- and three-dimensional cascade flowfields p 514 A89-39035  
A physical model of the streamwise corner vortices in a compressor cascade p 515 A89-39473

- Numerical solutions of unsteady inviscid transonic turbine cascade flows p 516 N89-21767  
The effects of incidence angle and free stream turbulence on the performance of a variable geometry two-dimensional compressor cascade at high Reynolds numbers  
[AD-A202650] p 557 N89-22052  
Transonic viscous flow calculations for a turbine cascade with a two equation turbulence model  
[NASA-TM-101944] p 537 N89-22607
- CAST ALLOYS**  
A hafnium-free directionally solidified nickel-base superalloy p 546 A89-36435
- CAVITATION FLOW**  
Color helium bubble flow-visualization technique p 556 A89-39186  
Cavitation effects on the pressure distribution of a squeeze film damper bearing p 559 N89-22897
- CENTRIFUGAL COMPRESSORS**  
Contribution to centrifugal impeller design p 553 A89-37525  
Stress tensor measurements within the vaneless diffuser of a centrifugal compressor p 556 A89-39050  
Some field experience with subsynchronous vibration of centrifugal compressors p 559 N89-22892  
High stability design for new centrifugal compressor p 561 N89-22917
- CENTRIFUGAL PUMPS**  
Influence of impeller shroud forces on turbopump rotor dynamics p 560 N89-22909
- CERAMIC COATINGS**  
Laser drilling of a superalloy coated with ceramic p 551 A89-36455  
CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 N89-22658
- CERAMIC FIBERS**  
Taming ceramic fiber p 547 A89-36721  
Monolithic and fiber ceramic components for turboengines and rockets p 549 N89-22657
- CERAMIC MATRIX COMPOSITES**  
Beyond superalloys - The goals, the materials and some reality p 546 A89-36418  
Material/manufacturing process interaction in advanced material technologies p 549 N89-22662
- CERAMICS**  
Effect of crack size on the tensile strength of ceramics in a high-temperature corrosive environment p 547 A89-38021  
Simulation analysis on ceramic gas turbine  
[DE88-756469] p 548 N89-21926  
The demonstration of monolithic and composite ceramics in aircraft gas turbine combustors p 550 N89-22665
- CHANNEL FLOW**  
The aeroacoustics of the interaction between vortices and bodies in a transonic flow p 566 N89-22445  
[MPIS-3/1988]  
Numerical study of a multipurpose transonic wind tunnel with an adaptable injection-suction system p 543 N89-22621
- CHINA**  
Visiting China's aerodynamics research and development center  
[AD-A203980] p 543 N89-22615
- CHROMIUM ALLOYS**  
Development of Gatorized MERL 76 for gas turbine disk applications p 545 A89-36411
- CIRCULAR CYLINDERS**  
Electromagnetic backscatter from open-ended circular cylinder with complex termination p 536 A89-39284  
Unsteady force calculations on circular cylinders and elliptical airfoils with circulation control p 516 N89-21766  
The inviscid axisymmetric stability of the supersonic flow along a circular cylinder  
[NASA-CR-181816] p 519 N89-22574
- CIRCULATION CONTROL AIRFOILS**  
Unsteady force calculations on circular cylinders and elliptical airfoils with circulation control p 516 N89-21766
- CIVIL AVIATION**  
Inmarsat's aeronautical satellite communication system p 552 A89-36593  
Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596  
The maturing of commercial aviation p 507 A89-36900  
Optimization of flight regimes according to economic criteria (2nd revised and enlarged edition) --- Russian book p 528 A89-38498  
The Chicago Convention - Article 33 and the SFAR 40 episode p 566 A89-38876  
Coming to terms with TCAS p 522 A89-39088  
Accident investigation and the public interest - A pilot's view p 523 A89-39224

- Safe skies for tomorrow: Aviation safety in a competitive environment  
[PB89-114318] p 524 N89-22591
- CLEANING**  
Plastic media blasting recycling equipment study  
[AD-A202463] p 556 N89-21987
- CLEARANCES**  
Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 N89-22912
- COATINGS**  
Plastic media blasting recycling equipment study  
[AD-A202463] p 556 N89-21987
- COBALT ALLOYS**  
Development of Gatorized MERL 76 for gas turbine disk applications p 545 A89-36411
- COCKPITS**  
Color displays can reduce workload p 532 A89-38949  
Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system  
[AD-A204030] p 530 N89-21790
- COLLISION AVOIDANCE**  
The aviation wire strike problem - The duty to warn of this aerial hazard p 522 A89-38878  
Coming to terms with TCAS p 522 A89-39088  
Automatic conflict detection logic for future air traffic control p 525 A89-39829  
Ground collision warning system performance criteria for high maneuverability aircraft  
[AD-A204390] p 523 N89-21779  
Description of the derivation of the collision risk model used in the vertical separation simulation risk model  
[AD-A205109] p 523 N89-21781
- COLLISIONS**  
Ground collision warning system performance criteria for high maneuverability aircraft  
[AD-A204390] p 523 N89-21779
- COLOR**  
Color helium bubble flow-visualization technique p 556 A89-39186
- COLOR CODING**  
Color displays can reduce workload p 532 A89-38949
- COMBUSTIBLE FLOW**  
Highly-resolved flowfield induced by Mach reflection p 512 A89-38125  
An explicit Runge-Kutta method for turbulent reacting flow calculations  
[NASA-TM-101945] p 536 N89-21799
- COMBUSTION CHAMBERS**  
A study on exit radial temperature profile of 2D experimental combustor p 535 A89-37759  
Research on temperature profile factor at exit in an annular combustor p 535 A89-37769  
Aerodynamic device for generating mono-disperse fuel droplets p 554 A89-37878  
Isothermal flow in a gas turbine combustor - A benchmark experimental study p 514 A89-38873  
Investigation of a small solid fuel ramjet combustor p 544 A89-39028  
A research experiment of discrete fuel injection in aero-engine combustion chamber p 536 A89-39480  
Investigation of low NOx staged combustor concept in high-speed civil transport engines  
[NASA-TM-101977] p 537 N89-22606  
The demonstration of monolithic and composite ceramics in aircraft gas turbine combustors p 550 N89-22665  
Combustor flow visualization using innovative infrared thermographics techniques  
[AD-A205905] p 550 N89-22718
- COMBUSTION EFFICIENCY**  
Investigation of a small solid fuel ramjet combustor p 544 A89-39028  
Research as part of the Air Force Research in Aero Propulsion Technology (AFRAPT) Program  
[AD-A204968] p 537 N89-21801  
Investigation of low NOx staged combustor concept in high-speed civil transport engines  
[NASA-TM-101977] p 537 N89-22606
- COMMERCIAL AIRCRAFT**  
Passenger seat design commercial transport aircraft  
[SAE ARP 750] p 527 A89-37660  
Good prospects for LET's 40-seater p 528 A89-39226  
Ground collision warning system performance criteria for high maneuverability aircraft  
[AD-A204390] p 523 N89-21779
- COMMUNICATION NETWORKS**  
Combining the use of geostationary and inclined orbit satellites for integrated communications and navigation applications p 544 A89-36611

**COMPASSES**

Air navigation systems. I - Astronomical navigation in the air 1919-1969. Part II - Instruments p 532 A89-39828

**COMPONENT RELIABILITY**

Fundamentals of the maintenance of the radio-electronic equipment of aircraft --- Russian book p 525 A89-38513

Monolithic and fiber ceramic components for turboengines and rockets p 549 A89-22657  
Transmission overhaul and replacement predictions using Weibull and renewal theory [NASA-TM-102022] p 562 A89-22925

**COMPOSITE MATERIALS**

Application of nondestructive inspection methods to composites p 555 A89-38951  
Composites - Helicopters leading the way p 528 A89-39086  
Future advanced aero-engines: The materials challenge p 538 A89-22659

**COMPOSITE STRUCTURES**

Consideration of environmental conditions for the fatigue evaluation of composite airframe structure p 551 A89-36304  
Fracture of pressurized composite cylinders with a high strain-to-failure matrix system p 551 A89-36319  
Control augmented structural optimization of aeroelastically tailored fiber composite wings [AD-A204534] p 530 A89-21791

**COMPRESSIBLE BOUNDARY LAYER**

Theoretical investigation of 3-D shock wave-turbulent boundary layer interactions, part 7 [AD-A204482] p 557 A89-22070

**COMPRESSIBLE FLOW**

Aero-optical analysis of compressible flow over an open cavity p 509 A89-36914  
Modeling of density fluctuations in supersonic turbulent boundary layer p 509 A89-36923  
Development of a streamline method [AD-A205146] p 557 A89-22078  
Compressible Euler solution around a wing canard sting configuration [FFA-TN-1988-62] p 519 A89-22578  
Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

**COMPRESSION LOADS**

Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method p 553 A89-37006

**COMPRESSOR BLADES**

Contribution to centrifugal impeller design p 553 A89-37525  
Investigation on simulation of foreign object impact damage to compressor blade p 534 A89-37757  
A physical model of the streamwise corner vortices in a compressor cascade p 515 A89-39473  
The effects of incidence angle and free stream turbulence on the performance of a variable geometry two-dimensional compressor cascade at high Reynolds numbers [AD-A202650] p 557 A89-22052

**COMPRESSORS**

Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 [NASA-CP-3026] p 558 A89-22891

**COMPUTATIONAL FLUID DYNAMICS**

Extension and application of flux-vector splitting to calculations on dynamic meshes p 508 A89-36901  
Numerical and experimental evaluations of the flow past nested chevrons p 508 A89-36902  
Blade-vortex interaction p 508 A89-36905  
Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916  
New possibilities of viscous-inviscid numerical techniques for solving viscous flow equations with massive separation [ONERA, TP NO. 1989-24] p 554 A89-37640  
The computation of the viscous/inviscid interaction p 510 A89-37777  
An explicit multistage finite-area method for 2D transonic flow calculations p 510 A89-37778  
AF-2 scheme for solution of axial symmetric transonic inlet-flowfield p 511 A89-37791  
Highly-resolved flowfield induced by Mach reflection p 512 A89-38125  
Some properties of nonisentropic transonic flows p 512 A89-38426  
Approximate calculation of supersonic flow past bodies of revolution with a front separation zone at a small angle of attack p 512 A89-38427  
Nonstationary supersonic flow past a body p 512 A89-38437  
Stability of gas flows in Laval nozzles p 512 A89-38438  
Swirling flows in an annular-to-rectangular transition section p 555 A89-39037

Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188

Optimizing advanced propeller designs by simultaneously updating flow variables and design parameters p 514 A89-39189

Numerical solutions of unsteady inviscid transonic turbine cascade flows p 516 A89-21767

Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements p 517 A89-21772

An explicit Runge-Kutta method for turbulent reacting flow calculations [NASA-TM-101945] p 536 A89-21799

Theoretical investigation of 3-D shock wave-turbulent boundary layer interactions, part 7 [AD-A204482] p 557 A89-22070

Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow [PB89-111470] p 518 A89-22571

A numerical study of viscous vortex rings using a spectral method p 518 A89-22572

The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack [FFA-141] p 520 A89-22583

Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds [FFA-TN-1988-44] p 532 A89-22602

Transonic viscous flow calculations for a turbine cascade with a two equation turbulence model [NASA-TM-101944] p 537 A89-22607

Computational fluid dynamics research in three-dimensional zonal techniques [NASA-CR-181406] p 558 A89-22838

**COMPUTATIONAL GRIDS**

Extension and application of flux-vector splitting to calculations on dynamic meshes p 508 A89-36901  
Aerodynamics of engine-airframe interaction [NASA-CR-184824] p 517 A89-21769

Convergence of discrete-vortex induced-flow calculations by optimum choice of mesh p 521 A89-22585

Computational fluid dynamics research in three-dimensional zonal techniques [NASA-CR-181406] p 558 A89-22838

**COMPUTER AIDED DESIGN**

GDPP - A practical CAD software package p 563 A89-37014

A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance [AD-A204856] p 531 A89-21793

A perspective on future directions in aerospace propulsion system simulation [NASA-TM-102038] p 536 A89-21798

Multivariable control law design for the Control Reconfigurable Combat Aircraft (CRCA) [AD-A202697] p 540 A89-21803

An OOD (Object-Oriented Design) paradigm for flight simulators, 2nd edition [AD-A204849] p 542 A89-21813

Design, implementation and computer aided tests of a shaped reflector for an air traffic control system [ETN-89-94229] p 556 A89-22014

**COMPUTER AIDED TOMOGRAPHY**

Nondestructive volumetric CT-scan evaluation of monolithic ceramic turbine components p 555 A89-38954

**COMPUTER PROGRAMS**

The effect of exhaust plume/afterbody on installed scramjet performance p 536 A89-21797

Aeroballistic Research Facility Data Analysis System (ARFDAS) [AD-A204308] p 542 A89-21810

COMPUTER SYSTEMS PERFORMANCE  
A perspective on future directions in aerospace propulsion system simulation [NASA-TM-102038] p 536 A89-21798

COMPUTER SYSTEMS PROGRAMS  
INTERFACE 2: Advanced diagnostic software [AD-A204527] p 563 A89-22366

**COMPUTER TECHNIQUES**

Aeroballistic Research Facility Data Analysis System (ARFDAS) [AD-A204308] p 542 A89-21810

COMPUTERIZED SIMULATION  
Flight control system design for an in-flight simulator p 539 A89-36934

Computer simulation of the movement of loading door retraction mechanism with slide tracks p 527 A89-37019

Influence of pitching motion on subsonic wing rock of slender delta wings p 514 A89-39187

Two-dimensional simulation of electrothermal deicing of aircraft components p 528 A89-39194

Interferometry against differential Doppler - Performance comparison of two emitter location airborne systems p 525 A89-39203

Description of the derivation of the collision risk model used in the vertical separation simulation risk model [AD-A205109] p 523 A89-21781

Functional performance specification for an inertial navigation system [AD-A204850] p 526 A89-21785

A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance [AD-A204856] p 531 A89-21793

A flight dynamic study of the helicopter including blade dynamics p 531 A89-21796

A perspective on future directions in aerospace propulsion system simulation [NASA-TM-102038] p 536 A89-21798

Study of the real emulation of the electronic integrated system [PB89-116271] p 557 A89-22016

PARC code validation for propulsion flows [AD-A204293] p 557 A89-22066

A vortex panel analysis of circular-arc bluff-bodies in unsteady flow [DE89-007141] p 558 A89-22845

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

**CONDENSATION NUCLEI**  
Condensation phenomena in a turbine blade passage p 511 A89-37939

**CONDUCTIVE HEAT TRANSFER**  
Generalized criteria for microwave breakdown in air-filled waveguides p 552 A89-36655

**CONFERENCES**  
International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings p 552 A89-36576

Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 [NASA-CP-3026] p 558 A89-22891

Calendar of selected aeronautical and space meetings [AGARD-CAL-88/2] p 566 A89-23361

**CONICAL BODIES**  
Nonlinear supersonic potential flow over sideslip conical bodies, delta wings and fuselages p 511 A89-37792

**CONICAL FLOW**  
Boundary-layer transition on a cone and flat plate at Mach 3.5 p 508 A89-36904

**CONSERVATION EQUATIONS**  
An explicit Runge-Kutta method for turbulent reacting flow calculations [NASA-TM-101945] p 536 A89-21799

**CONTROL CONFIGURED VEHICLES**  
Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931

Multivariable control law design for the Control Reconfigurable Combat Aircraft (CRCA) [AD-A202697] p 540 A89-21803

**CONTROL EQUIPMENT**  
A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510

**CONTROL SURFACES**  
Experimental investigation of aerodynamic heating by flow through control surface gaps p 510 A89-37785

Integral rudder system for aircraft steering p 539 A89-39258

**CONTROL SYSTEMS DESIGN**  
Eigenstructure assignment for the control of highly augmented aircraft p 538 A89-36930

Simulation evaluation of an advanced control concept for a V/STOL aircraft p 539 A89-36932

Flight control system design for an in-flight simulator p 539 A89-36934

Neural computing for numeric-to-symbolic conversion in control systems p 563 A89-37234

Voice of authority --- control systems for space vehicles p 544 A89-37646

Adaptive automatic control systems for flight vehicles --- Russian book p 563 A89-38511

Synthesis of systems for the motion control of nonstationary objects --- Russian book p 563 A89-38512

Color displays can reduce workload p 532 A89-38949

Application of a fuzzy controller in the fuel system of a turbojet engine p 536 A89-39043

Aircraft automatic landing systems using GPS p 525 A89-39827

Automatic conflict detection logic for future air traffic control p 525 A89-39829

An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft [AD-A202910] p 526 A89-21782

- AFTI (Advanced Fighter Technology Integration)/F-111 mission adaptive wing briefing to industry  
[AD-A202467] p 530 N89-21787
- Energy concepts applied to control of airplane flight in wind shear p 540 N89-21806
- Single channel test controllers  
[AD-A204088] p 541 N89-22611
- Microcomputer based controller for the Langley 0.3-meter Transonic Cryogenic Tunnel  
[NASA-CR-181808] p 543 N89-22616
- Magnetic bearing stiffness control using frequency band filtering p 560 N89-22910
- A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 N89-22911
- CONTROL THEORY**
- Eigenstructure assignment for the control of highly augmented aircraft p 538 A89-36930
- Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931
- Neural computing for numeric-to-symbolic conversion in control systems p 563 A89-37234
- Robust control of an active vibration isolation system for helicopters p 539 A89-39458
- The structure and control of three-dimensional shock wave turbulent boundary layer interactions  
[AD-A205923] p 558 N89-22866
- Magnetic bearing stiffness control using frequency band filtering p 560 N89-22910
- CONTROLLABILITY**
- Measures of modal controllability and observability for first- and second-order linear systems p 563 A89-36943
- CONTROLLERS**
- Energy concepts applied to control of airplane flight in wind shear p 540 N89-21806
- Single channel test controllers  
[AD-A204088] p 541 N89-22611
- CONVECTIVE HEAT TRANSFER**
- Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating  
[AD-A205077] p 518 N89-21775
- CONVERGENT NOZZLES**
- Static internal performance of convergent single-expansion-ramp nozzles with various combinations of internal geometric parameters  
[NASA-TM-4112] p 517 N89-21768
- CONVERGENT-DIVERGENT NOZZLES**
- Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349
- COORDINATE TRANSFORMATIONS**
- Lifetime aerofoil calculations using von Mises variables p 516 A89-39666
- CORNER FLOW**
- A physical model of the streamwise corner vortexes in a compressor cascade p 515 A89-39473
- CORROSION PREVENTION**
- The fatigue in aircraft corrosion testing (FACT) programme  
[AGARD-R-713] p 548 N89-21873
- COUETTE FLOW**
- Primitive numerical simulation of circular Couette flow p 516 N89-21764
- COUNTER ROTATION**
- Prediction of counter-rotation propeller noise  
[AIAA PAPER 89-1141] p 564 A89-36221
- CRACK GEOMETRY**
- Effect of crack size on the tensile strength of ceramics in a high-temperature corrosive environment p 547 A89-38021
- Acoustic emission testing the F-111 p 541 A89-39008
- Scattering from three-dimensional cracks p 565 A89-39588
- CRACK PROPAGATION**
- A study on GH169 crack propagation under creep-fatigue interaction p 547 A89-37756
- Effect of crack size on the tensile strength of ceramics in a high-temperature corrosive environment p 547 A89-38021
- Environmentally induced discontinuities in transparent polymers  
[AD-A205483] p 550 N89-22768
- CRACKING (CHEMICAL ENGINEERING)**
- Environmentally induced discontinuities in transparent polymers  
[AD-A205483] p 550 N89-22768
- CRASH LANDING**
- Aircraft accident report: Trans-Colorado Airlines, Inc., Flight 2286, Fairchild Metro 3, SA227 AC, N68TC Bayfield, Colorado, January 19, 1988  
[PB89-910401] p 524 N89-22593
- CRASHES**
- F.E. simulation of crash for helicopters p 529 A89-39472
- CRASHWORTHINESS**
- The naval aircraft crash environment: Aircrew survivability and aircraft structural response  
[AD-A204825] p 523 N89-21780
- CREEP PROPERTIES**
- A study on GH169 crack propagation under creep-fatigue interaction p 547 A89-37756
- Development of stress and lifing criteria for single crystal turbine blades p 549 N89-22663
- CRITICAL LOADING**
- Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method p 553 A89-37006
- CRITICAL VELOCITY**
- Variation of critical speed of a rotor-bearing system with slight relocation of bearing p 554 A89-37766
- Some in-field experiences of non-synchronous vibrations in large rotating machinery p 559 N89-22894
- CROSS FLOW**
- Effects of swirl and high turbulence on a jet in a crossflow p 515 A89-39192
- CRUISING FLIGHT**
- Singular trajectories in airplane cruise-dash optimization p 538 A89-36928
- CRYOGENIC WIND TUNNELS**
- Application of infrared thermography to the interpretation of tests in an icing wind tunnel  
[ONERA, TP NO. 1989-28] p 554 A89-37642
- Hardware and operating features of the adaptive wall test section for the 0.3-meter transonic cryogenic tunnel  
[NASA-TM-4114] p 542 N89-22614
- Microcomputer based controller for the Langley 0.3-meter Transonic Cryogenic Tunnel  
[NASA-CR-181808] p 543 N89-22616
- CYCLIC LOADS**
- The fatigue in aircraft corrosion testing (FACT) programme  
[AGARD-R-713] p 548 N89-21873
- CYLINDRICAL BODIES**
- Fracture of pressurized composite cylinders with a high strain-to-failure matrix system p 551 A89-36319
- Separation shock motion in fin, cylinder, and compression ramp - induced turbulent interactions p 509 A89-36911
- The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body p 516 N89-21765
- CYLINDRICAL SHELLS**
- Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method p 553 A89-37006
- Application of the theory of fuzzy sets to the two-criterion stochastic optimization of ribbed shells p 556 A89-39823
- D**
- DAMAGE**
- Artificial and natural icing tests of the EH-60A quick fix helicopter  
[AD-A204589] p 530 N89-21792
- DAMAGE ASSESSMENT**
- Damage tolerance concepts for advanced materials and engines p 549 N89-22661
- The effects of plastic media blasting paint removal on the microstructure of graphite/epoxy composite materials  
[AD-A204801] p 550 N89-22688
- DAMPERS**
- Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988  
[NASA-CP-3026] p 558 N89-22891
- DATA PROCESSING**
- Aeroballistic Research Facility Data Analysis System (ARFDAS)  
[AD-A204308] p 542 N89-21810
- National airspace system plan: Facilities, equipment, associated development and other capital needs  
[AD-A202615] p 526 N89-22596
- DEFORMATION**
- Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 N89-22586
- DEICERS**
- Application of infrared thermography to the interpretation of tests in an icing wind tunnel  
[ONERA, TP NO. 1989-28] p 554 A89-37642
- DEICING**
- Electroimpulse deicing - Electrodynamic solution by discrete elements p 528 A89-39193
- Two-dimensional simulation of electrothermal deicing of aircraft components p 528 A89-39194
- NASA's program on icing research and technology  
[NASA-TM-101989] p 507 N89-22569
- Electro-impulse de-icing research: Fatigue and electromagnetic interference tests  
[DOT/FAA/CT-88/27] p 524 N89-22594
- DELTA WINGS**
- The effects of vortex breakdown on the aerodynamic properties of a wing and the engineering predicting method p 510 A89-37780
- Nonlinear supersonic potential flow over sideslip conical bodies, delta wings and fuselages p 511 A89-37792
- Experimental investigation of dynamic ground effect p 514 A89-39185
- Influence of pitching motion on subsonic wing rock of slender delta wings p 514 A89-39187
- Transonic and supersonic flow past a 65 deg delta wing with rounded leading edges: Analysis of experimental data  
[DFVLR-FB-88-44] p 520 N89-22580
- The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack  
[FFA-141] p 520 N89-22583
- DEOXYGENATION**
- Jet fuel deoxygenation  
[AD-A205006] p 548 N89-21943
- DESCENT**
- Aircraft accident report: Trans-Colorado Airlines, Inc., Flight 2286, Fairchild Metro 3, SA227 AC, N68TC Bayfield, Colorado, January 19, 1988  
[PB89-910401] p 524 N89-22593
- DESIGN ANALYSIS**
- Optimizing advanced propeller designs by simultaneously updating flow variables and design parameters p 514 A89-39189
- High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 A89-39195
- A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance  
[AD-A204856] p 531 N89-21793
- Design, implementation and computer aided tests of a shaped reflector for an air traffic control system  
[ETN-89-94229] p 556 N89-22014
- An efficient inverse method for the design of blended wing-body configurations p 532 N89-22603
- Experimental verification of an eddy-current bearing p 561 N89-22913
- DIFFUSION**
- CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 N89-22658
- DIFFUSION WELDING**
- Modern joining methods for future aircraft structures p 556 A89-39076
- DIGITAL DATA**
- The use of DFDR information in the analysis of a turbulence incident over Greenland p 562 A89-39647
- DIGITAL FILTERS**
- A way for upgrading the accuracy of force measurement p 553 A89-37011
- DIGITAL SIMULATION**
- Microburst simulation via vortex-ring and turbulent jet models p 562 N89-22287
- DIGITAL SYSTEMS**
- Sensitivity analysis of digital flight control systems using singular-value concepts p 538 A89-36927
- DIRECTION FINDING**
- Interferometry against differential Doppler - Performance comparison of two emitter location airborne systems p 525 A89-39203
- DIRECTIONAL SOLIDIFICATION (CRYSTALS)**
- A hafnium-free directionally solidified nickel-base superalloy p 546 A89-36435
- The processing and testing of a hollow DS eutectic high pressure turbine blade p 551 A89-36436
- Degradation of aluminide coated directionally solidified superalloy turbine blades in an aero gas turbine engine p 546 A89-36480
- DIRECTIONAL STABILITY**
- Lateral stability analysis for X-29A drop model using system identification methodology  
[NASA-TM-4108] p 539 N89-21802
- DISPLAY DEVICES**
- Color displays can reduce workload p 532 A89-38949
- Model-based analysis and cooperative synthesis of control and display augmentation for piloted flight vehicles p 540 A89-22610
- DOPPLER EFFECT**
- Interferometry against differential Doppler - Performance comparison of two emitter location airborne systems p 525 A89-39203
- DRAG CHUTES**
- Wake recontact: An experimental investigation using a ringslot parachute  
[DE89-008320] p 518 N89-21773
- DRAG REDUCTION**
- Riblet drag at flight conditions p 515 A89-39196

## DROP SIZE

The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack  
[FFA-141] p 520 N89-22583

## DROP SIZE

Aerodynamic device for generating mono-disperse fuel droplets p 554 A89-37878  
Condensation phenomena in a turbine blade passage p 511 A89-37939

## DROP TESTS

Lateral stability analysis for X-29A drop model using system identification methodology  
[NASA-TM-4108] p 539 N89-21802  
A preliminary characterization of parachute wake recontact  
[DE89-006442] p 519 N89-22576

## DROPS (LIQUIDS)

Aerodynamic device for generating mono-disperse fuel droplets p 554 A89-37878

## DUCTED FLOW

Experimental investigation of shock wave/boundary-layer interactions in an annular duct p 514 A89-39039  
Development of a streamline method  
[AD-A205146] p 557 N89-22078

## DYNAMIC CHARACTERISTICS

Motion of a three-degrees-of-freedom gyroscope with a dynamically unbalanced rotor in the case of contact between the internal frame and an elastic limiter p 565 A89-39816  
Organized structures in a supersonic turbulent boundary layer p 517 N89-21771  
A seal test facility for the measurement of isotropic and anisotropic linear rotordynamic characteristics p 560 N89-22905  
Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position p 560 N89-22906  
Role of circumferential flow in the stability of fluid-handling machine rotors p 561 N89-22915

## DYNAMIC CONTROL

Synthesis of systems for the motion control of nonstationary objects --- Russian book p 563 A89-38512

Stability and control of hypervelocity vehicles  
[AD-A205160] p 540 N89-21807

## DYNAMIC LOADS

A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance  
[AD-A204856] p 531 N89-21793

## DYNAMIC MODELS

Experimental studies in system identification of helicopter rotor dynamics p 528 A89-38554  
Ground and air resonance of bearingless rotors in hover and forward flight p 529 N89-21786

## DYNAMIC RESPONSE

Experimental investigation of dynamic ground effect p 514 A89-39185  
A flight dynamic study of the helicopter including blade dynamics p 531 N89-21796  
Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 N89-22912

Structural dynamics branch research and accomplishments for FY 1988  
[NASA-TM-101406] p 562 N89-22939

## DYNAMIC STABILITY

Dynamics and control of truss structures with extending members p 523 N89-21778  
Stability and control of hypervelocity vehicles  
[AD-A205160] p 540 N89-21807  
Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 558 N89-22891  
[NASA-CP-3026]

## DYNAMIC STRUCTURAL ANALYSIS

Dynamical calculations of engine components based on elasticity equations p 553 A89-37421  
Dynamics and control of truss structures with extending members p 523 N89-21778  
Structural dynamics branch research and accomplishments for FY 1988  
[NASA-TM-101406] p 562 N89-22939

## E

## EARTH SURFACE

Some mathematical considerations on views of the ground surface in flight p 562 A89-36351

## ECONOMIC FACTORS

Optimization of flight regimes according to economic criteria (2nd revised and enlarged edition) --- Russian book p 528 A89-38498

## EDDY CURRENTS

Experimental verification of an eddy-current bearing p 561 N89-22913

## EIGENVALUES

Eigenstructure assignment for the control of highly augmented aircraft p 538 A89-36930  
Eigensolution of periodic assemblies of multi-mode component systems p 556 A89-39519

## ELASTIC PLATES

An approximate method for sonic fatigue analysis of plates and shells p 565 A89-39515

## ELASTIC PROPERTIES

Dynamical calculations of engine components based on elasticity equations p 553 A89-37421  
Evaluation of barrier cable impact pad materials  
[AD-A204356] p 542 N89-21811

## ELASTODYNAMICS

Coupling factor method for studying elastic motion of flight vehicles p 544 A89-37004

## ELECTRIC CONDUCTORS

Leads, flexible, shielded, high energy ignition --- for gas turbine engines  
[SAE ARP 841] p 534 A89-37661

## ELECTRIC GENERATORS

The all-electric (secondary power) airplane p 535 A89-38950

## ELECTRIC IGNITION

Interrelation of engine design and burner configuration with selection and performance of electrical ignition systems for gas turbine engines  
[SAE AIR 784] p 534 A89-37654

## ELECTRIC POTENTIAL

An electroviscous damper p 559 N89-22898

## ELECTRIC POWER TRANSMISSION

The all-electric (secondary power) airplane p 535 A89-38950

## ELECTRICAL FAULTS

Generalized criteria for microwave breakdown in air-filled waveguides p 552 A89-36655

## ELECTRODYNAMICS

Electroimpulse deicing - Electrodynamical solution by discrete elements p 528 A89-39193

## ELECTROMAGNETIC COMPATIBILITY

Pre and post modification electromagnetic compatibility test report for the C-130H self contained navigation system with MLS A-kit, revision  
[AD-A205167] p 533 N89-22604

## ELECTROMAGNETIC INTERACTIONS

Experimental verification of an eddy-current bearing p 561 N89-22913

## ELECTROMAGNETIC INTERFERENCE

Electro-impulse de-icing research: Fatigue and electromagnetic interference tests  
[DOT/FAA/CT-88/27] p 524 N89-22594

## ELECTROMAGNETIC RADIATION

Electromagnetic backscatter from open-ended circular cylinder with complex termination p 536 A89-39284

## ELECTROMECHANICAL DEVICES

Calculation of the principal parameters of the actuating mechanisms of aircraft slave drives --- Russian book p 555 A89-38500

## ELECTRON BEAMS

Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK50 p 546 A89-36440

## ELECTRONIC EQUIPMENT

Study of the real emulation of the electronic integrated system  
[PB89-116271] p 557 N89-22016

## ELECTROREFINING

Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK50 p 546 A89-36440

## ELECTROSLAG REFINING

Causes and effects of center segregation in electro-slag remelted alloy 718 for critical rotating part applications p 545 A89-36410

## ELLIPSES

Pulsating flow over an ellipse at an angle of attack p 513 A89-38620

## EMBEDDING

Control of embedded vortices using wall jets  
[AD-A202606] p 558 N89-22835

## EMERGENCIES

Experiences of rocket seat ejections in the Swedish Air Force - 1967-1987 p 522 A89-36122

## ENERGY DISTRIBUTION

Energy concepts applied to control of airplane flight in wind shear p 540 N89-21806

## ENGINE CONTROL

Study on exchange operation between two microcomputers in aeroengine digital control p 535 A89-37774

## ENGINE DESIGN

T700 - Growing to meet the challenge p 533 A89-36400  
Aircraft engines. IV p 534 A89-36898

Interrelation of engine design and burner configuration with selection and performance of electrical ignition systems for gas turbine engines

[SAE AIR 784] p 534 A89-37654

On evaluation of aircraft propulsion system performance p 534 A89-37752

Optimizing design for turboengine digital speed controller p 535 A89-37773

Variable-cycle turbojet engines for multiple-regime aircraft --- Russian book p 535 A89-38510

A perspective on future directions in aerospace propulsion system simulation  
[NASA-TM-102038] p 536 N89-21798

Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800

Technical evaluation report p 548 N89-22655

## ENGINE INLETS

Artificial and natural icing tests of the EH-60A quick fix helicopter  
[AD-A204589] p 530 N89-21792

## ENGINE MONITORING INSTRUMENTS

INTERFACE 2: Advanced diagnostic software  
[AD-A204527] p 563 N89-22366

## ENGINE PARTS

The transmission development process at Lucas Western p 551 A89-36398

Dynamical calculations of engine components based on elasticity equations p 553 A89-37421

A study on GH169 crack propagation under creep-fatigue interaction p 547 A89-37756

Nonstationary thermal duty of the structural elements of flight vehicles --- Russian book p 535 A89-38502

Monolithic and fiber ceramic components for turboengines and rockets p 549 N89-22657

## ENGINE TESTS

A review and forecast of engine system research at the Army Propulsion Directorate p 533 A89-36397

T800/A129 flight program p 533 A89-36399

LEADER - An automatic, real-time diagnostic knowledge system

[SAE PAPER 881443] p 534 A89-37651

Aircraft turbine fuel contamination history and endurance test requirements  
[SAE AIR 4023] p 547 A89-37658

On evaluation of aircraft propulsion system performance p 534 A89-37752

Performance analysis of a propulsion system p 534 A89-37753

The demonstration of monolithic and composite ceramics in aircraft gas turbine combustors p 550 N89-22665

The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895

The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895

## ENGINES

The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895

## ENVIRONMENTAL TESTS

Consideration of environmental conditions for the fatigue evaluation of composite airframe structure p 551 A89-36304

## EPOXY MATRIX COMPOSITES

Fracture of pressurized composite cylinders with a high strain-to-failure matrix system p 551 A89-36319

## EQUATIONS OF MOTION

Motion of a three-degrees-of-freedom gyroscope with a dynamically unbalanced rotor in the case of contact between the internal frame and an elastic limiter p 565 A89-39816

Stability and control of hypervelocity vehicles  
[AD-A205160] p 540 N89-21807

Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 p 558 N89-22891

Development of a streamline method  
[AD-A205146] p 557 N89-22078

## EQUIPMENT SPECIFICATIONS

Leads, flexible, shielded, high energy ignition --- for gas turbine engines  
[SAE ARP 841] p 534 A89-37661

## ERROR ANALYSIS

Interferometry against differential Doppler - Performance comparison of two emitter location airborne systems p 525 A89-39203

## ESCAPE SYSTEMS

Testing of a new recovery parachute system for the F111 aircraft crew escape module: An update  
[DE89-007139] p 524 N89-22592

## EULER EQUATIONS OF MOTION

Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916

The application of the two-dimensional unsteady Euler equations perturbation solutions on the supersonic rectangular wings p 511 A89-37787

Aerodynamics of engine-airframe interaction  
[NASA-CR-184824] p 517 N89-21769

Compressible Euler solution around a wing canard sting configuration  
[FFA-TN-1988-62] p 519 N89-22578

- The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack  
[FFA-141] p 520 N89-22583
- EUROPEAN AIRBUS**  
Development and testing of critical components for technological preparation of an Airbus-CFRP-fuselage, phase 2  
[MBB-UT-129/87] p 531 N89-22600
- EUTECTIC ALLOYS**  
The processing and testing of a hollow DS eutectic high pressure turbine blade p 551 A89-36436
- EVACUATING (TRANSPORTATION)**  
Human factors in cabin safety p 522 A89-36069
- EXCITATION**  
An electroviscous damper p 559 N89-22898
- EXHAUST EMISSION**  
Investigation of low NOx staged combustor concept in high-speed civil transport engines  
[NASA-TM-101977] p 537 N89-22606
- EXHAUST NOZZLES**  
Effects of swirl and high turbulence on a jet in a crossflow p 515 A89-39192  
Rectangular nozzle plume velocity modeling for use in jet noise prediction  
[NASA-TM-102047] p 519 N89-22577
- EXHAUST VELOCITY**  
Rectangular nozzle plume velocity modeling for use in jet noise prediction  
[NASA-TM-102047] p 519 N89-22577
- EXPANDABLE STRUCTURES**  
Dynamics and control of truss structures with extending members p 523 N89-21778
- EXPERIMENT DESIGN**  
The low-speed wind tunnel at DVFLR in Brunswick (Fed. Republic of Germany)  
[DFVLR-MITT-88-25] p 543 N89-22619
- EXPERT SYSTEMS**  
LEADER - An automatic, real-time diagnostic knowledge system  
[SAE PAPER 881443] p 534 A89-37651  
INTERFACE 2: Advanced diagnostic software  
[AD-A204527] p 563 N89-22366
- EXTERNAL STORES**  
Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds  
[FFA-TN-1988-44] p 532 N89-22602
- F**
- F-106 AIRCRAFT**  
Experimental investigation of dynamic ground effect p 514 A89-39185
- F-111 AIRCRAFT**  
Acoustic emission testing the F-111 p 541 A89-39008
- F-18 AIRCRAFT**  
Flutter analysis of the CF-18 aircraft at supersonic speeds p 528 A89-39199
- FAILURE**  
Composite failure criterion: Probabilistic formulation and geometric interpretation  
[AD-A205275] p 548 N89-21851
- FAILURE ANALYSIS**  
Fracture of pressurized composite cylinders with a high strain-to-failure matrix system p 551 A89-36319  
Prediction of fatigue life under aircraft loading with and without use of material memory rules p 527 A89-38028  
Failure analysis: Analysis of landing gear fatigue test results for mechanical and metallurgical considerations in order to determine the authorized run time p 556 N89-21984
- FAR FIELDS**  
Installed propfan (SR-7L) far-field noise characteristics  
[AIAA PAPER 89-1056] p 564 A89-36216
- FATIGUE LIFE**  
Consideration of environmental conditions for the fatigue evaluation of composite airframe structure p 551 A89-36304  
A study on GH169 crack propagation under creep-fatigue interaction p 547 A89-37756  
Prediction of fatigue life under aircraft loading with and without use of material memory rules p 527 A89-38028  
Damage tolerance concepts for advanced materials and engines p 549 N89-22661  
Transmission overhaul and replacement predictions using Weibull and renewal theory  
[NASA-TM-102022] p 562 N89-22925
- FATIGUE TESTS**  
The fatigue in aircraft corrosion testing (FACT) programme  
[AGARD-R-713] p 548 N89-21873
- Failure analysis: Analysis of landing gear fatigue test results for mechanical and metallurgical considerations in order to determine the authorized run time p 556 N89-21984
- Electro-impulse de-icing research: Fatigue and electromagnetic interference tests  
[DOT/FAA/CT-88/27] p 524 N89-22594
- FEEDBACK CONTROL**  
Coupling factor method for studying elastic motion of flight vehicles p 544 A89-37004  
Control augmented structural optimization of aeroelastically tailored fiber composite wings  
[AD-A204534] p 530 N89-21791  
A flight dynamic study of the helicopter including blade dynamics p 531 N89-21796  
Active vibration control for flexible rotor by optimal direct-output feedback control  
[NASA-TM-101972] p 537 N89-22605  
Single channel test controllers  
[AD-A204088] p 541 N89-22611  
Microcomputer based controller for the Langley 0.3-meter Transonic Cryogenic Tunnel  
[NASA-CR-181808] p 543 N89-22616
- FERROUS METALS**  
Plastic media blasting recycling equipment study  
[AD-A202463] p 556 N89-21987
- FIBER COMPOSITES**  
Control augmented structural optimization of aeroelastically tailored fiber composite wings  
[AD-A204534] p 530 N89-21791
- FIBER STRENGTH**  
Composite failure criterion: Probabilistic formulation and geometric interpretation  
[AD-A205275] p 548 N89-21851
- FIELD OF VIEW**  
Some mathematical considerations on views of the ground surface in flight p 562 A89-36351
- FIGHTER AIRCRAFT**  
HUD on the head for combat pilots p 532 A89-39227  
Multi-input/multi-output frequency domain modal identification method and its application in ground vibration testing p 529 A89-39454  
AFTI (Advanced Fighter Technology Integration)/F-111 mission adaptive wing briefing to industry  
[AD-A202467] p 530 N89-21787
- FINITE DIFFERENCE THEORY**  
Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 N89-22900  
Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position p 560 N89-22906
- FINITE ELEMENT METHOD**  
F.E. simulation of crash for helicopters p 529 A89-39472  
Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating  
[AD-A205077] p 518 N89-21775  
Ground and air resonance of bearingless rotors in hover and forward flight p 529 N89-21786  
Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 N89-22912  
Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 N89-22916
- FINS**  
Separation shock motion in fin, cylinder, and compression ramp - Induced turbulent interactions p 509 A89-36911  
Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds  
[FFA-TN-1988-44] p 532 N89-22602
- FIRE CONTROL**  
Study of the real emulation of the electronic integrated system  
[PB89-116271] p 557 N89-22016
- FIXED WINGS**  
The naval aircraft crash environment: Aircrew survivability and aircraft structural response  
[AD-A204825] p 523 N89-21780  
Convergence of discrete-vortex induced-flow calculations by optimum choice of mesh p 521 N89-22585
- FLAPS (CONTROL SURFACES)**  
Experimental investigation of aerodynamic heating by flow through control surface gaps p 510 A89-37785
- FLAT PLATES**  
Boundary-layer transition on a cone and flat plate at Mach 3.5 p 508 A89-36904  
Experimental investigation of aerodynamic heating by flow through control surface gaps p 510 A89-37785  
Organized structures in a supersonic turbulent boundary layer p 517 N89-21771
- FLEXIBILITY**  
Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 N89-22912
- FLEXIBLE BODIES**  
Coupling factor method for studying elastic motion of flight vehicles p 544 A89-37004  
Experimental investigation of sudden imbalance response on a flexible rotor system with squeeze-film damper p 554 A89-37768  
Active vibration control of flexible rotors - An experimental and theoretical study p 554 A89-37847  
Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 N89-22586
- FLIGHT CHARACTERISTICS**  
Equivalent systems method to evaluate the flight qualities p 539 A89-36998  
Validation of nonstationary aerodynamics models for longitudinal aeroplane motion on the basis of flight measurements p 539 A89-37524  
Input signal selection in the identification of linear continuous dynamic systems from discrete observations p 563 A89-39777  
A method for determining the inertia tensor of a craft in flight p 565 A89-39819  
Lateral stability analysis for X-29A drop model using system identification methodology  
[NASA-TM-4108] p 539 N89-21802
- FLIGHT CONTROL**  
Sensitivity analysis of digital flight control systems using singular-value concepts p 538 A89-36927  
Eigenstructure assignment for the control of highly augmented aircraft p 538 A89-36930  
Flight control system design for an in-flight simulator p 539 A89-36934  
Equivalent systems method to evaluate the flight qualities p 539 A89-36998  
Ground collision warning system performance criteria for high maneuverability aircraft  
[AD-A204390] p 523 N89-21779  
An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft  
[AD-A202910] p 526 N89-21782  
Energy concepts applied to control of airplane flight in wind shear p 540 N89-21806
- FLIGHT CREWS**  
Testing of a new recovery parachute system for the F111 aircraft crew escape module: An update  
[DE89-007139] p 524 N89-22592
- FLIGHT HAZARDS**  
Coming to terms with TCAS p 522 A89-39088  
The naval aircraft crash environment: Aircrew survivability and aircraft structural response  
[AD-A204825] p 523 N89-21780  
Hazard index calculation for 31 May 1984 microburst at Erie, Colorado  
[NASA-CR-184968] p 562 N89-23048
- FLIGHT MANAGEMENT SYSTEMS**  
Color displays can reduce workload p 532 A89-38949
- FLIGHT OPTIMIZATION**  
Optimization of flight regimes according to economic criteria (2nd revised and enlarged edition) --- Russian book p 528 A89-38498
- FLIGHT PATHS**  
Trajectory optimization with risk minimization for military aircraft p 538 A89-36929  
Simulation of optimal flight paths of dynamical soaring flight and the design of a model aircraft p 529 A89-39259
- FLIGHT RECORDERS**  
The use of DFDR information in the analysis of a turbulence incident over Greenland p 562 A89-39647
- FLIGHT SAFETY**  
Experiences of rocket seat ejections in the Swedish Air Force - 1967-1987 p 522 A89-36122  
Safe skies for tomorrow: Aviation safety in a competitive environment  
[PB89-114318] p 524 N89-22591  
National airspace system plan: Facilities, equipment, associated development and other capital needs  
[AD-A202615] p 526 N89-22596
- FLIGHT SIMULATION**  
Investigation on simulation of foreign object impact damage to compressor blade p 534 A89-37757  
Simulation of optimal flight paths of dynamical soaring flight and the design of a model aircraft p 529 A89-39259  
An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft  
[AD-A202910] p 526 N89-21782
- FLIGHT SIMULATORS**  
Flight control system design for an in-flight simulator p 539 A89-36934

- An OOD (Object-Oriented Design) paradigm for flight simulators, 2nd edition  
[AD-A204849] p 542 N89-21813
- FLIGHT STABILITY TESTS**  
Lateral stability analysis for X-29A drop model using system identification methodology  
[NASA-TM-4108] p 539 N89-21802
- FLIGHT TESTS**  
T800/A129 flight program p 533 A89-36399  
V-22 prepared for further expansion of flight envelope p 527 A89-36575  
Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements  
[NASA-CR-184896] p 517 N89-21772  
AFTI (Advanced Fighter Technology Integration)/F-111 mission adaptive wing briefing to industry  
[AD-A202467] p 530 N89-21787  
Artificial and natural icing tests of the EH-60A quick fix helicopter  
[AD-A204589] p 530 N89-21792  
NASA's program on icing research and technology  
[NASA-TM-101989] p 507 N89-22569
- FLIGHT VEHICLES**  
Hydrodynamics and heat transfer in the porous elements of flight vehicle structures --- Russian book p 554 A89-38499  
Synthesis of systems for the motion control of nonstationary objects --- Russian book p 563 A89-38512
- FLOW CHARACTERISTICS**  
Some properties of nonisentropic transonic flows p 512 A89-38426
- FLOW DISTORTION**  
Hardware and operating features of the adaptive wall test section for the 0.3-meter transonic cryogenic tunnel  
[NASA-TM-4114] p 542 N89-22614
- FLOW DISTRIBUTION**  
Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764  
Swirling flows in an annular-to-rectangular transition section p 555 A89-39037  
Experimental investigation of shock wave/boundary-layer interactions in an annular duct p 514 A89-39039  
Primitive numerical simulation of circular Couette flow p 516 N89-21764  
The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body p 516 N89-21765  
Flow past bluff bodies p 517 N89-21770  
Organized structures in a supersonic turbulent boundary layer p 517 N89-21771  
Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows p 518 N89-21774  
[AD-A204364]  
The evaluation and representation of interferograms of transonic flow fields p 518 N89-21777  
[MPS-11/1987]  
The effect of exhaust plume/afterbody on installed scramjet performance p 536 N89-21797  
Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800  
Description of a simple rotor test rig and preliminary wake studies p 541 N89-21808  
[AD-A204089]  
Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow [PB89-111470] p 518 N89-22571  
Transonic and supersonic flow past a 65 deg delta wing with rounded leading edges: Analysis of experimental data p 520 N89-22580  
[DFVLR-FB-88-44]  
Flow over a leading edge with distributed roughness [DFVLR-FB-88-45] p 520 N89-22581  
Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel p 520 N89-22584  
Convergence of discrete-vortex induced-flow calculations by optimum choice of mesh p 521 N89-22585  
Aerodynamic detuning of a loaded airfoil cascade in an incompressible flow by a locally analytical method p 521 N89-22588  
Computational investigation of incompressible airfoil flows at high angles of attack p 522 N89-22590  
[AD-A205885]  
LDV measurements and investigation of flow field through radial turbine guide vanes p 538 N89-22609  
Hardware and operating features of the adaptive wall test section for the 0.3-meter transonic cryogenic tunnel [NASA-TM-4114] p 542 N89-22614

- A vortex panel analysis of circular-arc bluff-bodies in unsteady flow  
[DE89-007141] p 558 N89-22845
- FLOW EQUATIONS**  
New possibilities of viscous-inviscid numerical techniques for solving viscous flow equations with massive separation  
[ONERA, TP NO. 1989-24] p 554 A89-37640  
Numerical solutions of unsteady inviscid transonic turbine cascade flows p 516 N89-21767  
An explicit Runge-Kutta method for turbulent reacting flow calculations  
[NASA-TM-101945] p 536 N89-21799
- FLOW GEOMETRY**  
Numerical and experimental evaluations of the flow past nested chevrons p 508 A89-36902
- FLOW MEASUREMENT**  
Measurements in separating boundary layers p 552 A89-36909  
Pulsating flow over an ellipse at an angle of attack p 513 A89-38620  
Development of a second generation injector driven transonic wind tunnel at BUAA p 541 A89-39469  
LDV measurements and investigation of flow field through radial turbine guide vanes p 538 N89-22609  
Implementation of a two-component laser anemometer at the T2 wind tunnel  
[A-501-H] p 558 N89-22879
- FLOW STABILITY**  
Linear instability waves in supersonic turbulent mixing layers p 508 A89-36903  
Stability of gas flows in Laval nozzles p 512 A89-38438  
Primitive numerical simulation of circular Couette flow p 516 N89-21764
- FLOW THEORY**  
Theoretical investigation of 3-D shock wave-turbulent boundary layer interactions, part 7  
[AD-A204482] p 557 N89-22070
- FLOW VELOCITY**  
LDV measurements and investigation of flow field through radial turbine guide vanes p 538 N89-22609  
Implementation of a two-component laser anemometer at the T2 wind tunnel  
[A-501-H] p 558 N89-22879  
Role of circumferential flow in the stability of fluid-handling machine rotors p 561 N89-22915
- FLOW VISUALIZATION**  
Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764  
Color helium bubble flow-visualization technique p 556 A89-39186  
Combustor flow visualization using innovative infrared thermographics techniques p 550 N89-22718  
[AD-A205905]
- FLUID DYNAMICS**  
Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating  
[AD-A205077] p 518 N89-21775  
AGARD highlights 88/2 p 566 N89-23403
- FLUID FLOW**  
Analytical modeling of helicopter static and dynamic induced velocity in GRASP p 513 A89-38555
- FLUID INJECTION**  
Development of a second generation injector driven transonic wind tunnel at BUAA p 541 A89-39469
- FLUID-SOLID INTERACTIONS**  
Integrated approach for active coupling of structures and fluids p 552 A89-36917
- FLUTTER**  
A study of unsteady turbulent flow past airfoils p 521 N89-22587
- FLUTTER ANALYSIS**  
Integrated approach for active coupling of structures and fluids p 552 A89-36917  
Flutter of a wing with an aileron in transonic flow p 539 A89-37461  
Wing-store flutter analysis of an airfoil in incompressible flow p 528 A89-39198  
Flutter analysis of the CF-18 aircraft at supersonic speeds p 528 A89-39199  
Stall flutter of graphite/epoxy wings with bending-torsion coupling  
[AD-A203077] p 540 N89-21804
- FLUX VECTOR SPLITTING**  
Extension and application of flux-vector splitting to calculations on dynamic meshes p 508 A89-36901
- FLY BY WIRE CONTROL**  
Simulation evaluation of an advanced control concept for a V/STOL aircraft p 539 A89-36932
- FLYING EJECTION SEATS**  
Experiences of rocket seat ejections in the Swedish Air Force - 1967-1987 p 522 A89-36122

- FORCED VIBRATION**  
Some field experience with subsynchronous vibration of centrifugal compressors p 559 N89-22892
- FORMING TECHNIQUES**  
Modern joining methods for future aircraft structures p 556 A89-39076
- FRACTURE MECHANICS**  
Fracture of pressurized composite cylinders with a high strain-to-failure matrix system p 551 A89-36319
- FRACTURE STRENGTH**  
Environmentally induced discontinuities in transparent polymers  
[AD-A205483] p 550 N89-22768
- FREE FLIGHT**  
Aeroballistic Research Facility Data Analysis System (ARFAS)  
[AD-A204308] p 542 N89-21810
- FREE FLOW**  
Unsteady force calculations on circular cylinders and elliptical airfoils with circulation control p 516 N89-21766  
The effects of incidence angle and free stream turbulence on the performance of a variable geometry two-dimensional compressor cascade at high Reynolds numbers  
[AD-A202650] p 557 N89-22052
- FREE MOLECULAR FLOW**  
Aerodynamic characteristics of arbitrarily rotating bodies in a variable-density gas p 509 A89-37355
- FREE VIBRATION**  
Variations of undamped rotor blade frequencies subjected to transient heat flux p 553 A89-36919  
Eigensolution of periodic assemblies of multi-mode component systems p 556 A89-39519
- FREQUENCY RESPONSE**  
Multi-input/multi-output frequency domain modal identification method and its application in ground vibration testing p 529 A89-39454
- FREQUENCY STABILITY**  
Magnetic bearing stiffness control using frequency band filtering p 560 N89-22910
- FUEL COMBUSTION**  
Aerodynamic device for generating mono-disperse fuel droplets p 554 A89-37878
- FUEL CONSUMPTION**  
Singular trajectories in airplane cruise-dash optimization p 538 A89-36928
- FUEL CONTAMINATION**  
Aircraft turbine fuel contamination history and endurance test requirements  
[SAE AIR 4023] p 547 A89-37658
- FUEL CONTROL**  
Application of a fuzzy controller in the fuel system of a turbojet engine p 536 A89-39043
- FUEL INJECTION**  
A research experiment of discrete fuel injection in aero-engine combustion chamber p 536 A89-39480
- FUNCTIONAL ANALYSIS**  
Functional performance specification for an inertial navigation system  
[AD-A204850] p 526 N89-21785
- FUNCTIONAL DESIGN SPECIFICATIONS**  
Functional performance specification for an inertial navigation system p 526 N89-21785  
Surface temperature measurements using a thin film thermal array  
[NASA-TM-101549] p 558 N89-22868
- FURNACES**  
A proposal for funding to purchase a high-temperature furnace to enable determination of the high temperature mechanical properties of structural carbon materials  
[AD-A204103] p 542 N89-21809
- FUSELAGES**  
A numerical method for the analysis of a flight vehicle with a solid fuselage p 509 A89-37460  
Nonlinear supersonic potential flow over sideslip conical bodies, delta wings and fuselages p 511 A89-37792  
Development and testing of critical components for technological preparation of an Airbus-CFRP-fuselage, phase 2  
[MBB-UT-129/87] p 531 N89-22600
- FUZZY SETS**  
Application of the theory of fuzzy sets to the two-criterion stochastic optimization of ribbed shells p 556 A89-39823
- FUZZY SYSTEMS**  
Application of a fuzzy controller in the fuel system of a turbojet engine p 536 A89-39043

## G

- GAPS**  
Experimental investigation of aerodynamic heating by flow through control surface gaps p 510 A89-37785



# **GAS DENSITY**

Aerodynamic characteristics of arbitrarily rotating bodies in a variable-density gas p 509 A89-37355

# **GAS DETECTORS**

Supersonic particle probes: Measurement of internal wall losses  
[AD-A205863] p 521 N89-22589

# **GAS DISCHARGES**

A study of shock wave radiation near models at hypersonic velocities in air p 513 A89-38445

# **GAS FLOW**

Aerodynamic device for generating mono-disperse fuel droplets p 554 A89-37878  
Stability of gas flows in Laval nozzles p 512 A89-38438  
Simulation analysis on ceramic gas turbine [DE88-756469] p 548 N89-21926

# **GAS STREAMS**

Computation of dynamic process with large disturbance for split-shaft gas turbine p 535 A89-37772

# **GAS TURBINE ENGINES**

Metallurgical stability of Inconel alloy 718 p 545 A89-36405  
Development of Gatorized MERL 76 for gas turbine disk applications p 545 A89-36411  
Development of Inconel alloy MA 6000 turbine blades for advanced gas turbine engine designs p 545 A89-36414  
Beyond superalloys - The goals, the materials and some reality p 546 A89-36418  
The processing and testing of a hollow DS eutectic high pressure turbine blade p 541 A89-36436  
Aircraft gas turbine blade and vane repair p 533 A89-36473  
Degradation of aluminide coated directionally solidified supralloy turbine blades in an aero gas turbine engine p 546 A89-36480  
Dynamical calculations of engine components based on elasticity equations p 553 A89-37421  
LEADER - An automatic, real-time diagnostic knowledge system [SAE PAPER 881443] p 534 A89-37651  
Interrelation of engine design and burner configuration with selection and performance of electrical ignition systems for gas turbine engines p 534 A89-37654  
Aircraft turbine fuel contamination history and endurance test requirements p 547 A89-37658  
[SAE AIR 4023] p 547 A89-37658  
Leads, flexible, shielded, high energy ignition --- for gas turbine engines p 534 A89-37661  
[SAE ARP 841] p 534 A89-37661  
Computation of dynamic process with large disturbance for split-shaft gas turbine p 535 A89-37772  
Optimizing design for turboengine digital speed controller p 535 A89-37773  
INTERFACE 2: Advanced diagnostic software [AD-A204527] p 563 N89-22366  
Application of advanced materials for turbomachinery and rocket propulsion p 549 N89-22656  
Monolithic and fiber ceramic components for turboengines and rockets p 549 N89-22657  
CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 N89-22658  
New metallic materials for gas turbines p 549 N89-22660  
Damage tolerance concepts for advanced materials and engines p 549 N89-22661  
Material/manufacturing process interaction in advanced material technologies p 549 N89-22662  
The demonstration of monolithic and composite ceramics in aircraft gas turbine combustors p 550 N89-22665

# **GAS TURBINES**

Isothermal flow in a gas turbine combustor - A benchmark experimental study p 514 A89-38873  
Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800  
Research as part of the Air Force Research in Aero Propulsion Technology (AFRAPT) Program [AD-A204968] p 537 N89-21801  
Simulation analysis on ceramic gas turbine [DE88-756469] p 548 N89-21926

# **GEARS**

The transmission development process at Lucas Western p 551 A89-36398

# **GEODETIC COORDINATES**

Geodetic positioning system for flying aircraft (May 1987) p 527 N89-22598  
[REPT-013/88]

# **GEODIMETERS**

Geodetic positioning system for flying aircraft (May 1987) p 527 N89-22598  
[REPT-013/88]

# **GEOMETRICAL OPTICS**

Scattering from three-dimensional cracks p 565 A89-39588

# **GLIDE PATHS**

An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft [AD-A202910] p 526 N89-21782

# **GLIDERS**

Simulation of optimal flight paths of dynamical soaring flight and the design of a model aircraft p 529 A89-39259

# **GLOBAL POSITIONING SYSTEM**

Aircraft automatic landing systems using GPS p 525 A89-39827  
Geodetic positioning system for flying aircraft (May 1987) p 527 N89-22598  
[REPT-013/88]

# **GRANTS**

Eligibility of noise abatement proposals for grants-in-aid under the Airport Improvement Program [AD-A204724] p 542 N89-21812

# **GRAPHITE-EPOXY COMPOSITES**

Consideration of environmental conditions for the fatigue evaluation of composite airframe structure p 551 A89-36304  
Fracture of pressurized composite cylinders with a high strain-to-failure matrix system p 551 A89-36319  
Stall flutter of graphite/epoxy wings with bending-torsion coupling [AD-A203077] p 540 N89-21804  
The effects of plastic media blasting paint removal on the microstructure of graphite/epoxy composite materials [AD-A204801] p 550 N89-22688

# **GRAY SCALE**

Combustor flow visualization using innovative infrared thermographics techniques [AD-A205905] p 550 N89-22718

# **GRID GENERATION (MATHEMATICS)**

Transfinite interpolation method for 3-D grid generations p 509 A89-36986

# **GROOVES**

Riblet drag at flight conditions p 515 A89-39196

# **GROUND EFFECT (AERODYNAMICS)**

Rotor vortex wake distortion and its induced velocity in ground effect at low speed p 510 A89-37779  
Experimental investigation of dynamic ground effect p 514 A89-39185

# **GROUND RESONANCE**

Ground and air resonance of bearingless rotors in hover and forward flight p 529 N89-21786

# **GROUND STATIONS**

NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results p 552 A89-36585  
Inmarsat's aeronautical satellite communication system p 552 A89-36593  
Technical design and performance analysis of aeronautical satellite communication systems p 524 A89-36594  
Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

# **GROUND TESTS**

Human factors in cabin safety p 522 A89-36069  
NASA's program on icing research and technology [NASA-TM-101989] p 507 N89-22569

# **GUIDE VANES**

LDV measurements and investigation of flow field through radial turbine guide vanes p 538 N89-22609

# **GUST LOADS**

Gust analysis of an aircraft with highly non-linear systems interaction [AIAA PAPER 89-1377] p 527 A89-37650  
Prediction of fatigue life under aircraft loading with and without use of material memory rules p 527 A89-38028

# **GYROSCOPES**

Configuration of tuned dry gyro redundant system p 554 A89-38189

## **H**

# **HEAD-UP DISPLAYS**

HUD on the head for combat pilots p 532 A89-39227

# **HEAT RESISTANT ALLOYS**

On developing a microstructurally and thermally stable iron-nickel base superalloy p 545 A89-36406  
Causes and effects of center segregation in electro-slag remelted alloy 718 for critical rotating part applications p 545 A89-36410  
Development of Gatorized MERL 76 for gas turbine disk applications p 545 A89-36411

Development of Inconel alloy MA 6000 turbine blades for advanced gas turbine engine designs p 545 A89-36414

Second-generation nickel-base single crystal superalloy p 546 A89-36424  
Enhanced rupture properties in advanced single crystal alloys p 546 A89-36425  
A hafnium-free directionally solidified nickel-base superalloy p 546 A89-36435  
Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK50 p 546 A89-36440

Property optimization in superalloys through the use of heat treat process modelling p 546 A89-36452  
Laser drilling of a superalloy coated with ceramic p 551 A89-36455

Degradation of aluminide coated directionally solidified superalloy turbine blades in an aero gas turbine engine p 546 A89-36480

Application of Advanced Material for Turbomachinery and Rocket Propulsion [AGARD-CP-449] p 548 N89-22654

# **HEAT TRANSFER**

Hydrodynamics and heat transfer in the porous elements of flight vehicle structures --- Russian book p 554 A89-38499  
Nonstationary thermal duty of the structural elements of flight vehicles --- Russian book p 535 A89-38502

# **HEAT TREATMENT**

Metallurgical stability of Inconel alloy 718 p 545 A89-36405  
Property optimization in superalloys through the use of heat treat process modelling p 546 A89-36452

# **HEATING EQUIPMENT**

Two-dimensional simulation of electrothermal deicing of aircraft components p 528 A89-39194

# **HELICOPTER CONTROL**

More helicopter aerodynamics --- Book p 513 A89-38578  
A flight dynamic study of the helicopter including blade dynamics p 531 N89-21796

# **HELICOPTER DESIGN**

Helicopters and VTOL I p 527 A89-36899  
Experimental studies in system identification of helicopter rotor dynamics p 528 A89-38554  
More helicopter aerodynamics --- Book p 513 A89-38578  
Extension of classical tip loss formulas --- for rotorcraft design p 528 A89-38652  
Composites - Helicopters leading the way p 528 A89-39086  
Robust control of an active vibration isolation system for helicopters p 539 A89-39458

# **HELICOPTER ENGINES**

A review and forecast of engine system research at the Army Propulsion Directorate p 533 A89-36397  
The transmission development process at Lucas Western p 551 A89-36398  
T800/A129 flight program p 533 A89-36399  
T700 - Growing to meet the challenge p 533 A89-36400

# **HELICOPTER WAKES**

Extension of classical tip loss formulas --- for rotorcraft design p 528 A89-38652  
Description of a simple rotor test rig and preliminary wake studies [AD-A204089] p 541 N89-21808

# **HELICOPTERS**

Lateral induced velocity distribution of a helicopter rotor p 509 A89-36987  
Analytical modeling of helicopter static and dynamic induced velocity in GRASP p 513 A89-38555  
F.E. simulation of crash for helicopters p 529 A89-39472  
The naval aircraft crash environment: Aircrew survivability and aircraft structural response [AD-A204825] p 523 N89-21780  
Artificial and natural icing tests of the EH-60A quick fix helicopter [AD-A204589] p 530 N89-21792  
A flight dynamic study of the helicopter including blade dynamics p 531 N89-21796

# **HELIUM**

Color helium bubble flow-visualization technique p 556 A89-39186

# **HIGH REYNOLDS NUMBER**

Transonic and supersonic flow past a 65 deg delta wing with rounded leading edges: Analysis of experimental data [DFVLR-FB-88-44] p 520 N89-22580

# **HIGH SPEED**

On the three families of instability waves of high-speed jets p 513 A89-38624

# **HIGH SPEED CAMERAS**

A two-spark schlieren system for very-high velocity measurement p 555 A89-38874



## HIGH TEMPERATURE ENVIRONMENTS

## SUBJECT INDEX

### HIGH TEMPERATURE ENVIRONMENTS

Effect of crack size on the tensile strength of ceramics in a high-temperature corrosive environment p 547 A89-38021

### HOLES (MECHANICS)

Laser drilling of a superalloy coated with ceramic p 551 A89-36455

### HOLOGRAPHIC INTERFEROMETRY

Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764

### HONEYCOMB STRUCTURES

Annular honeycomb seals: Test results for leakage and rotodynamic coefficients; comparisons to labyrinth and smooth configurations p 559 A89-22899

### HORIZONTAL FLIGHT

Ground and air resonance of bearingless rotors in hover and forward flight p 529 A89-21786

### HOT CORROSION

Influence of thermal fatigue on hot corrosion of an intermetallic Ni-aluminide coating p 547 A89-36484  
Effect of crack size on the tensile strength of ceramics in a high-temperature corrosive environment p 547 A89-38021

### HOT ISOSTATIC PRESSING

Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474

### HOUSINGS

Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 A89-22912

### HOVERING

Ground and air resonance of bearingless rotors in hover and forward flight p 529 A89-21786

### HOVERING STABILITY

The constraint wake analysis for hovering rotors p 511 A89-37790

### HUMAN FACTORS ENGINEERING

Human factors in cabin safety p 522 A89-36069  
Model-based analysis and cooperative synthesis of control and display augmentation for piloted flight vehicles p 540 A89-22610  
AGARD highlights 88/2 p 566 A89-23403

### HYDRAULIC EQUIPMENT

Acta Aeronautica et Astronautica Sinica (selected articles) p 508 A89-22570

### HYDRODYNAMICS

Hydrodynamics and heat transfer in the porous elements of flight vehicle structures --- Russian book p 554 A89-38499

### HYGROMETERS

Test of a calibration device for airborne Lyman-alpha hygrometers p 532 A89-37537

### HYPERSONIC AIRCRAFT

Experimental investigation of applicability of waverider configuration to hypersonic transport and aerospace-plane p 511 A89-38123

### HYPERSONIC BOUNDARY LAYER

Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows p 518 A89-21774

### HYPERSONIC FLIGHT

The effect of exhaust plume/afterbody on installed scramjet performance p 536 A89-21797  
New hypersonic facility capability at NASA Lewis Research Center [NASA-TM-102028] p 543 A89-22617

### HYPERSONIC FLOW

Separation shock motion in fin, cylinder, and compression ramp - Induced turbulent interactions p 509 A89-36911  
Dependence of regime coefficients on regime parameters in local interaction theory p 512 A89-38435

A study of shock wave radiation near models at hypersonic velocities in air p 513 A89-38445

Numerical calculations of hypersonic nonequilibrium flow over a blunt wedge p 515 A89-39461

Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements [NASA-CR-184896] p 517 A89-21772

Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows p 518 A89-21774

Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating [AD-A205077] p 518 A89-21775

Transition to turbulence in laminar hypersonic flow p 522 A89-22830

### HYPERSONIC FORCES

The effect of exhaust plume/afterbody on installed scramjet performance p 536 A89-21797

### HYPERSONIC HEAT TRANSFER

Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows p 518 A89-21774

### HYPERSONIC REENTRY

Stability and control of hypervelocity vehicles [AD-A205160] p 540 A89-21807

### HYPERSONIC VEHICLES

Materials for the NASP p 547 A89-36722  
Structures for hypervelocity flight p 552 A89-36723  
Hypersonic technology for military application --- Book p 507 A89-37875

Stability and control of hypervelocity vehicles [AD-A205160] p 540 A89-21807

New hypersonic facility capability at NASA Lewis Research Center [NASA-TM-102028] p 543 A89-22617

### HYPERSONIC WIND TUNNELS

New hypersonic facility capability at NASA Lewis Research Center [NASA-TM-102028] p 543 A89-22617

### HYPERSONICS

Review of sonic boom theory [AIAA PAPER 89-1105] p 564 A89-36219  
Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements [NASA-CR-184896] p 517 A89-21772

### HYPERVELOCITY

Structures for hypervelocity flight p 552 A89-36723

### HYSTERESIS

A study of unsteady turbulent flow past airfoils p 521 A89-22587

## I

### ICE

Artificial and natural icing tests of the UH-60A helicopter configured with the XM-139 multiple mine dispensing system (VOLCANO) [AD-A205031] p 531 A89-21794

### ICE ENVIRONMENTS

Artificial and natural icing tests of the EH-60A quick fix helicopter [AD-A204589] p 530 A89-21792

### ICE FORMATION

Artificial and natural icing tests of the EH-60A quick fix helicopter [AD-A204589] p 530 A89-21792  
Artificial and natural icing tests of the UH-60A helicopter configured with the XM-139 multiple mine dispensing system (VOLCANO) [AD-A205031] p 531 A89-21794  
NASA's program on icing research and technology [NASA-TM-101989] p 507 A89-22569

### ICE PREVENTION

NASA's program on icing research and technology [NASA-TM-101989] p 507 A89-22569  
Electro-impulse de-icing research: Fatigue and electromagnetic interference tests [DOT/FAA/CT-88/27] p 524 A89-22594

### IGNITION SYSTEMS

Interrelation of engine design and burner configuration with selection and performance of electrical ignition systems for gas turbine engines [SAE AIR 784] p 534 A89-37654  
Leads, flexible, shielded, high energy ignition --- for gas turbine engines [SAE ARP 841] p 534 A89-37661

### IMAGE PROCESSING

Modeling of density fluctuations in supersonic turbulent boundary layer p 509 A89-36923  
Combustor flow visualization using innovative infrared thermographics techniques [AD-A205905] p 550 A89-22718

### IMPACT

Evaluation of barrier cable impact pad materials [AD-A204356] p 542 A89-21811

### IMPACT DAMAGE

Investigation on simulation of foreign object impact damage to compressor blade p 534 A89-37757

### IMPACT TESTS

Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft p 544 A89-36543  
CSPC test 319.30: Study on impact tolerance of preimpregnated carbon-epoxy systems [REPT-47-323/F] p 550 A89-22703

### IMPELLERS

Contribution to centrifugal impeller design p 553 A89-37525  
Rotodynamic Instability Problems in High-Performance Turbomachinery, 1988 [NASA-CP-3026] p 558 A89-22891

Some field experience with subsynchronous vibration of centrifugal compressors p 559 A89-22892  
Influence of impeller shroud forces on turbopump rotor dynamics p 560 A89-22909

### IN-FLIGHT MONITORING

Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise p 529 A89-39509

### INCIDENCE

The effects of incidence angle and free stream turbulence on the performance of a variable geometry two-dimensional compressor cascade at high Reynolds numbers [AD-A202650] p 557 A89-22052

### INCOMPRESSIBLE FLOW

Potential flow over bodies of revolution in unsteady motion p 508 A89-36910  
Note on the lifting-surface problem for a circular wing in incompressible flow p 514 A89-38939  
Wing-store flutter analysis of an airfoil in incompressible flow p 528 A89-39198  
Lifetime aerofoil calculations using von Mises variables p 516 A89-39666  
Primitive numerical simulation of circular Couette flow p 516 A89-21764

Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 A89-22586  
Aerodynamic detuning of a loaded airfoil cascade in an incompressible flow by a locally analytical method p 521 A89-22588

Computational investigation of incompressible airfoil flows at high angles of attack [AD-A205885] p 522 A89-22590

### INCONEL (TRADEMARK)

Metallurgical stability of Inconel alloy 718 p 545 A89-36405  
Development of Inconel alloy MA 6000 turbine blades for advanced gas turbine engine designs p 545 A89-36414  
Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK50 p 546 A89-36440

### INDEPENDENT VARIABLES

Investigations of the parameter reduction in the optimization of aircraft wing structures [ILR-MITT-203] p 531 A89-21795

### INERTIAL NAVIGATION

Functional performance specification for an inertial navigation system [AD-A204850] p 526 A89-21785  
Pre and post modification electromagnetic compatibility test report for the C-130H self contained navigation system with MLS A-kit, revision [AD-A205167] p 533 A89-22604

### INFILTRATION

CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 A89-22658

### INFINITE SPAN WINGS

Flutter of a wing with an aileron in transonic flow p 539 A89-37461

### INFRARED IMAGERY

Infrared thermography - A quantitative tool for heat study [ONERA, TP NO. 1989-3] p 553 A89-37627  
Application of infrared thermography to the interpretation of tests in an icing wind tunnel [ONERA, TP NO. 1989-28] p 554 A89-37642  
Combustor flow visualization using innovative infrared thermographics techniques [AD-A205905] p 550 A89-22718

### INFRARED TRACKING

The problems of the infrared stealth of the flying vehicles p 507 A89-37003

### INJECTION

Numerical study of a multipurpose transonic wind tunnel with an adaptable injection-suction system p 543 A89-22621

### INLET FLOW

AF-2 scheme for solution of axial symmetric transonic inlet-flowfield p 511 A89-37791  
Numerical simulation of flow through a two-strut scramjet inlet p 514 A89-39038

### INSTRUMENT APPROACH

A procedure for operating dependent instrument approaches to converging runways [AD-A204723] p 526 A89-21784

### INSTRUMENT COMPENSATION

Test of a calibration device for airborne Lyman-alpha hygrometers p 532 A89-37537

**INSTRUMENT FLIGHT RULES**

- An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft  
[AD-A202910] p 526 N89-21782
- A procedure for operating dependent instrument approaches to converging runways  
[AD-A204723] p 526 N89-21784

**INSTRUMENT LANDING SYSTEMS**

- Instrument landing system mathematical modeling study for Orlando International Airport Runway 17R localizer, Orlando, Florida, revised airside docking plan (Scheme 3A)  
[AD-A204722] p 526 N89-21783

**INTAKE SYSTEMS**

- Electromagnetic backscatter from open-ended circular cylinder with complex termination p 536 A89-39284

**INTERACTIONAL AERODYNAMICS**

- Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186
- Fluctuating pressures on wing surfaces in the slipstream of a single-rotor propfan  
[AIAA PAPER 89-1058] p 564 A89-36218
- Blade-vortex interaction p 508 A89-36905
- Separation shock motion in fin, cylinder, and compression ramp - Induced turbulent interactions  
p 509 A89-36911
- Explicit Runge-Kutta method for unsteady rotor/stator interaction p 509 A89-36912
- Integrated approach for active coupling of structures and fluids p 552 A89-36917
- New possibilities of viscous-inviscid numerical techniques for solving viscous flow equations with massive separation  
[ONERA, TP NO. 1989-24] p 554 A89-37640
- Gust analysis of an aircraft with highly non-linear systems interaction p 512 A89-38432
- The computation of the viscous/inviscid interaction p 510 A89-37777
- Consideration of the effect of surface roughness on regime coefficients in local interaction theory p 512 A89-38432
- Dependence of regime coefficients on regime parameters in local interaction theory p 512 A89-38435
- Three-dimensional Navier-Stokes simulations of turbine rotor-stator interaction. I - Methodology p 514 A89-39034
- Experimental investigation of shock wave/boundary-layer interactions in an annular duct p 514 A89-39039
- Wing-store flutter analysis of an airfoil in incompressible flow p 528 A89-39198
- Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800
- Interaction between an isolated vortex and a wing profile  
[ETN-89-94364] p 520 N89-22579
- Computational investigation of incompressible airfoil flows at high angles of attack  
[AD-A205885] p 522 N89-22590

- INTERFEROMETRY**
- Interferometry against differential Doppler - Performance comparison of two emitter location airborne systems p 525 A89-39203
- The evaluation and representation of interferograms of transonic flow fields  
[MPIS-21/1987] p 518 N89-21777
- INTERMETALLICS**
- Beyond superalloys - The goals, the materials and some reality p 546 A89-36418
- INTERNATIONAL COOPERATION**
- Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596
- The Chicago Convention - Article 33 and the SFAR 40 episode p 566 A89-38876
- INTERPOLATION**
- Transfinite interpolation method for 3-D grid generations p 509 A89-36986
- Compressible Euler solution around a wing canard sting configuration  
[FFA-TN-1988-62] p 519 N89-22578

- INVISID FLOW**
- The computation of the viscous/inviscid interaction p 510 A89-37777
- Inviscid, unsteady, transonic axisymmetric flow with shock waves - Response to time and space-time dependent perturbations p 512 A89-38129
- Numerical solutions of unsteady inviscid transonic turbine cascade flows p 516 N89-21767
- Aerodynamics of engine-airframe interaction  
[NASA-CR-184824] p 517 N89-21769

- IRON ALLOYS**
- On developing a microstructurally and thermally stable iron-nickel base superalloy p 545 A89-36406

**ISOTHERMAL FLOW**

- Isothermal flow in a gas turbine combustor - A benchmark experimental study p 514 A89-38873

**ISOTROPIC TURBULENCE**

- A seal test facility for the measurement of isotropic and anisotropic linear rotordynamic characteristics p 560 N89-22905

**J****J-85 ENGINE**

- J85 surge transient simulation p 536 A89-39044

**JAPANESE SPACECRAFT**

- Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

**JET AIRCRAFT NOISE**

- Rectangular nozzle plume velocity modeling for use in jet noise prediction  
[NASA-TM-102047] p 519 N89-22577

**JET ENGINE FUELS**

- Scramjet combustion with an aid of silane p 547 A89-38387
- Jet fuel deoxygenation  
[AD-A205006] p 548 N89-21943

**JET ENGINES**

- Electromagnetic backscatter from open-ended circular cylinder with complex termination p 536 A89-39284
- PARC code validation for propulsion flows  
[AD-A204293] p 557 N89-22066
- INTERFACE 2: Advanced diagnostic software  
[AD-A204527] p 563 N89-22366
- Supersonic particle probes: Measurement of internal wall losses  
[AD-A205863] p 521 N89-22589

**JET FLOW**

- The application of wall pressure method in low speed return wind tunnel with closed jet p 541 A89-37786
- On the three families of instability waves of high-speed jets p 513 A89-38624

**JET VANES**

- Aircraft gas turbine blade and vane repair p 533 A89-36473

**JOINED WINGS**

- The joined wing - The benefits and drawbacks. I p 507 A89-38800

**JOINTS (JUNCTIONS)**

- The fatigue in aircraft corrosion testing (FACT) programme  
[AGARD-R-713] p 548 N89-21873

**JOURNAL BEARINGS**

- Active vibration control of flexible rotors - An experimental and theoretical study p 554 A89-37847

**K****K-EPSILON TURBULENCE MODEL**

- Transonic viscous flow calculations for a turbine cascade with a two equation turbulence model  
[NASA-TM-101944] p 537 N89-22607
- Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 N89-22900
- Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position p 560 N89-22906

**KELVIN-HELMHOLTZ INSTABILITY**

- On the three families of instability waves of high-speed jets p 513 A89-38624

**KINEMATICS**

- Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 N89-22586

**L****LABYRINTH SEALS**

- Annular honeycomb seals: Test results for leakage and rotordynamic coefficients; comparisons to labyrinth and smooth configurations p 559 N89-22899
- Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 N89-22900
- Rotordynamic coefficients for stepped labyrinth gas seals p 560 N89-22901
- Rotordynamic stability problems and solutions in high pressure turbocompressors p 561 N89-22914

**LAMINAR FLOW**

- The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration  
[NASA-TM-4100] p 516 N89-21762
- Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds  
[AD-A205206] p 519 N89-22575

- Transition to turbulence in laminar hypersonic flow p 522 N89-22830

**LAMINAR HEAT TRANSFER**

- PARC code validation for propulsion flows  
[AD-A204293] p 557 N89-22066

**LAND MOBILE SATELLITE SERVICE**

- NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results p 552 A89-36585

**LANDING**

- High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 A89-39195

**LANDING GEAR**

- Failure analysis: Analysis of landing gear fatigue test results for mechanical and metallurgical considerations in order to determine the authorized run time p 556 N89-21984
- Acta Aeronautica et Astronautica Sinica (selected articles)  
[AD-A205128] p 508 N89-22570

**LASER ANEMOMETERS**

- Three component laser Doppler anemometry in large wind tunnels p 555 A89-38615
- Implementation of a two-component laser anemometer at the T2 wind tunnel  
[A-501-H] p 558 N89-22879

**LASER DOPPLER VELOCIMETERS**

- Three component laser Doppler anemometry in large wind tunnels p 555 A89-38615
- LDV measurements and investigation of flow field through radial turbine guide vanes p 538 N89-22609

**LASER DRILLING**

- Laser drilling of a superalloy coated with ceramic p 551 A89-36455

**LATERAL STABILITY**

- Lateral stability analysis for X-29A drop model using system identification methodology  
[NASA-TM-4108] p 539 N89-21802

**LAUNCHERS**

- Artificial and natural icing tests of the UH-60A helicopter configured with the XM-139 multiple mine dispensing system (VOLCANO)  
[AD-A205031] p 531 N89-21794

**LAW (JURISPRUDENCE)**

- Accident investigation and the public interest - A pilot's view p 523 A89-39224

**LEACHING**

- Jet fuel deoxygenation  
[AD-A205006] p 548 N89-21943

**LEADING EDGES**

- On the unsteady leading edge suction of a sweptback wing p 510 A89-37776
- Electroimpulse deicing - Electrodynamical solution by discrete elements p 528 A89-39193
- Flow over a leading edge with distributed roughness  
[DFVLR-FB-88-45] p 520 N89-22581
- Electro-impulse de-icing research: Fatigue and electromagnetic interference tests  
[DOT/FAA/CT-88/27] p 524 N89-22594

**LEAKAGE**

- Annular honeycomb seals: Test results for leakage and rotordynamic coefficients; comparisons to labyrinth and smooth configurations p 559 N89-22899

**LIFE (DURABILITY)**

- Failure analysis: Analysis of landing gear fatigue test results for mechanical and metallurgical considerations in order to determine the authorized run time p 556 N89-21984
- Technical evaluation report p 548 N89-22655
- Acceleration test for aircraft low-pass filter  
[PB89-116263] p 557 N89-22807

**LIFT DEVICES**

- Control augmented structural optimization of aeroelastically tailored fiber composite wings  
[AD-A204534] p 530 N89-21791

**LIFTING BODIES**

- Note on the lifting-surface problem for a circular wing in incompressible flow p 514 A89-38939
- Lifetime aerofoil calculations using von Mises variables p 516 A89-39666

**LIFTING ROTORS**

- Development of stress and lifting criteria for single crystal turbine blades p 549 N89-22663

**LIGHT HELICOPTERS**

- T800/A129 flight program p 533 A89-36399

**LINEAR QUADRATIC GAUSSIAN CONTROL**

- Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931

**LINEAR QUADRATIC REGULATOR**

- Selection of weighting matrices for linear optimal regulator p 563 A89-36990

**LINEAR SYSTEMS**

- Sensitivity analysis of digital flight control systems using singular-value concepts p 538 A89-36927

## LINEARIZATION

Input signal selection in the identification of linear continuous dynamic systems from discrete observations p 563 A89-39777

### LINEARIZATION

Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916  
Measures of modal controllability and observability for first- and second-order linear systems p 563 A89-36943

Acta Aeronautica et Astronautica Sinica (selected articles) p 508 A89-22570  
[AD-A205128]

### LIQUID PROPELLANT ROCKET ENGINES

Application of advanced materials for turbomachinery and rocket propulsion p 549 A89-22656

### LITHIUM NIOBATES

Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764

### LOAD DISTRIBUTION (FORCES)

The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body p 516 A89-21765

### LOAD TESTING MACHINES

Single channel test controllers p 541 A89-22611  
[AD-A204088]

### LOADING OPERATIONS

Computer simulation of the movement of loading door retraction mechanism with slide tracks p 527 A89-37019

### LOADS (FORCES)

Influence of impeller shroud forces on turbopump rotor dynamics p 560 A89-22909

### LOCKHEED AIRCRAFT

USAF/Lockheed F-117A has high wing sweep but low wing loading p 528 A89-39234

### LONGITUDINAL STABILITY

Validation of nonstationary aerodynamics models for longitudinal aeroplane motion on the basis of flight measurements p 539 A89-37524

### LOW PASS FILTERS

Acceleration test for aircraft low-pass filter [PB89-116263] p 557 A89-22807

### LOW SPEED WIND TUNNELS

The application of wall pressure method in low speed return wind tunnel with closed jet p 541 A89-37786  
The low-speed wind tunnel at DVFLR in Brunswick (Fed. Republic of Germany) [DFVLR-MITT-88-25] p 543 A89-22619

### LYMAN ALPHA RADIATION

Test of a calibration device for airborne Lyman-alpha hygrometers p 532 A89-37537

## M

### MACH NUMBER

Mach number effects on high-angles-of-attack aerodynamic characteristics of a cone-cylinder with various nose shapes p 511 A89-38122

### MACH REFLECTION

Investigation of Mach reflection for a planar moving shock propagating into steady supersonic flow field around wedge p 510 A89-37782  
Highly-resolved flowfield induced by Mach reflection p 512 A89-38125

### MAGNETIC BEARINGS

Magnetic bearing stiffness control using frequency band filtering p 560 A89-22910

### MAGNETIC CIRCUITS

Experimental verification of an eddy-current bearing p 561 A89-22913

### MAGNETIC EFFECTS

A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 A89-22911

### MAGNETIC MATERIALS

Plastic media blasting recycling equipment study [AD-A202463] p 556 A89-21987

### MAINTENANCE

Transmission overhaul and replacement predictions using Weibull and renewal theory [NASA-TM-102022] p 562 A89-22925

### MAN MACHINE SYSTEMS

Voice of authority --- control systems for space vehicles p 544 A89-37646

Model-based analysis and cooperative synthesis of control and display augmentation for piloted flight vehicles p 540 A89-22610

### MANAGEMENT PLANNING

Eligibility of noise abatement proposals for grants-in-aid under the Airport Improvement Program [AD-A204724] p 542 A89-21812

### MANEUVERABILITY

Ground collision warning system performance criteria for high maneuverability aircraft [AD-A204390] p 523 A89-21779

### MANEUVERS

An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft [AD-A202910] p 526 A89-21782

### MANUAL CONTROL

Model-based analysis and cooperative synthesis of control and display augmentation for piloted flight vehicles p 540 A89-22610

### MARITIME SATELLITES

NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results p 552 A89-36585

### MASS BALANCE

Experimental investigation of sudden imbalance response on a flexible rotor system with squeeze-film damper p 554 A89-37768

### MASS RATIOS

Wake recontact: An experimental investigation using a ringslot parachute [DE89-008320] p 518 A89-21773

### MATERIALS RECOVERY

Plastic media blasting recycling equipment study [AD-A202463] p 556 A89-21987

### MATHEMATICAL MODELS

Property optimization in superalloys through the use of heat treat process modelling p 546 A89-36452  
Primitive numerical simulation of circular Couette flow p 516 A89-21764

Flow past bluff bodies p 517 A89-21770

Instrument landing system mathematical modeling study for Orlando International Airport Runway 17R localizer, Orlando, Florida, revised airside docking plan (Scheme 3A) [AD-A204722] p 526 A89-21783

A flight dynamic study of the helicopter including blade dynamics p 531 A89-21796

Energy concepts applied to control of airplane flight in wind shear p 540 A89-21806

Theoretical investigation of 3-D shock wave-turbulent boundary layer interactions, part 7 [AD-A204482] p 557 A89-22070

Microburst simulation via vortex-ring and turbulent jet models p 562 A89-22287

Acta Aeronautica et Astronautica Sinica (selected articles) [AD-A205128] p 508 A89-22570

Rectangular nozzle plume velocity modeling for use in jet noise prediction [NASA-TM-102047] p 519 A89-22577

Aerodynamic detuning of a loaded airfoil cascade in an incompressible flow by a locally analytical method p 521 A89-22588

Transition to turbulence in laminar hypersonic flow p 522 A89-22830

Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 [NASA-CP-3026] p 558 A89-22891

A seal test facility for the measurement of isotropic and anisotropic linear rotordynamic characteristics p 560 A89-22905

A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 A89-22911

Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 A89-22912

Enhanced rotor modelling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

### MATRICES (MATHEMATICS)

Selection of weighting matrices for linear optimal regulator p 563 A89-36990

### MATRIX MATERIALS

Taming ceramic fiber p 547 A89-36721

### MECHANICAL DRIVES

Calculation of the principal parameters of the actuating mechanisms of aircraft slave drives --- Russian book p 555 A89-38500

### MECHANICAL PROPERTIES

A hafnium-free directionally solidified nickel-base superalloy p 546 A89-36435

The processing and testing of a hollow DS eutectic high pressure turbine blade p 551 A89-36436

Property optimization in superalloys through the use of heat treat process modelling p 546 A89-36452

A proposal for funding to purchase a high-temperature furnace to enable determination of the high temperature mechanical properties of structural carbon materials [AD-A204103] p 542 A89-21809

Evaluation of barrier cable impact pad materials [AD-A204356] p 542 A89-21811

Materials tests: Means and techniques p 548 A89-21983

Theoretical investigation of 3-D shock wave-turbulent boundary layer interactions, part 7 [AD-A204482] p 557 A89-22070

Tests of new materials with second generation carbon fibers, test report [REPT-47-188/F] p 550 A89-22702

CSPC test 319.30: Study on impact tolerance of preimpregnated carbon-epoxy systems [REPT-47-323/F] p 550 A89-22703

### MELTING

Causes and effects of center segregation in electro-slag remelted alloy 718 for critical rotating part applications p 545 A89-36410

### METAL COATINGS

Anodized aluminum and aluminum alloy coatings for thermal control p 547 A89-38153

### METAL MATRIX COMPOSITES

Beyond superalloys - The goals, the materials and some reality p 546 A89-36418

Material/manufacturing process interaction in advanced material technologies p 549 A89-22662

### METAL SHEETS

Modern joining methods for future aircraft structures p 556 A89-39076

### MICROBURSTS (METEOROLOGY)

Energy concepts applied to control of airplane flight in wind shear p 540 A89-21806

Microburst simulation via vortex-ring and turbulent jet models p 562 A89-22287

Hazard index calculation for 31 May 1984 microburst at Erie, Colorado [NASA-CR-184968] p 562 A89-23048

### MICROCOMPUTERS

Study on exchange operation between two microcomputers in aeroengine digital control p 535 A89-37774

Microcomputer based controller for the Langley 0.3-meter Transonic Cryogenic Tunnel [NASA-CR-181808] p 543 A89-22616

### MICROGRAVITY APPLICATIONS

The optical bidirectional accelerometer --- for microgravity experiments p 553 A89-36966

### MICROSTRUCTURE

On developing a microstructurally and thermally stable iron-nickel base superalloy p 545 A89-36406

The effects of plastic media blasting paint removal on the microstructure of graphite/epoxy composite materials [AD-A204801] p 550 A89-22688

### MICROWAVE CIRCUITS

Generalized criteria for microwave breakdown in air-filled waveguides p 552 A89-36655

### MICROWAVE LANDING SYSTEMS

Instrument landing system mathematical modeling study for Orlando International Airport Runway 17R localizer, Orlando, Florida, revised airside docking plan (Scheme 3A) [AD-A204722] p 526 A89-21783

Pre and post modification electromagnetic compatibility test report for the C-130H self contained navigation system with MLS A-kit, revision [AD-A205167] p 533 A89-22604

### MIDAIR COLLISIONS

Coming to terms with TCAS p 522 A89-39088

Description of the derivation of the collision risk model used in the vertical separation simulation risk model [AD-A205109] p 523 A89-21781

### MILITARY AIRCRAFT

V-22 prepared for further expansion of flight envelope p 527 A89-36575

Trajectory optimization with risk minimization for military aircraft p 538 A89-36929

The problems of the infrared stealth of the flying vehicles p 507 A89-37003

Hypersonic technology for military application --- Book p 507 A89-37875

Application of nondestructive inspection methods to composites p 555 A89-38951

### MILITARY HELICOPTERS

A review and forecast of engine system research at the Army Propulsion Directorate p 533 A89-36397

### MILITARY OPERATIONS

Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system [AD-A204030] p 530 A89-21790

### MINES (ORDNANCE)

Artificial and natural icing tests of the UH-60A helicopter configured with the XM-139 multiple mine dispensing system (VOLCANO) [AD-A205031] p 531 A89-21794

### MISSILE CONFIGURATIONS

Transonic and supersonic wind tunnel tests on control effectiveness on schematic missile configurations with canard controls [FFA-TN-1988-11] p 531 A89-22601

## SUBJECT INDEX

### MISSILE CONTROL

Transonic and supersonic wind tunnel tests on control effectiveness on schematic missile configurations with canard controls  
[FFA-TN-1988-11] p 531 N89-22601

### MISSION ADAPTIVE WINGS

AFTI (Advanced Fighter Technology Integration)/F-111 mission adaptive wing briefing to industry  
[AD-A202467] p 530 N89-21787

### MISSION PLANNING

A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance  
[AD-A204856] p 531 N89-21793

### MIXING LAYERS (FLUIDS)

Linear instability waves in supersonic turbulent mixing layers p 508 A89-36903

### MOBILE COMMUNICATION SYSTEMS

International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings p 552 A89-36576  
NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results p 552 A89-36585

### MODAL RESPONSE

Measures of modal controllability and observability for first- and second-order linear systems p 563 A89-36943  
Multi-input/multi-output frequency domain modal identification method and its application in ground vibration testing p 529 A89-39454

### MODEL REFERENCE ADAPTIVE CONTROL

Flight control system design for an in-flight simulator p 539 A89-36934

### MOIRE FRINGES

Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method p 553 A89-37006

### MOTION PICTURES

Cavitation effects on the pressure distribution of a squeeze film damper bearing p 559 N89-22897

### MOTION STABILITY

Synthesis of systems for the motion control of nonstationary objects --- Russian book p 563 A89-38512

### MOTORS

Experimental verification of an eddy-current bearing p 561 N89-22913

### MULTISENSOR APPLICATIONS

Fusion of multisensor data: A summary of the JASMIN project  
[FOA-C-30498-3.3] p 563 N89-23213

### MULTIVARIATE STATISTICAL ANALYSIS

Multivariable control law design for the Control Reconfigurable Combat Aircraft (CRCA)  
[AD-A202697] p 540 N89-21803

## N

### NATIONAL AIRSPACE SYSTEM

National airspace system plan: Facilities, equipment, associated development and other capital needs  
[AD-A202615] p 526 N89-22596

### NATIONAL AIRSPACE UTILIZATION SYSTEM

National airspace system plan: Facilities, equipment, associated development and other capital needs  
[AD-A202615] p 526 N89-22596

### NAVIER-STOKES EQUATION

Navier-Stokes computations of two- and three-dimensional cascade flowfields p 514 A89-39035  
Primitive numerical simulation of circular Couette flow p 516 N89-21764

PARC code validation for propulsion flows  
[AD-A204293] p 557 N89-22066

Theoretical investigation of 3-D shock wave-turbulent boundary layer interactions, part 7  
[AD-A204482] p 557 N89-22070  
Computational fluid dynamics research in three-dimensional zonal techniques  
[NASA-CR-181406] p 558 N89-22838

### NAVIGATION AIDS

Air navigation systems. I - Astronomical navigation in the air 1919-1969. Part II - Instruments p 532 A89-39828

### NAVIGATION SATELLITES

International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings p 552 A89-36576  
Combining the use of geostationary and inclined orbit satellites for integrated communications and navigation applications p 544 A89-36611  
Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

### NEAR FIELDS

Near-field acoustic characteristics of a single-rotor propfan  
[AIAA PAPER 89-1055] p 533 A89-36215  
Near-field scattering measurements for determining complex target RCS p 532 A89-39587

### NEURAL NETS

Neural computing for numeric-to-symbolic conversion in control systems p 563 A89-37234

### NICKEL ALLOYS

On developing a microstructurally and thermally stable iron-nickel base superalloy p 545 A89-36406  
Development of Gatorized MERL 76 for gas turbine disk applications p 545 A89-36411  
Second-generation nickel-base single crystal superalloy p 546 A89-36424  
A hafnium-free directionally solidified nickel-base superalloy p 546 A89-36435  
The processing and testing of a hollow DS eutectic high pressure turbine blade p 551 A89-36436  
Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK10 p 546 A89-36440  
Influence of thermal fatigue on hot corrosion of an intermetallic Ni-aluminide coating p 547 A89-36484  
New metallic materials for gas turbines p 549 N89-22660  
Material/manufacturing process interaction in advanced material technologies p 549 N89-22662

### NIGHT VISION

Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system  
[AD-A204030] p 530 N89-21790

### NIMONIC ALLOYS

Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK10 p 546 A89-36440

### NITROGEN OXIDES

Investigation of low NOx staged combustor concept in high-speed civil transport engines  
[NASA-TM-101977] p 537 N89-22606

### NOISE GENERATORS

Shock structure in non-circular jets  
[AIAA PAPER 89-1083] p 510 A89-37653  
A note on sound from the interruption of a cylindrical flow by a semi-infinite aerofoil of subsonic speed p 565 A89-39506

### NOISE PREDICTION

High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 A89-39195

### NOISE PREDICTION (AIRCRAFT)

Near-field acoustic characteristics of a single-rotor propfan  
[AIAA PAPER 89-1055] p 533 A89-36215  
Installed propfan (SR-7L) far-field noise characteristics  
[AIAA PAPER 89-1056] p 564 A89-36216  
Lateral noise attenuation of the advanced propeller of the propfan test assessment aircraft  
[AIAA PAPER 89-1057] p 564 A89-36217  
Fluctuating pressures on wing surfaces in the slipstream of a single-rotor propfan  
[AIAA PAPER 89-1058] p 564 A89-36218  
A prediction of high-speed rotor noise  
[AIAA PAPER 89-1132] p 564 A89-36220  
Prediction of counter-rotation propeller noise  
[AIAA PAPER 89-1141] p 564 A89-36221  
Asymptotic analysis of the transonic region of a high-speed propeller  
[AIAA PAPER 89-1077] p 565 A89-37652  
Rectangular nozzle plume velocity modeling for use in jet noise prediction  
[NASA-TM-102047] p 519 N89-22577

### NOISE REDUCTION

Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise p 529 A89-39509  
A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510  
Eligibility of noise abatement proposals for grants-in-aid under the Airport Improvement Program  
[AD-A204724] p 542 N89-21812

### NOISE TOLERANCE

Evaluation of the ride quality of a light twin engine airplane using a ride quality meter  
[NASA-TP-2913] p 507 N89-22568

### NONDESTRUCTIVE TESTS

Infrared thermography - A quantitative tool for heat study  
[ONERA, TP NO. 1989-3] p 553 A89-37627  
Application of nondestructive inspection methods to composites p 555 A89-38951  
Nondestructive volumetric CT-scan evaluation of monolithic ceramic turbine components p 555 A89-38954  
Acoustic emission testing the F-111 p 541 A89-39008

## OBSERVABILITY (SYSTEMS)

Scattering from three-dimensional cracks p 565 A89-39588

### NONEQUILIBRIUM FLOW

Numerical calculations of hypersonic nonequilibrium flow over a blunt wedge p 515 A89-39461

### NONISENTROPICITY

Some properties of nonisentropic transonic flows p 512 A89-38426

### NONLINEAR SYSTEMS

Gust analysis of an aircraft with highly non-linear systems interaction  
[AIAA PAPER 89-1377] p 527 A89-37650

### NONLINEARITY

Acta Aeronautica et Astronautica Sinica (selected articles)  
[AD-A205128] p 508 N89-22570

### NONUNIFORM FLOW

Aerodynamic characteristics of arbitrarily rotating bodies in a variable-density gas p 509 A89-37355

### NOSE CONES

Mach number effects on high-angles-of-attack aerodynamic characteristics of a cone-cylinder with various nose shapes p 511 A89-38122

### NOZZLE DESIGN

Static internal performance of convergent single-expansion-ramp nozzles with various combinations of internal geometric parameters  
[NASA-TM-4112] p 517 N89-21768  
Supersonic particle probes: Measurement of internal wall losses  
[AD-A205863] p 521 N89-22589  
Numerical study of a multipurpose transonic wind tunnel with an adaptable injection-suction system p 543 N89-22621

### NOZZLE FLOW

Inviscid, unsteady, transonic axisymmetric flow with shock waves - Response to time and space-time dependent perturbations p 512 A89-38129  
Swirling flows in an annular-to-rectangular transition section p 555 A89-39037  
Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349  
Rectangular nozzle plume velocity modeling for use in jet noise prediction  
[NASA-TM-102047] p 519 N89-22577

### NOZZLE GEOMETRY

Shock structure in non-circular jets  
[AIAA PAPER 89-1083] p 510 A89-37653  
Stability of gas flows in Laval nozzles p 512 A89-38438

Static internal performance of convergent single-expansion-ramp nozzles with various combinations of internal geometric parameters  
[NASA-TM-4112] p 517 N89-21768

### NOZZLES

Gravity refueling nozzles and ports interface standards for civil aircraft  
[SAE AS 1852] p 544 A89-37659

### NUMERICAL ANALYSIS

Some mathematical considerations on views of the ground surface in flight p 562 A89-36351  
Numerical study of a multipurpose transonic wind tunnel with an adaptable injection-suction system p 543 N89-22621

### NUMERICAL CONTROL

Study on exchange operation between two microcomputers in aeroengine digital control p 535 A89-37774

### NUMERICAL FLOW VISUALIZATION

Aero-optical analysis of compressible flow over an open cavity p 509 A89-36914  
Numerical simulation of supersonic flows past a space-plane p 511 A89-38124  
Navier-Stokes computations of two- and three-dimensional cascade flowfields p 514 A89-39035  
Numerical simulation of flow through a two-strut scramjet inlet p 514 A89-39038  
Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188  
Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349

### NUMERICAL INTEGRATION

Integrated approach for active coupling of structures and fluids p 552 A89-36917

## O

### OBSERVABILITY (SYSTEMS)

Measures of modal controllability and observability for first- and second-order linear systems p 563 A89-36943

## OGIVES

The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body p 516 N89-21765

## OPERATING TEMPERATURE

Material/manufacturing process interaction in advanced material technologies p 549 N89-22662  
The demonstration of monolithic and composite ceramics in aircraft gas turbine combustors p 550 N89-22665

## OPTICAL EQUIPMENT

The optical bidirectional accelerometer --- for microgravity experiments p 553 N89-36966

## OPTICAL MEASURING INSTRUMENTS

Aero-optical analysis of compressible flow over an open cavity p 509 N89-36914

## OPTICAL PROPERTIES

A study of shock wave radiation near models at hypersonic velocities in air p 513 N89-38445

## OPTIMAL CONTROL

Selection of weighting matrices for linear optimal regulator p 563 N89-36990  
Active vibration control of flexible rotors - An experimental and theoretical study p 554 N89-37847  
Synthesis of systems for the motion control of nonstationary objects --- Russian book p 563 N89-38512

Input signal selection in the identification of linear continuous dynamic systems from discrete observations p 563 N89-39777

Active vibration control for flexible rotor by optimal direct-output feedback control [NASA-TM-101972] p 537 N89-22605

Model-based analysis and cooperative synthesis of control and display augmentation for piloted flight vehicles p 540 N89-22610

## OPTIMIZATION

Property optimization in superalloys through the use of heat treat process modelling p 546 N89-36452

Trajectory optimization with risk minimization for military aircraft p 538 N89-36929

Optimizing advanced propeller designs by simultaneously updating flow variables and design parameters p 514 N89-39189

Investigations of the parameter reduction in the optimization of aircraft wing structures [ILR-MITT-203] p 531 N89-21795

## OSCILLATING FLOW

Potential flow over bodies of revolution in unsteady motion p 508 N89-36910

Pulsating flow over an ellipse at an angle of attack p 513 N89-38620

## P

## PAINTS

The effects of plastic media blasting paint removal on the microstructure of graphite/epoxy composite materials [AD-A204801] p 550 N89-22688

## PANEL METHOD (FLUID DYNAMICS)

Potential flow over bodies of revolution in unsteady motion p 508 N89-36910

A vortex panel analysis of circular-arc bluff-bodies in unsteady flow [DE89-007141] p 558 N89-22845

## PARABOLIC FLIGHT

Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft p 544 N89-36543

## PARACHUTE DESCENT

Wake recontact: An experimental investigation using a ringslot parachute [DE89-008320] p 518 N89-21773

## PARACHUTES

Calculated and experimental stresses in solid and ring slot parachutes p 523 N89-39200

A preliminary characterization of parachute wake recontact [DE89-006442] p 519 N89-22576

## PARALLEL PROCESSING (COMPUTERS)

Neural computing for numeric-to-symbolic conversion in control systems p 563 N89-37234

## PARAMETER IDENTIFICATION

Estimation of aircraft aerodynamic parameters from flight data p 513 N89-38614

## PASSENGER AIRCRAFT

Passenger seat design commercial transport aircraft [SAE ARP 750] p 527 N89-37660  
Good prospects for LET's 40-seater p 528 N89-39226

Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise p 529 N89-39509

A demonstration of active noise reduction in an aircraft cabin p 529 N89-39510

Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency [MTU-TB-87/010] p 537 N89-22608

## PASSENGERS

Human factors in cabin safety p 522 N89-36069

## PATTERN RECOGNITION

Neural computing for numeric-to-symbolic conversion in control systems p 563 N89-37234

## PEEK

A survey of poly-ether-ether-ketone and its advanced composites [FFA-TN-1988-37] p 550 N89-22707

## PEELING

Plastic media blasting recycling equipment study [AD-A202463] p 556 N89-21987

## PERFORMANCE PREDICTION

Two-dimensional simulation of electrothermal deicing of aircraft components p 528 N89-39194

The analysis and prediction of the spin equilibrium point of modern aircrafts p 539 N89-39459

A study of unsteady turbulent flow past airfoils p 521 N89-22587

Aerodynamic detuning of a loaded airfoil cascade in an incompressible flow by a locally analytical method p 521 N89-22588

Transonic viscous flow calculations for a turbine cascade with a two equation turbulence model [NASA-TM-101944] p 537 N89-22607

Computational fluid dynamics research in three-dimensional zonal techniques [NASA-CR-181406] p 558 N89-22838

## PERFORMANCE TESTS

High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 N89-39195

Testing of a new recovery parachute system for the F111 aircraft crew escape module: An update [DE89-007139] p 524 N89-22592

Development and testing of critical components for technological preparation of an Airbus-CFRP-fuselage, phase 2 [MBB-UT-129/87] p 531 N89-22600

## PERSONNEL SELECTION

Studies of poststrike air traffic control specialist trainees. Part 2: Selection and screening programs [AD-A199177] p 526 N89-22595

## PILOT ERROR

Aircraft accident report: Trans-Colorado Airlines, Inc., Flight 2286, Fairchild Metro 3, SA227 AC, N68TC Bayfield, Colorado, January 19, 1988 [PB89-910401] p 524 N89-22593

## PILOT PERFORMANCE

Model-based analysis and cooperative synthesis of control and display augmentation for piloted flight vehicles p 540 N89-22610

AGARD highlights 88/2 p 566 N89-23403

## PITCHING MOMENTS

Influence of pitching motion on subsonic wing rock of slender delta wings p 514 N89-39187

## PLASTICS

Plastic media blasting recycling equipment study [AD-A202463] p 556 N89-21987

## PLUMES

Rectangular nozzle plume velocity modeling for use in jet noise prediction [NASA-TM-102047] p 519 N89-22577

## POLICIES

Safe skies for tomorrow: Aviation safety in a competitive environment [PB89-114318] p 524 N89-22591

## POLYMER MATRIX COMPOSITES

A survey of poly-ether-ether-ketone and its advanced composites [FFA-TN-1988-37] p 550 N89-22707

## POLYMERS

Polymers for advanced structures - An overview p 545 N89-36335

## POLYMETHYL METHACRYLATE

Investigation of a small solid fuel ramjet combustor p 544 N89-39028

## PONTYAGIN PRINCIPLE

Trajectory optimization with risk minimization for military aircraft p 538 N89-36929

## POROUS MATERIALS

Hydrodynamics and heat transfer in the porous elements of flight vehicle structures --- Russian book p 554 N89-38499

## PORTS

Gravity refueling nozzles and ports interface standards for civil aircraft [SAE AS 1852] p 544 N89-37659

## POTENTIAL FLOW

Potential flow over bodies of revolution in unsteady motion p 508 N89-36910

Nonlinear supersonic potential flow over sideslip conical bodies, delta wings and fuselages p 511 N89-37792

Unsteady force calculations on circular cylinders and elliptical airfoils with circulation control p 516 N89-21766

Flow past bluff bodies p 517 N89-21770

## POWER CONDITIONING

The all-electric (secondary power) airplane p 535 N89-38950

## POWER LINES

The aviation wire strike problem - The duty to warn of this aerial hazard p 522 N89-38878

## PREDICTION ANALYSIS TECHNIQUES

The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895

## PRESSURE DISTRIBUTION

Static internal performance of convergent single-expansion-ramp nozzles with various combinations of internal geometric parameters [NASA-TM-4112] p 517 N89-21768

The effects of incidence angle and free stream turbulence on the performance of a variable geometry two-dimensional compressor cascade at high Reynolds numbers [AD-A202650] p 557 N89-22052

Cavitation effects on the pressure distribution of a squeeze film damper bearing p 559 N89-22897

## PRESSURE DROP

Numerical and experimental evaluations of the flow past nested chevrons p 508 N89-36902

## PRESSURE GRADIENTS

Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows [AD-A204364] p 518 N89-21774

## PRESSURE OSCILLATIONS

Fluctuating pressures on wing surfaces in the slipstream of a single-rotor propan [AIAA PAPER 89-1058] p 564 N89-36218

## PRESSURE RATIO

Static internal performance of convergent single-expansion-ramp nozzles with various combinations of internal geometric parameters [NASA-TM-4112] p 517 N89-21768

## PRESSURE SENSORS

Supersonic particle probes: Measurement of internal wall losses [AD-A205863] p 521 N89-22589

## PRESSURE VESSELS

Fracture of pressurized composite cylinders with a high strain-to-failure matrix system p 551 N89-36319

## PROBABILITY THEORY

Composite failure criterion: Probabilistic formulation and geometric interpretation [AD-A205275] p 548 N89-21851

## PROCESS CONTROL (INDUSTRY)

New metallic materials for gas turbines p 549 N89-22660

## PRODUCT DEVELOPMENT

Development and testing of critical components for technological preparation of an Airbus-CFRP-fuselage, phase 2 [MBB-UT-129/87] p 531 N89-22600

## PROGRAM VERIFICATION (COMPUTERS)

PARC code validation for propulsion flows [AD-A204293] p 557 N89-22066

## PROJECTILE CRATERING

Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft p 544 N89-36543

## PROP-FAN TECHNOLOGY

Near-field acoustic characteristics of a single-rotor propan [AIAA PAPER 89-1055] p 533 N89-36215

Installed propan (SR-7L) far-field noise characteristics [AIAA PAPER 89-1056] p 564 N89-36216

Lateral noise attenuation of the advanced propeller of the propan test assessment aircraft [AIAA PAPER 89-1057] p 564 N89-36217

Fluctuating pressures on wing surfaces in the slipstream of a single-rotor propan [AIAA PAPER 89-1058] p 564 N89-36218

## PROPELLER BLADES

Optimizing advanced propeller designs by simultaneously updating flow variables and design parameters p 514 N89-39189

High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 N89-39195

## PROPELLERS

Prediction of counter-rotation propeller noise [AIAA PAPER 89-1141] p 564 N89-36221

## R

- Asymptotic analysis of the transonic region of a high-speed propeller  
[AIAA PAPER 89-1077] p 565 A89-37652
- PROPORTIONAL CONTROL**  
Multivariable control law design for the Control Reconfigurable Combat Aircraft (CRCA)  
[AD-A202697] p 540 N89-21803
- PROPULSION**  
Coupling factor method for studying elastic motion of flight vehicles p 544 A89-37004
- PROPULSION SYSTEM CONFIGURATIONS**  
Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency  
[MTU-TB-87/010] p 537 N89-22608
- PROPULSION SYSTEM PERFORMANCE**  
On evaluation of aircraft propulsion system performance p 534 A89-37752  
Performance analysis of a propulsion system p 534 A89-37753  
A perspective on future directions in aerospace propulsion system simulation  
[NASA-TM-102038] p 536 N89-21798  
Research as part of the Air Force Research in Aero Propulsion Technology (AFRAPT) Program  
[AD-A204968] p 537 N89-21801  
PARC code validation for propulsion flows  
[AD-A204293] p 557 N89-22066  
Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency  
[MTU-TB-87/010] p 537 N89-22608  
New hypersonic facility capability at NASA Lewis Research Center  
[NASA-TM-102028] p 543 N89-22617  
Technical evaluation report p 548 N89-22655  
Application of advanced materials for turbomachinery and rocket propulsion p 549 N89-22656  
Monolithic and fiber ceramic components for turboengines and rockets p 549 N89-22657  
Future advanced aero-engines: The materials challenge p 538 N89-22659  
Damage tolerance concepts for advanced materials and engines p 549 N89-22661  
Material/manufacturing process interaction in advanced material technologies p 549 N89-22662
- PROPULSIVE EFFICIENCY**  
A perspective on future directions in aerospace propulsion system simulation  
[NASA-TM-102038] p 536 N89-21798  
Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency  
[MTU-TB-87/010] p 537 N89-22608
- PROTECTIVE COATINGS**  
Laser drilling of a superalloy coated with ceramic p 551 A89-36455  
Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474  
Influence of thermal fatigue on hot corrosion of an intermetallic Ni-aluminide coating p 547 A89-36484
- PROXIMITY**  
Description of the derivation of the collision risk model used in the vertical separation simulation risk model  
[AD-A205109] p 523 N89-21781
- PSYCHOTROPIC DRUGS**  
Aircraft accident report: Trans-Colorado Airlines, Inc., Flight 2286, Fairchild Metro 3, SA227 AC, N68TC Bayfield, Colorado, January 19, 1988  
[PB89-910401] p 524 N89-22593
- PUBLIC LAW**  
Eligibility of noise abatement proposals for grants-in-aid under the Airport Improvement Program  
[AD-A204724] p 542 N89-21812
- PULSE COMMUNICATION**  
Field trials of aeronautical satellite communication system p 524 A89-36595
- PYLONS**  
Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds  
[FFA-TN-1988-44] p 532 N89-22602
- QUALITY CONTROL**  
Materials tests: Means and techniques p 548 N89-21983
- QUANTITATIVE ANALYSIS**  
Infrared thermography - A quantitative tool for heat study  
[ONERA, TP NO. 1989-3] p 553 A89-37627

- RADAR CROSS SECTIONS**  
Near-field scattering measurements for determining complex target RCS p 532 A89-39587
- RADAR SCATTERING**  
Near-field scattering measurements for determining complex target RCS p 532 A89-39587
- RADAR TARGETS**  
Near-field scattering measurements for determining complex target RCS p 532 A89-39587
- RADIAL DISTRIBUTION**  
A study on exit radial temperature profile of 2D experimental combustor p 535 A89-37759
- RADIAL FLOW**  
LDV measurements and investigation of flow field through radial turbine guide vanes p 538 N89-22609
- RADIO DIRECTION FINDERS**  
Geodetic positioning system for flying aircraft (May 1987)  
[REPT-013/88] p 527 N89-22598
- RADIO ELECTRONICS**  
Fundamentals of the maintenance of the radio-electronic equipment of aircraft --- Russian book p 525 A89-38513
- RADIO NAVIGATION**  
Formulation of gain and impedance relations for corner reflectors employed in conjunction with localizer antenna arrays p 525 A89-39500
- RAKES**  
Riblet drag at flight conditions p 515 A89-39196
- RAMJET ENGINES**  
Investigation of a small solid fuel ramjet combustor p 544 A89-39028
- RANGEFINDING**  
Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618
- RAREFIED GASES**  
Consideration of the effect of surface roughness on regime coefficients in local interaction theory p 512 A89-38432
- REAL TIME OPERATION**  
LEADER - An automatic, real-time diagnostic knowledge system  
[SAE PAPER 881443] p 534 A89-37651  
Study of the real emulation of the electronic integrated system  
[PB89-116271] p 557 N89-22016
- RECEIVERS**  
Geodetic positioning system for flying aircraft (May 1987)  
[REPT-013/88] p 527 N89-22598
- RECONNAISSANCE**  
Fusion of multisensor data: A summary of the JASMIN project  
[FOAC-30498-3.3] p 563 N89-23213
- RECOVERY PARACHUTES**  
Testing of a new recovery parachute system for the F111 aircraft crew escape module: An update  
[DEB9-007139] p 524 N89-22592
- RECTANGULAR PLATES**  
An approximate method for sonic fatigue analysis of plates and shells p 565 A89-39515
- RECTANGULAR WINGS**  
The application of the two-dimensional unsteady Euler equations perturbation solutions on the supersonic rectangular wings p 511 A89-37787
- RECYCLING**  
Plastic media blasting recycling equipment study  
[AD-A202463] p 556 N89-21987
- REDUCED GRAVITY**  
Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft p 544 A89-36543
- REDUCED ORDER FILTERS**  
Measures of modal controllability and observability for first- and second-order linear systems p 563 A89-36943
- REDUNDANCY**  
Configuration of tuned dry gyro redundant system p 554 A89-38189
- REENTRY TRAJECTORIES**  
Stability and control of hypervelocity vehicles  
[AD-A205160] p 540 N89-21807
- REENTRY VEHICLES**  
Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements  
[NASA-CR-184896] p 517 N89-21772
- REFLECTOR ANTENNAS**  
Design, implementation and computer aided tests of a shaped reflector for an air traffic control system  
[ETN-89-94229] p 556 N89-22014

## REFLECTORS

- Formulation of gain and impedance relations for corner reflectors employed in conjunction with localizer antenna arrays p 525 A89-39500

## REFRACTIVITY

- Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764

## REFRACTORY MATERIALS

- Taming ceramic fiber p 547 A89-36721  
A proposal for funding to purchase a high-temperature furnace to enable determination of the high temperature mechanical properties of structural carbon materials  
[AD-A204103] p 542 N89-21809

## REFRACTORY METAL ALLOYS

- Beyond superalloys - The goals, the materials and some reality p 546 A89-36418

## REFUELING

- Gravity refueling nozzles and ports interface standards for civil aircraft  
[SAE AS 1852] p 544 A89-37659

## REGIONAL PLANNING

- Instrument landing system mathematical modeling study for Orlando International Airport Runway 17R localizer, Orlando, Florida, revised airside docking plan (Scheme 3A)  
[AD-A204722] p 526 N89-21783

## REGULATIONS

- A procedure for operating dependent instrument approaches to converging runways  
[AD-A204723] p 526 N89-21784  
Safe skies for tomorrow: Aviation safety in a competitive environment  
[PB89-114318] p 524 N89-22591

## REINFORCED SHELLS

- Application of the theory of fuzzy sets to the two-criterion stochastic optimization of ribbed shells p 556 A89-39823

## RELIABILITY ANALYSIS

- Transmission overhaul and replacement predictions using Weibull and renewal theory  
[NASA-TM-102022] p 562 N89-22925

## RELIABILITY ENGINEERING

- XRD techniques in aero engine development --- X-ray diffraction p 555 A89-38632

## REQUIREMENTS

- Functional performance specification for an inertial navigation system  
[AD-A204850] p 526 N89-21785  
Surface temperature measurements using a thin film thermal array  
[NASA-TM-101549] p 558 N89-22868

## RESEARCH AIRCRAFT

- Simulation evaluation of an advanced control concept for a V/STOL aircraft p 539 A89-36932

## RESEARCH AND DEVELOPMENT

- Hypersonic technology for military application --- Book p 507 A89-37875

## RESEARCH FACILITIES

- Visting China's aerodynamics research and development center  
[AD-A203980] p 543 N89-22615

## RESEARCH PROJECTS

- A review and forecast of engine system research at the Army Propulsion Directorate p 533 A89-36397

## RESILIENCE

- Evaluation of barrier cable impact pad materials  
[AD-A204356] p 542 N89-21811

## RESIN MATRIX COMPOSITES

- Material/manufacturing process interaction in advanced material technologies p 549 N89-22662  
A survey of poly-ether-ether-ketone and its advanced composites  
[FFA-TN-1988-37] p 550 N89-22707

## RESONANT FREQUENCIES

- Variations of undamped rotor blade frequencies subjected to transient heat flux p 553 A89-36919

## RETRACTABLE EQUIPMENT

- Computer simulation of the movement of loading door retraction mechanism with slide tracks p 527 A89-37019

## REYNOLDS STRESS

- Stress tensor measurements within the vaneless diffuser of a centrifugal compressor p 556 A89-39050

## RIBLETS

- Riblet drag at flight conditions p 515 A89-39196

## RISK

- Trajectory optimization with risk minimization for military aircraft p 538 A89-36929  
Description of the derivation of the collision risk model used in the vertical separation simulation risk model  
[AD-A205109] p 523 N89-21781

## ROBOTICS

- Structural dynamics branch research and accomplishments for FY 1988  
[NASA-TM-101406] p 562 N89-22939

## Q

**ROBUSTNESS (MATHEMATICS)**

Robust control of an active vibration isolation system for helicopters p 539 A89-39458

**ROCKET ENGINE DESIGN**

Application of Advanced Material for Turbomachinery and Rocket Propulsion [AGARD-CP-449] p 548 A89-22654

Future advanced aero-engines: The materials challenge p 538 A89-22659

New metallic materials for gas turbines p 549 A89-22660

Damage tolerance concepts for advanced materials and engines p 549 A89-22661

**ROCKET ENGINES**

PARC code validation for propulsion flows [AD-A204293] p 557 A89-22066

CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 A89-22658

**ROCKET EXHAUST**

The effect of exhaust plume/afterbody on installed scramjet performance p 536 A89-21797

**ROCKET LININGS**

The demonstration of monolithic and composite ceramics in aircraft gas turbine combustors p 550 A89-22665

**ROLLING CONTACT LOADS**

Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 A89-22912

**ROTARY GYROSCOPES**

Motion of a three-degrees-of-freedom gyroscope with a dynamically unbalanced rotor in the case of contact between the internal frame and an elastic limiter p 565 A89-39816

**ROTARY STABILITY**

Rotordynamic stability problems and solutions in high pressure turbocompressors p 561 A89-22914

**ROTARY WING AIRCRAFT**

NASA's program on icing research and technology [NASA-TM-101989] p 507 A89-22569

Convergence of discrete-vortex induced-flow calculations by optimum choice of mesh p 521 A89-22585

**ROTARY WINGS**

A prediction of high-speed rotor noise [AIAA PAPER 89-1132] p 564 A89-36220

Blade-vortex interaction p 508 A89-36905

Lateral induced velocity distribution of a helicopter rotor p 509 A89-36987

Application of infrared thermography to the interpretation of tests in an icing wind tunnel [ONERA, TP NO. 1989-28] p 554 A89-37642

Rotor vortex wake distortion and its induced velocity in ground effect at low speed p 510 A89-37779

The constraint wake analysis for hovering rotors p 511 A89-37790

An experimental and computational study of rotor-vortex interactions p 513 A89-38553

Experimental studies in system identification of helicopter rotor dynamics p 528 A89-38554

Analytical modeling of helicopter static and dynamic induced velocity in GRASP p 513 A89-38555

Extension of classical tip loss formulas --- for rotorcraft design p 528 A89-38652

Two-dimensional simulation of electrothermal deicing of aircraft components p 528 A89-39194

On sound generated when a vortex is chopped by a circular airfoil p 565 A89-39514

**ROTATING BODIES**

Causes and effects of center segregation in electro-slag remelted alloy 718 for critical rotating part applications p 545 A89-36410

Aerodynamic characteristics of arbitrarily rotating bodies in a variable-density gas p 509 A89-37355

Some in-field experiences of non-synchronous vibrations in large rotating machinery p 559 A89-22894

**ROTATING STALLS**

Some field experience with subsynchronous vibration of centrifugal compressors p 559 A89-22892

**ROTATION**

Influence of impeller shroud forces on turbopump rotor dynamics p 560 A89-22909

**ROTOR AERODYNAMICS**

A prediction of high-speed rotor noise [AIAA PAPER 89-1132] p 564 A89-36220

Lateral induced velocity distribution of a helicopter rotor p 509 A89-36987

Rotor vortex wake distortion and its induced velocity in ground effect at low speed p 510 A89-37779

Vibrations of the blades of turbomachines --- Russian book p 535 A89-38504

An experimental and computational study of rotor-vortex interactions p 513 A89-38553

Experimental studies in system identification of helicopter rotor dynamics p 528 A89-38554

More helicopter aerodynamics --- Book

p 513 A89-38578

Three-dimensional Navier-Stokes simulations of turbine rotor-stator interaction. I - Methodology p 514 A89-39034

Description of a simple rotor test rig and preliminary wake studies [AD-A204089] p 541 A89-21808

A study of unsteady turbulent flow past airfoils p 521 A89-22587

Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 [NASA-CP-3026] p 558 A89-22891

Annular honeycomb seals: Test results for leakage and rotordynamic coefficients; comparisons to labyrinth and smooth configurations p 559 A89-22899

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 A89-22900

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

A seal test facility for the measurement of isotropic and anisotropic linear rotordynamic characteristics p 560 A89-22905

Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position p 560 A89-22906

Influence of impeller shroud forces on turbopump rotor dynamics p 560 A89-22909

Magnetic bearing stiffness control using frequency band filtering p 560 A89-22910

Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 A89-22912

Role of circumferential flow in the stability of fluid-handling machine rotors p 561 A89-22915

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

High stability design for new centrifugal compressor p 561 A89-22917

**ROTOR BLADES**

Asymptotic analysis of the transonic region of a high-speed propeller [AIAA PAPER 89-1077] p 565 A89-37652

An experimental and computational study of rotor-vortex interactions p 513 A89-38553

**ROTOR BLADES (TURBOMACHINERY)**

Explicit Runge-Kutta method for unsteady rotor/stator interaction p 509 A89-36912

Variations of undamped rotor blade frequencies subjected to transient heat flux p 553 A89-36919

A study of unsteady turbulent flow past airfoils p 521 A89-22587

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 A89-22900

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

Role of circumferential flow in the stability of fluid-handling machine rotors p 561 A89-22915

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 A89-22900

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

Role of circumferential flow in the stability of fluid-handling machine rotors p 561 A89-22915

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 A89-22900

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

Role of circumferential flow in the stability of fluid-handling machine rotors p 561 A89-22915

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 A89-22900

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

Role of circumferential flow in the stability of fluid-handling machine rotors p 561 A89-22915

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 A89-22900

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

Role of circumferential flow in the stability of fluid-handling machine rotors p 561 A89-22915

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 A89-22900

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

Role of circumferential flow in the stability of fluid-handling machine rotors p 561 A89-22915

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 A89-22900

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

Role of circumferential flow in the stability of fluid-handling machine rotors p 561 A89-22915

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 A89-22900

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

Role of circumferential flow in the stability of fluid-handling machine rotors p 561 A89-22915

Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 A89-22916

Experimental verification of an eddy-current bearing p 561 A89-22913

**RUDDERS**

Integral rudder system for aircraft steering p 539 A89-39258

**RUNGE-KUTTA METHOD**

Explicit Runge-Kutta method for unsteady rotor/stator interaction p 509 A89-36912

An explicit Runge-Kutta method for turbulent reacting flow calculations [NASA-TM-101945] p 536 A89-21799

**RUNWAYS**

Instrument landing system mathematical modeling study for Orlando International Airport Runway 17R localizer, Orlando, Florida, revised airside docking plan (Scheme 3A) [AD-A204722] p 526 A89-21783

Evaluation of barrier cable impact pad materials [AD-A204356] p 542 A89-21811

**RUPTURING**

Enhanced rupture properties in advanced single crystal alloys p 546 A89-36425

**S**

**SAFETY FACTORS**

Human factors in cabin safety p 522 A89-36069

Privatization of the air traffic control system - Its rationale, implementation and implications p 566 A89-38877

The aviation wire strike problem - The duty to warn of this aerial hazard p 522 A89-38878

**SAFETY MANAGEMENT**

Safe skies for tomorrow: Aviation safety in a competitive environment [PB89-114318] p 524 A89-22591

**SATELLITE ANTENNAS**

AvSat - The first dedicated aeronautical satellite communications system p 524 A89-36592

Field trials of aeronautical satellite communication system p 524 A89-36595

**SATELLITE COMMUNICATION**

International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings p 552 A89-36576

NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results p 552 A89-36585

AvSat - The first dedicated aeronautical satellite communications system p 524 A89-36592

Inmarsat's aeronautical satellite communication system p 552 A89-36593

Technical design and performance analysis of aeronautical satellite communication systems p 524 A89-36594

Field trials of aeronautical satellite communication system p 524 A89-36595

Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

Field trials of aeronautical satellite communication system p 524 A89-36595

Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

Field trials of aeronautical satellite communication system p 524 A89-36595

Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

Field trials of aeronautical satellite communication system p 524 A89-36595

Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

Field trials of aeronautical satellite communication system p 524 A89-36595

Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

Field trials of aeronautical satellite communication system p 524 A89-36595

Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

Field trials of aeronautical satellite communication system p 524 A89-36595

Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

Field trials of aeronautical satellite communication system p 524 A89-36595

Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

Field trials of aeronautical satellite communication system p 524 A89-36595

Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618



## SUBJECT INDEX

- Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position p 560 N89-22906
- Rotordynamic stability problems and solutions in high pressure turbocompressors p 561 N89-22914
- SEAPLANES**  
Fly, great sea eagle [AD-A203979] p 530 N89-21789
- SEARCHLIGHTS**  
Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system [AD-A204030] p 530 N89-21790
- SEATS**  
Passenger seat design commercial transport aircraft [SAE ARP 750] p 527 A89-37660
- SECONDARY FLOW**  
Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800
- SELF ADAPTIVE CONTROL SYSTEMS**  
Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931
- SELF EXCITATION**  
Some field experience with subsynchronous vibration of centrifugal compressors p 559 N89-22892  
Some in-field experiences of non-synchronous vibrations in large rotating machinery p 559 N89-22894  
Rotordynamic stability problems and solutions in high pressure turbocompressors p 561 N89-22914
- SELF INDUCED VIBRATION**  
Some field experience with subsynchronous vibration of centrifugal compressors p 559 N89-22892
- SEPARATED FLOW**  
Measurements in separating boundary layers p 552 A89-36909  
New possibilities of viscous-inviscid numerical techniques for solving viscous flow equations with massive separation [ONERA, TP NO. 1989-24] p 554 A89-37640  
Approximate calculation of supersonic flow past bodies of revolution with a front separation zone at a small angle of attack p 512 A89-38427
- SERVICE LIFE**  
Transmission overhaul and replacement predictions using Weibull and renewal theory [NASA-TM-102022] p 562 N89-22925
- SET THEORY**  
Application of the theory of fuzzy sets to the two-criterion stochastic optimization of ribbed shells p 556 A89-39823
- SEXTANTS**  
Air navigation systems. I - Astronomical navigation in the air 1919-1969. Part II - Instruments p 532 A89-39828
- SHAFTS (MACHINE ELEMENTS)**  
Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position p 560 N89-22906
- SHEAR FLOW**  
Highly-resolved flowfield induced by Mach reflection p 512 A89-38125
- SHEAR LAYERS**  
Aero-optical analysis of compressible flow over an open cavity p 509 A89-36914  
The application of dynamic schlieren-photon correlation technique to a supersonic shear layer p 515 A89-39474
- SHELLS (STRUCTURAL FORMS)**  
An approximate method for sonic fatigue analysis of plates and shells p 565 A89-39515
- SHOCK LAYERS**  
A study of shock wave radiation near models at hypersonic velocities in air p 513 A89-38445
- SHOCK WAVE INTERACTION**  
Highly-resolved flowfield induced by Mach reflection p 512 A89-38125  
Inviscid, unsteady, transonic axisymmetric flow with shock waves - Response to time and space-time dependent perturbations p 512 A89-38129  
Experimental investigation of shock wave/boundary-layer interactions in an annular duct p 514 A89-39039  
Theoretical investigation of 3-D shock wave-turbulent boundary layer interactions, part 7 [AD-A204482] p 557 N89-22070  
The structure and control of three-dimensional shock wave turbulent boundary layer interactions [AD-A205923] p 558 N89-22866
- SHOCK WAVE PROPAGATION**  
Investigation of Mach reflection for a planar moving shock propagating into steady supersonic flow field around wedge p 510 A89-37782
- SHOCK WAVES**  
Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916
- Shock structure in non-circular jets [AIAA PAPER 89-1083] p 510 A89-37653
- SHROUDED TURBINES**  
Influence of impeller shroud forces on turbopump rotor dynamics p 560 N89-22909
- SIDESLIP**  
An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft [AD-A202910] p 526 N89-21782
- SIGNAL ANALYSIS**  
Input signal selection in the identification of linear continuous dynamic systems from discrete observations p 563 A89-39777
- SILANES**  
Scramjet combustion with an aid of silane p 547 A89-38387
- SILICON NITRIDES**  
Nondestructive volumetric CT-scan evaluation of monolithic ceramic turbine components p 555 A89-38954
- SIMULATION**  
Simulation analysis on ceramic gas turbine [DE88-756469] p 548 N89-21926
- SINGLE CRYSTALS**  
Second-generation nickel-base single crystal superalloy p 546 A89-36424  
Enhanced rupture properties in advanced single crystal alloys p 546 A89-36425  
Development of stress and life criteria for single crystal turbine blades p 549 N89-22663
- SINGLE STAGE TO ORBIT VEHICLES**  
Fundamental aspects of an aerospaceplane p 544 A89-38234
- SKIN FRICTION**  
Riblet drag at flight conditions p 515 A89-39196  
Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows [AD-A204364] p 518 N89-21774
- SLENDER WINGS**  
Influence of pitching motion on subsonic wing rock of slender delta wings p 514 A89-39187
- SLIPSTREAMS**  
Fluctuating pressures on wing surfaces in the slipstream of a single-rotor propfan [AIAA PAPER 89-1058] p 564 A89-36218
- SMALL PERTURBATION FLOW**  
Unsteady transonic small-disturbance theory including entropy and vorticity effects p 515 A89-39191
- SOARING**  
Simulation of optimal flight paths of dynamical soaring flight and the design of a model aircraft p 529 A89-39259
- SOFTWARE TOOLS**  
GDPP - A practical CAD software package p 563 A89-37014
- SOLID PROPELLANT COMBUSTION**  
Investigation of a small solid fuel ramjet combustor p 544 A89-39028
- SOLVENTS**  
The effects of plastic media blasting paint removal on the microstructure of graphite/epoxy composite materials [AD-A204801] p 550 N89-22688
- SONIC BOOMS**  
Review of sonic boom theory [AIAA PAPER 89-1105] p 564 A89-36219
- SOUND FIELDS**  
An approximate method for sonic fatigue analysis of plates and shells p 565 A89-39515
- SOUND GENERATORS**  
On sound generated when a vortex is chopped by a circular airfoil p 565 A89-39514
- SOUND TRANSMISSION**  
Evaluation of the ride quality of a light twin engine airplane using a ride quality meter [NASA-TP-2913] p 507 N89-22568
- SPACE SHUTTLES**  
Stability and control of hypervelocity vehicles [AD-A205160] p 540 N89-21807
- SPACECRAFT CONTROL**  
Voice of authority --- control systems for space vehicles p 544 A89-37646
- SPACECRAFT DESIGN**  
Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements [NASA-CR-184896] p 517 N89-21772  
Transition to turbulence in laminar hypersonic flow p 522 N89-22830
- SPACECRAFT MAINTENANCE**  
Technical evaluation report p 548 N89-22655

## STRESS ANALYSIS

- SPACECRAFT PROPULSION**  
Application of Advanced Material for Turbomachinery and Rocket Propulsion [AGARD-CP-449] p 548 N89-22654  
Technical evaluation report p 548 N89-22655  
Application of advanced materials for turbomachinery and rocket propulsion p 549 N89-22656
- SPACECRAFT STRUCTURES**  
Vibrations in aerospace structures - Prediction, prevention and control [ONERA, TP NO. 1989-9] p 553 A89-37631  
Eigensolution of periodic assemblies of multi-mode component systems p 556 A89-39519
- SPACECRAFT TEMPERATURE**  
Anodized aluminum and aluminum alloy coatings for thermal control p 547 A89-38153
- SPATIAL DISTRIBUTION**  
Effect of spatial wind gradients on airplane aerodynamics p 514 A89-39190
- SPECIFICATIONS**  
Materials tests: Means and techniques p 548 N89-21983
- SPECTRAL EMISSION**  
A study of shock wave radiation near models at hypersonic velocities in air p 513 A89-38445
- SPECTRAL METHODS**  
A numerical study of viscous vortex rings using a spectral method p 518 N89-22572
- SPECTRUM ANALYSIS**  
The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895
- SPEED CONTROL**  
Optimizing design for turboengine digital speed controller p 535 A89-37773
- SPIN DYNAMICS**  
The analysis and prediction of the spin equilibrium point of modern aircrafts p 539 A89-39459
- SPOILERS**  
Wind tunnel tests of 16 percent thick airfoil section with spoilers at different chordwise positions --- wind turbines [FFA-TN-1987-39] p 520 N89-22582
- SQUEEZE FILMS**  
Experimental investigation of sudden imbalance response on a flexible rotor system with squeeze-film damper p 554 A89-37768  
The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895  
Cavitation effects on the pressure distribution of a squeeze film damper bearing p 559 N89-22897
- STABILITY**  
High stability design for new centrifugal compressor p 561 N89-22917
- STAGNATION FLOW**  
Flow over a leading edge with distributed roughness [DFVLR-FB-88-45] p 520 N89-22581
- STAGNATION POINT**  
Supersonic particle probes: Measurement of internal wall losses [AD-A205863] p 521 N89-22589
- STATIC LOADS**  
A study of unsteady turbulent flow past airfoils p 521 N89-22587
- STATOR BLADES**  
Explicit Runge-Kutta method for unsteady rotor/stator interaction p 509 A89-36912
- STATORS**  
Three-dimensional Navier-Stokes simulations of turbine rotor-stator interaction. I - Methodology p 514 A89-39034
- STEADY FLOW**  
Investigation of Mach reflection for a planar moving shock propagating into steady supersonic flow field around wedge p 510 A89-37782  
Note on the lifting-surface problem for a circular wing in incompressible flow p 514 A89-38939  
Lifetime aerofoil calculations using von Mises variables p 516 A89-39666
- STEAM TURBINES**  
Condensation phenomena in a turbine blade passage p 511 A89-37939
- STEERABLE ANTENNAS**  
Field trials of aeronautical satellite communication system p 524 A89-36595
- STIFFNESS**  
Magnetic bearing stiffness control using frequency band filtering p 560 N89-22910  
Role of circumferential flow in the stability of fluid-handling machine rotors p 561 N89-22915
- STRAPDOWN INERTIAL GUIDANCE**  
Configuration of tuned dry gyro redundant system p 554 A89-38189
- STRESS ANALYSIS**  
Calculated and experimental stresses in solid and ring slot parachutes p 523 A89-39200

## STRESS CORROSION CRACKING

Simulation analysis on ceramic gas turbine  
[DE88-756469] p 548 N89-21926

### STRESS CORROSION CRACKING

The fatigue in aircraft corrosion testing (FACT) programme  
[AGARD-R-713] p 548 N89-21873

### STRESS MEASUREMENT

Stress tensor measurements within the vaneless diffuser of a centrifugal compressor p 556 A89-39050  
Calculated and experimental stresses in solid and ring slot parachutes p 523 A89-39200  
Composite failure criterion: Probabilistic formulation and geometric interpretation  
[AD-A205275] p 548 N89-21851

### STRUCTURAL ANALYSIS

Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating  
[AD-A205077] p 518 N89-21775

### STRUCTURAL DESIGN

Contribution to centrifugal impeller design p 553 A89-37525  
Hydrodynamics and heat transfer in the porous elements of flight vehicle structures --- Russian book p 554 A89-38499  
High stability design for new centrifugal compressor p 561 N89-22917

### STRUCTURAL DESIGN CRITERIA

Structures for hypervelocity flight p 552 A89-36723

### STRUCTURAL FAILURE

Acoustic emission testing the F-111 p 541 A89-39008

### STRUCTURAL VIBRATION

Variations of undamped rotor blade frequencies subjected to transient heat flux p 553 A89-36919  
Coupling factor method for studying elastic motion of flight vehicles p 544 A89-37004  
Dynamical calculations of engine components based on elasticity equations p 553 A89-37421  
Vibrations in aerospace structures - Prediction, prevention and control  
[ONERA, TP NO. 1989-9] p 553 A89-37631  
Vibrations of the blades of turbomachines --- Russian book p 535 A89-38504  
Multi-input/multi-output frequency domain modal identification method and its application in ground vibration testing p 529 A89-39454  
Structural dynamics branch research and accomplishments for FY 1988  
[NASA-TM-101406] p 562 N89-22939

### SUBSONIC FLOW

On the three families of instability waves of high-speed jets p 513 A89-38624  
Influence of pitching motion on subsonic wing rock of slender delta wings p 514 A89-39187  
A computational method of aerodynamics for subsonic, fully unsteady wings at high angles of attack in time-domain p 515 A89-39462  
A note on sound from the interruption of a cylindrical flow by a semi-infinite aerofoil of subsonic speed p 565 A89-39506  
Unsteady aerodynamic computational method of non-co-planar wing-tail combinations in subsonic flow [PB89-111470] p 518 N89-22571  
Supersonic particle probes: Measurement of internal wall losses  
[AD-A205863] p 521 N89-22589

### SUBSONIC SPEED

Development of a streamline method  
[AD-A205146] p 557 N89-22078

### SUBSONIC WIND TUNNELS

Three component laser Doppler anemometry in large wind tunnels p 555 A89-38615

### SUCTION

On the unsteady leading edge suction of a sweptback wing p 510 A89-37776  
Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel p 520 N89-22584  
Numerical study of a multipurpose transonic wind tunnel with an adaptable injection-suction system p 543 N89-22621

### SUPERCritical AIRFOILS

The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration  
[NASA-TM-4100] p 516 N89-21762  
Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds  
[AD-A205206] p 519 N89-22575

### SUPERPLASTICITY

Modern joining methods for future aircraft structures p 556 A89-39076

### SUPERSONIC AIRCRAFT

Review of sonic boom theory  
[AIAA PAPER 89-1105] p 564 A89-36219

### SUPERSONIC AIRFOILS

A note on sound from the interruption of a cylindrical flow by a semi-infinite aerofoil of subsonic speed p 565 A89-39506

### SUPERSONIC BOUNDARY LAYERS

Linear instability waves in supersonic turbulent mixing layers p 508 A89-36903  
Modeling of density fluctuations in supersonic turbulent boundary layer p 509 A89-36923  
Organized structures in a supersonic turbulent boundary layer p 517 N89-21771

### SUPERSONIC COMBUSTION

Scramjet combustion with an aid of silane p 547 A89-38387

### SUPERSONIC COMBUSTION RAMJET ENGINES

Highly-resolved flowfield induced by Mach reflection p 512 A89-38125  
Scramjet combustion with an aid of silane p 547 A89-38387  
Numerical simulation of flow through a two-strut scramjet inlet p 514 A89-39038  
Experimental investigation of shock wave/boundary-layer interactions in an annular duct p 514 A89-39039  
The effect of exhaust plume/afterbody on installed scramjet performance p 536 N89-21797

### SUPERSONIC DRAG

The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack  
[FFA-141] p 520 N89-22583

### SUPERSONIC FLIGHT

Flutter analysis of the CF-18 aircraft at supersonic speeds p 528 A89-39199

### SUPERSONIC FLOW

Boundary-layer transition on a cone and flat plate at Mach 3.5 p 508 A89-36904  
Investigation of Mach reflection for a planar moving shock propagating into steady supersonic flow field around wedge p 510 A89-37782  
The application of the two-dimensional unsteady Euler equations perturbation solutions on the supersonic rectangular wings p 511 A89-37787  
Nonlinear supersonic potential flow over sideslip conical bodies, delta wings and fuselages p 511 A89-37792  
Numerical simulation of supersonic flows past a space-plane p 511 A89-38124  
Approximate calculation of supersonic flow past bodies of revolution with a front separation zone at a small angle of attack p 512 A89-38427  
Nonstationary supersonic flow past a body p 512 A89-38437  
On the three families of instability waves of high-speed jets p 513 A89-38624  
A two-spark schlieren system for very-high velocity measurement p 555 A89-38874  
Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349  
A computational method of aerodynamics for subsonic, fully unsteady wings at high angles of attack in time-domain p 515 A89-39462  
The application of dynamic schlieren-photon correlation technique to a supersonic shear layer p 515 A89-39474  
The inviscid axisymmetric stability of the supersonic flow along a circular cylinder  
[NASA-CR-181816] p 519 N89-22574  
Transonic and supersonic flow past a 65 deg delta wing with rounded leading edges: Analysis of experimental data  
[DFVLR-FB-88-44] p 520 N89-22580  
Supersonic particle probes: Measurement of internal wall losses  
[AD-A205863] p 521 N89-22589  
The structure and control of three-dimensional shock wave turbulent boundary layer interactions  
[AD-A205923] p 558 N89-22866

### SUPERSONIC JET FLOW

Shock structure in non-circular jets  
[AIAA PAPER 89-1083] p 510 A89-37653

### SUPERSONIC SPEED

Investigation of low NOx staged combustor concept in high-speed civil transport engines  
[NASA-TM-101977] p 537 N89-22606

### SUPERSONIC TURBINES

Numerical solutions of unsteady inviscid transonic turbine cascade flows p 516 N89-21767  
Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800

### SUPERSONIC WIND TUNNELS

New hypersonic facility capability at NASA Lewis Research Center  
[NASA-TM-102028] p 543 N89-22617

### SURFACE CRACKS

Environmentally induced discontinuities in transparent polymers  
[AD-A205483] p 550 N89-22768

### SURFACE ROUGHNESS EFFECTS

Consideration of the effect of surface roughness on regime coefficients in local interaction theory p 512 A89-38432  
Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows  
[AD-A204364] p 518 N89-21774  
Flow over a leading edge with distributed roughness  
[DFVLR-FB-88-45] p 520 N89-22581

### SURFACE TEMPERATURE

Surface temperature measurements using a thin film thermal array  
[NASA-TM-101549] p 558 N89-22868

### SWEEP FORWARD WINGS

Lateral stability analysis for X-29A drop model using system identification methodology  
[NASA-TM-4108] p 539 N89-21802

### SWEPT WINGS

Buffering criteria for a systematic series of wings p 515 A89-39197  
The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration  
[NASA-TM-4100] p 516 N89-21762  
SWEEPBACK WINGS  
On the unsteady leading edge suction of a sweptback wing p 510 A89-37776

### SWIRLING

Swirling flows in an annular-to-rectangular transition section p 555 A89-39037  
Effects of swirl and high turbulence on a jet in a crossflow p 515 A89-39192

### SYNCHRONOUS SATELLITES

Combining the use of geostationary and inclined orbit satellites for integrated communications and navigation applications p 544 A89-36611

### SYSTEM IDENTIFICATION

Experimental studies in system identification of helicopter rotor dynamics p 528 A89-38554  
Estimation of aircraft aerodynamic parameters from flight data p 513 A89-38614  
Multi-input/multi-output frequency domain modal identification method and its application in ground vibration testing p 529 A89-39454  
Lateral stability analysis for X-29A drop model using system identification methodology  
[NASA-TM-4108] p 539 N89-21802

### SYSTEMS ENGINEERING

AvSat - The first dedicated aeronautical satellite communications system p 524 A89-36592  
Inmarsat's aeronautical satellite communication system p 552 A89-36593  
Technical design and performance analysis of aeronautical satellite communication systems p 524 A89-36594  
An OOD (Object-Oriented Design) paradigm for flight simulators, 2nd edition  
[AD-A204849] p 542 N89-21813

### SYSTEMS INTEGRATION

Performance analysis of a propulsion system p 534 A89-37753

### SYSTEMS STABILITY

Influence of impeller shroud forces on turbopump rotor dynamics p 560 N89-22909

## T

### TAKEOFF

High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 A89-39195

### TAYLOR INSTABILITY

Primitive numerical simulation of circular Couette flow p 516 N89-21764

### TECHNOLOGICAL FORECASTING

Aircraft engines. IV p 534 A89-36898  
Helicopters and VTOL. I p 527 A89-36899

### TECHNOLOGY ASSESSMENT

Beyond superalloys - The goals, the materials and some reality p 546 A89-36418  
Aircraft engines. IV p 534 A89-36898  
A survey of poly-ether-ether-ketone and its advanced composites  
[FFA-TN-1988-37] p 550 N89-22707

### TEMPERATURE CONTROL

Anodized aluminum and aluminum alloy coatings for thermal control p 547 A89-38153

### TEMPERATURE DEPENDENCE

Generalized criteria for microwave breakdown in air-filled waveguides p 552 A89-36655

## TEMPERATURE EFFECTS

- Variations of undamped rotor blade frequencies subjected to transient heat flux p 553 A89-36919  
Acceleration test for aircraft low-pass filter [PB89-116263] p 557 N89-22807

## TEMPERATURE MEASUREMENT

- Surface temperature measurements using a thin film thermal array [NASA-TM-101549] p 558 N89-22868

## TEMPERATURE PROFILES

- A study on exit radial temperature profile of 2D experimental combustor p 535 A89-37759  
Research on temperature profile factor at exit in an annular combustor p 535 A89-37769

## TENSILE STRENGTH

- Effect of crack size on the tensile strength of ceramics in a high-temperature corrosive environment p 547 A89-38021  
A proposal for funding to purchase a high-temperature furnace to enable determination of the high temperature mechanical properties of structural carbon materials [AD-A204103] p 542 N89-21809

## TENSOR ANALYSIS

- A method for determining the inertia tensor of a craft in flight p 565 A89-39819

## TERRAIN

- Ground collision warning system performance criteria for high maneuverability aircraft [AD-A204390] p 523 N89-21779

## TEST CHAMBERS

- Hardware and operating features of the adaptive wall test section for the 0.3-meter transonic cryogenic tunnel [NASA-TM-4114] p 542 N89-22614

## TEST FACILITIES

- On the accelerating airflow problem in the test section of a transonic wind tunnel p 541 A89-39477  
A seal test facility for the measurement of isotropic and anisotropic linear rotordynamic characteristics p 560 N89-22905

## THERMAL CONTROL COATINGS

- Anodized aluminum and aluminum alloy coatings for thermal control p 547 A89-38153

## THERMAL DEGRADATION

- Degradation of aluminate coated directionally solidified superalloy turbine blades in an aero gas turbine engine p 546 A89-36480

## THERMAL FATIGUE

- Influence of thermal fatigue on hot corrosion of an intermetallic Ni-aluminide coating p 547 A89-36484  
Development of stress and lifing criteria for single crystal turbine blades p 549 N89-22663

## THERMAL PROTECTION

- Polymers for advanced structures - An overview p 545 A89-36335

## THERMAL SHOCK

- Simulation analysis on ceramic gas turbine [DE88-756469] p 548 N89-21926

## THERMAL STABILITY

- Metallurgical stability of Inconel alloy 718 p 545 A89-36405  
On developing a microstructurally and thermally stable iron-nickel base superalloy p 545 A89-36406  
Jet fuel deoxygenation [AD-A205006] p 548 N89-21943

## THERMAL STRESSES

- Simulation analysis on ceramic gas turbine [DE88-756469] p 548 N89-21926

## THERMOCOUPLES

- Surface temperature measurements using a thin film thermal array [NASA-TM-101549] p 558 N89-22868

## THERMODYNAMIC PROPERTIES

- Nonstationary thermal duty of the structural elements of flight vehicles --- Russian book p 535 A89-38502

## THERMOGRAPHY

- Infrared thermography - A quantitative tool for heat study [ONERA, TP NO. 1989-3] p 553 A89-37627  
Application of infrared thermography to the interpretation of tests in an icing wind tunnel [ONERA, TP NO. 1989-28] p 554 A89-37642  
Combustor flow visualization using innovative infrared thermographics techniques [AD-A205905] p 550 N89-22718

## THIN AIRFOILS

- Convergence of discrete-vortex induced-flow calculations by optimum choice of mesh p 521 N89-22585

## THIN FILMS

- Surface temperature measurements using a thin film thermal array [NASA-TM-101549] p 558 N89-22868

## THIN WALLED SHELLS

- The inviscid axisymmetric stability of the supersonic flow along a circular cylinder [NASA-CR-181816] p 519 N89-22574

## THREE DIMENSIONAL BOUNDARY LAYER

- The structure and control of three-dimensional shock wave turbulent boundary layer interactions [AD-A205923] p 558 N89-22866

## THREE DIMENSIONAL COMPOSITES

- Composite failure criterion: Probabilistic formulation and geometric interpretation [AD-A205275] p 548 N89-21851

## THREE DIMENSIONAL FLOW

- Three-dimensional Navier-Stokes simulations of turbine rotor-stator interaction. I - Methodology p 514 A89-39034  
Navier-Stokes computations of two- and three-dimensional cascade flowfields p 514 A89-39035  
Stress tensor measurements within the vaneless diffuser of a centrifugal compressor p 556 A89-39050  
Primitive numerical simulation of circular Couette flow p 516 N89-21764

## TILT ROTOR AIRCRAFT

- V-22 prepared for further expansion of flight envelope p 527 A89-36575  
A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance [AD-A204856] p 531 N89-21793

## TIME DEPENDENCE

- Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 N89-22586

## TIME OPTIMAL CONTROL

- Singular trajectories in airplane cruise-dash optimization p 538 A89-36928  
Equivalent systems method to evaluate the flight qualities p 539 A89-36998

## TIME SERIES ANALYSIS

- A preliminary characterization of parachute wake recontact [DE89-006442] p 519 N89-22576  
TIME TEMPERATURE PARAMETER  
Metallurgical stability of Inconel alloy 718 p 545 A89-36405

## TITANIUM ALLOYS

- New metallic materials for gas turbines p 549 N89-22660

## TOLERANCES (MECHANICS)

- Technical evaluation report p 548 N89-22655  
Monolithic and fiber ceramic components for turboengines and rockets p 549 N89-22657  
Damage tolerance concepts for advanced materials and engines p 549 N89-22661

## TORSION

- Stall flutter of graphite/epoxy wings with bending-torsion coupling [AD-A203077] p 540 N89-21804

## TRACKING (POSITION)

- Description of the derivation of the collision risk model used in the vertical separation simulation risk model [AD-A205109] p 523 N89-21781  
An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft [AD-A202910] p 526 N89-21782

## TRAILING EDGES

- Blade-vortex interaction p 508 A89-36905

## TRAJECTORIES

- Aeroballistic Research Facility Data Analysis System (ARFDAS) [AD-A204308] p 542 N89-21810

## TRAJECTORY CONTROL

- Description of a simple rotor test rig and preliminary wake studies [AD-A204089] p 541 N89-21808

## TRAJECTORY OPTIMIZATION

- Singular trajectories in airplane cruise-dash optimization p 538 A89-36928  
Trajectory optimization with risk minimization for military aircraft p 538 A89-36929  
Simulation of optimal flight paths of dynamical soaring flight and the design of a model aircraft p 529 A89-39259

## TRANSIENT HEATING

- Variations of undamped rotor blade frequencies subjected to transient heat flux p 553 A89-36919

## TRANSITION FLOW

- Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds [AD-A205206] p 519 N89-22575

## TRANSMISSION LINES

- The aviation wire strike problem - The duty to warn of this aerial hazard p 522 A89-38878

## TRANSMISSIONS (MACHINE ELEMENTS)

- The transmission development process at Lucas Western p 551 A89-36398  
Transmission overhaul and replacement predictions using Weibull and renewal theory [NASA-TM-102022] p 562 N89-22925

## TRANSONIC FLIGHT

- Aero-optical analysis of compressible flow over an open cavity p 509 A89-36914

## TRANSONIC FLOW

- Integrated approach for active coupling of structures and fluids p 552 A89-36917  
Flutter of a wing with an aileron in transonic flow p 539 A89-37461  
Asymptotic analysis of the transonic region of a high-speed propeller [AIAA PAPER 89-1077] p 565 A89-37652  
An explicit multistage finite-area method for 2D transonic flow calculations p 510 A89-37778  
AF-2 scheme for solution of axial symmetric transonic inlet-flowfield p 511 A89-37791  
Inviscid, unsteady, transonic axisymmetric flow with shock waves - Response to time and space-time dependent perturbations p 512 A89-38129  
Some properties of nonisentropic transonic flows p 512 A89-38426  
Stability of gas flows in Laval nozzles p 512 A89-38438  
Unsteady transonic small-disturbance theory including entropy and vorticity effects p 515 A89-39191  
The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration [NASA-TM-4100] p 516 N89-21762  
Aerodynamics of engine-airframe interaction [NASA-CR-184824] p 517 N89-21769  
The evaluation and representation of interferograms of transonic flow fields [MPIS-21/1987] p 518 N89-21777  
The aeroacoustics of the interaction between vortices and bodies in a transonic flow [MPIS-3/1988] p 566 N89-22445  
Transonic and supersonic flow past a 65 deg delta wing with rounded leading edges: Analysis of experimental data [DFVLR-FB-88-44] p 520 N89-22580  
An efficient inverse method for the design of blended wing-body configurations p 532 N89-22603

## TRANSONIC NOZZLES

- Numerical study of a multipurpose transonic wind tunnel with an adaptable injection-suction system p 543 N89-22621

## TRANSONIC SPEED

- Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds [AD-A205206] p 519 N89-22575  
Prediction of loads on wing/body/external store/lins pylon-configurations at transonic speeds [FFA-TN-1988-44] p 532 N89-22602

## TRANSONIC WIND TUNNELS

- Three component laser Doppler anemometry in large wind tunnels p 555 A89-38815  
Development of a second generation injector driven transonic wind tunnel at BUAA p 541 A89-39469  
On the accelerating airflow problem in the test section of a transonic wind tunnel p 541 A89-39477  
Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel p 520 N89-22584  
Hardware and operating features of the adaptive wall test section for the 0.3-meter transonic cryogenic tunnel [NASA-TM-4114] p 542 N89-22614  
Microcomputer based controller for the Langley 0.3-meter Transonic Cryogenic Tunnel [NASA-CR-181808] p 543 N89-22616  
Numerical study of a multipurpose transonic wind tunnel with an adaptable injection-suction system p 543 N89-22621  
Implementation of a two-component laser anemometer at the T2 wind tunnel [A-501-H] p 558 N89-22879

## TRANSPORT AIRCRAFT

- Validation of nonstationary aerodynamics models for longitudinal aeroplane motion on the basis of flight measurements p 539 A89-37524  
Passenger seat design commercial transport aircraft [SAE ARP 750] p 527 A89-37660  
Experimental investigation of applicability of waverider configuration to hypersonic transport and aerospace-plane p 511 A89-38123  
Good prospects for LET's 40-seater p 528 A89-39226  
Investigation of low NOx staged combustor concept in high-speed civil transport engines [NASA-TM-101977] p 537 N89-22606

## TREES (MATHEMATICS)

- Neural computing for numeric-to-symbolic conversion in control systems p 563 A89-37234

## TRUSSES

- Dynamics and control of truss structures with extending members p 523 N89-21778

## U

## TURBINE BLADES

- Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186  
Development of Inconel alloy MA 6000 turbine blades for advanced gas turbine engine designs p 545 A89-36414  
The processing and testing of a hollow DS eutectic high pressure turbine blade p 551 A89-36436  
Aircraft gas turbine blade and vane repair p 533 A89-36473  
Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474  
Degradation of aluminate coated directionally solidified superalloy turbine blades in an aero gas turbine engine p 546 A89-36480  
Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916  
Condensation phenomena in a turbine blade passage p 511 A89-37939  
XRD techniques in aero engine development --- X-ray diffraction p 555 A89-38632  
Development of stress and lifing criteria for single crystal turbine blades p 549 N89-22663

## TURBINE ENGINES

- A review and forecast of engine system research at the Army Propulsion Directorate p 533 A89-36397  
PARC code validation for propulsion flows [AD-A204293] p 557 N89-22066  
Transonic viscous flow calculations for a turbine cascade with a two equation turbulence model [NASA-TM-101944] p 537 N89-22607

## TURBINE PUMPS

- Influence of impeller shroud forces on turbopump rotor dynamics p 560 N89-22909

## TURBINE WHEELS

- Development of Gatorized MERL 76 for gas turbine disk applications p 545 A89-36411

## TURBINES

- Nondestructive volumetric CT-scan evaluation of monolithic ceramic turbine components p 555 A89-38954  
LDV measurements and investigation of flow field through radial turbine guide vanes p 538 N89-22609  
Some field experience with subsynchronous vibration of centrifugal compressors p 559 N89-22892  
Some in-field experiences of non-synchronous vibrations in large rotating machinery p 559 N89-22894

## TURBOCOMPRESSORS

- Investigation on simulation of foreign object impact damage to compressor blade p 534 A89-37757  
J85 surge transient simulation p 536 A89-39044  
Development of a streamline method [AD-A205146] p 557 N89-22078  
Rotordynamic stability problems and solutions in high pressure turbocompressors p 561 N89-22914

## TURBOJET ENGINES

- Adjustment of ratio of rotation speed difference in a twin-spool turbojet engine p 534 A89-37754  
Variable-cycle turbojet engines for multiple-regime aircraft --- Russian book p 535 A89-38510  
Application of a fuzzy controller in the fuel system of a turbojet engine p 536 A89-39043  
J85 surge transient simulation p 536 A89-39044

## TURBOMACHINE BLADES

- Vibrations of the blades of turbomachines --- Russian book p 535 A89-38504

## TURBOMACHINERY

- Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916  
Application of Advanced Material for Turbomachinery and Rocket Propulsion [AGARD-CP-449] p 548 N89-22654  
Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 [NASA-CP-3026] p 558 N89-22891  
High stability design for new centrifugal compressor p 561 N89-22917  
Structural dynamics branch research and accomplishments for FY 1988 [NASA-TM-101406] p 562 N89-22939

## TURBOPROP AIRCRAFT

- Good prospects for LET's 40-seater p 528 A89-39226

## TURBOSHAFTS

- T700 - Growing to meet the challenge p 533 A89-36400

## TURBULENCE

- A preliminary characterization of parachute wake recontact [DE89-006442] p 519 N89-22576  
Transition to turbulence in laminar hypersonic flow p 522 N89-22830

## TURBULENCE EFFECTS

- The effects of incidence angle and free stream turbulence on the performance of a variable geometry two-dimensional compressor cascade at high Reynolds numbers [AD-A202650] p 557 N89-22052

## TURBULENCE MODELS

- Navier-Stokes computations of two- and three-dimensional cascade flowfields p 514 A89-39035  
Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349  
A study of unsteady turbulent flow past airfoils p 521 N89-22587  
Computational fluid dynamics research in three-dimensional zonal techniques [NASA-CR-181406] p 558 N89-22838

## TURBULENT BOUNDARY LAYER

- Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186  
Separation shock motion in fin, cylinder, and compression ramp - Induced turbulent interactions p 509 A89-36911  
Modeling of density fluctuations in supersonic turbulent boundary layer p 509 A89-36923  
Experimental investigation of shock wave/boundary-layer interactions in an annular duct p 514 A89-39039  
Organized structures in a supersonic turbulent boundary layer p 517 N89-21771  
The effects of incidence angle and free stream turbulence on the performance of a variable geometry two-dimensional compressor cascade at high Reynolds numbers [AD-A202650] p 557 N89-22052  
Control of embedded vortices using wall jets [AD-A202606] p 558 N89-22835  
The structure and control of three-dimensional shock wave turbulent boundary layer interactions [AD-A205923] p 558 N89-22866

## TURBULENT FLOW

- The application of dynamic schlieren-photon correlation technique to a supersonic shear layer p 515 A89-39474  
An explicit Runge-Kutta method for turbulent reacting flow calculations [NASA-TM-101945] p 536 N89-21799  
A study of unsteady turbulent flow past airfoils p 521 N89-22587  
Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position p 560 N89-22906

## TURBULENT JETS

- Effects of swirl and high turbulence on a jet in a crossflow p 515 A89-39192  
Microburst simulation via vortex-ring and turbulent jet models p 562 N89-22287

## TURBULENT MIXING

- Linear instability waves in supersonic turbulent mixing layers p 508 A89-36903

## TURBULENT WAKES

- Wakes of four complex bodies of revolution at zero angle of attack p 508 A89-36907

## TURNING FLIGHT

- A method for determining the inertia tensor of a craft in flight p 565 A89-39819

## TWO DIMENSIONAL FLOW

- An explicit multistage finite-area method for 2D transonic flow calculations p 510 A89-37778  
The application of the two-dimensional unsteady Euler equations perturbation solutions on the supersonic rectangular wings p 511 A89-37787  
Navier-Stokes computations of two- and three-dimensional cascade flowfields p 514 A89-39035  
Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349  
Lifetime aerofoil calculations using von Mises variables p 516 A89-39666  
Numerical solutions of unsteady inviscid transonic turbine cascade flows p 516 N89-21767  
Flow past bluff bodies p 517 N89-21770  
Interaction between an isolated vortex and a wing profile [ETN-89-94364] p 520 N89-22579

## TWO PHASE FLOW

- Condensation phenomena in a turbine blade passage p 511 A89-37939

## UH-60A HELICOPTER

- Artificial and natural icing tests of the UH-60A helicopter configured with the XM-139 multiple mine dispensing system (VOLCANO) [AD-A205031] p 531 N89-21794

## ULTRALIGHT AIRCRAFT

- Integral rudder system for aircraft steering p 539 A89-39258

## UNIFORM FLOW

- The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body p 516 N89-21765

## UNSTEADY AERODYNAMICS

- Potential flow over bodies of revolution in unsteady motion p 508 A89-36910  
The application of the two-dimensional unsteady Euler equations perturbation solutions on the supersonic rectangular wings p 511 A89-37787  
Unsteady transonic small-disturbance theory including entropy and vorticity effects p 515 A89-39191  
Buffeting criteria for a systematic series of wings p 515 A89-39197  
A computational method of aerodynamics for subsonic, fully unsteady wings at high angles of attack in time-domain p 515 A89-39462  
Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800  
Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow [PB89-111470] p 518 N89-22571  
Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 N89-22586  
Aerodynamic detuning of a loaded airfoil cascade in an incompressible flow by a locally analytical method p 521 N89-22588

## UNSTEADY FLOW

- Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186  
Extension and application of flux-vector splitting to calculations on dynamic meshes p 508 A89-36901  
Explicit Runge-Kutta method for unsteady rotor/stator interaction p 509 A89-36912  
Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916  
On the unsteady leading edge suction of a sweptback wing p 510 A89-37776  
Inviscid, unsteady, transonic axisymmetric flow with shock waves - Response to time and space-time dependent perturbations p 512 A89-38129  
Pulsating flow over an ellipse at an angle of attack p 513 A89-38620  
Three-dimensional Navier-Stokes simulations of turbine rotor-stator interaction. I - Methodology p 514 A89-39034  
J85 surge transient simulation p 536 A89-39044  
Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188  
Unsteady force calculations on circular cylinders and elliptical airfoils with circulation control p 516 N89-21766  
Numerical solutions of unsteady inviscid transonic turbine cascade flows p 516 N89-21767  
A study of unsteady turbulent flow past airfoils p 521 N89-22587  
A vortex panel analysis of circular-arc bluff-bodies in unsteady flow [DE89-007141] p 558 N89-22845  
USER MANUALS (COMPUTER PROGRAMS)  
Aeroballistic Research Facility Data Analysis System (ARFAS) [AD-A204308] p 542 N89-21810

## V

## V/STOL AIRCRAFT

- Simulation evaluation of an advanced control concept for a V/STOL aircraft p 539 A89-36932

## VANELESS DIFFUSERS

- Stress tensor measurements within the vaneless diffuser of a centrifugal compressor p 556 A89-39050

## VAPOR DEPOSITION

- CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 N89-22658

## VARIABLE CYCLE ENGINES

- Variable-cycle turbojet engines for multiple-regime aircraft --- Russian book p 535 A89-38510

## VELOCITY

- Analytical modeling of helicopter static and dynamic induced velocity in GRASP p 513 A89-38555

**VELOCITY DISTRIBUTION**

Lateral induced velocity distribution of a helicopter rotor p 509 A89-36987

**VELOCITY MEASUREMENT**

Measurements in separating boundary layers p 552 A89-36909  
A two-spark schlieren system for very-high velocity measurement p 555 A89-38874  
Implementation of a two-component laser anemometer at the T2 wind tunnel [A-501-H] p 558 N89-22879

**VENTING**

Investigation for venting test technology with large-sized model in a large wind tunnel p 541 A89-37783

**VERTICAL TAKEOFF AIRCRAFT**

Helicopters and VTOL I p 527 A89-36899

**VIBRATION**

Evaluation of the ride quality of a light twin engine airplane using a ride quality meter [NASA-TP-2913] p 507 N89-22568  
Some in-field experiences of non-synchronous vibrations in large rotating machinery p 559 N89-22894  
The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895  
Magnetic bearing stiffness control using frequency band filtering p 560 N89-22910

**VIBRATION DAMPING**

Vibrations in aerospace structures - Prediction, prevention and control [ONERA, TP NO. 1989-9] p 553 A89-37631  
Active vibration control of flexible rotors - An experimental and theoretical study p 554 A89-37847  
Dynamics and control of truss structures with extending members p 523 N89-21778  
Acta Aeronautica et Astronautica Sinica (selected articles) [AD-A205128] p 508 N89-22570  
Active vibration control for flexible rotor by optimal direct-output feedback control [NASA-TM-101972] p 537 N89-22605  
The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895  
An electroviscous damper p 559 N89-22898  
A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 N89-22911  
High stability design for new centrifugal compressor p 561 N89-22917  
Structural dynamics branch research and accomplishments for FY 1988 [NASA-TM-101406] p 562 N89-22939

**VIBRATION ISOLATORS**

Experimental investigation of sudden imbalance response on a flexible rotor system with squeeze-film damper p 554 A89-37768  
Robust control of an active vibration isolation system for helicopters p 539 A89-39458  
A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 N89-22911

**VIBRATION MEASUREMENT**

Active vibration control of flexible rotors - An experimental and theoretical study p 554 A89-37847

**VIBRATION MODE**

Eigensolution of periodic assemblies of multi-mode component systems p 556 A89-39519

**VIBRATION TESTS**

Multi-input/multi-output frequency domain modal identification method and its application in ground vibration testing p 529 A89-39454

**VIDEO SIGNALS**

Combustor flow visualization using innovative infrared thermographics techniques [AD-A205905] p 550 N89-22718

**VISCOUS FLOW**

New possibilities of viscous-inviscid numerical techniques for solving viscous flow equations with massive separation [ONERA, TP NO. 1989-24] p 554 A89-37640  
The computation of the viscous/inviscid interaction p 510 A89-37777  
An explicit Runge-Kutta method for turbulent reacting flow calculations [NASA-TM-101945] p 536 N89-21799  
A numerical study of viscous vortex rings using a spectral method p 518 N89-22572  
Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 N89-22586  
Transonic viscous flow calculations for a turbine cascade with a two equation turbulence model [NASA-TM-101944] p 537 N89-22607

**VISCOUS FLUIDS**

An electroviscous damper p 559 N89-22898

**VISUAL FLIGHT**

Some mathematical considerations on views of the ground surface in flight p 562 A89-36351

**VITERBI DECODERS**

Field trials of aeronautical satellite communication system p 524 A89-36595

**VOICE COMMUNICATION**

AvSat - The first dedicated aeronautical satellite communications system p 524 A89-36592  
Technical design and performance analysis of aeronautical satellite communication systems p 524 A89-36594  
National airspace system plan: Facilities, equipment, associated development and other capital needs [AD-A202615] p 526 N89-22596

**VOICE CONTROL**

Voice of authority --- control systems for space vehicles p 544 A89-37646

**VORTEX BREAKDOWN**

The effects of vortex breakdown on the aerodynamic properties of a wing and the engineering predicting method p 510 A89-37780

**VORTEX FILAMENTS**

Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 N89-22586

**VORTEX RINGS**

Microburst simulation via vortex-ring and turbulent jet models p 562 N89-22287  
A numerical study of viscous vortex rings using a spectral method p 518 N89-22572

**VORTEX SHEETS**

Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 N89-22586

**VORTEX STREETS**

The aeroacoustics of the interaction between vortices and bodies in a transonic flow [MPIS-3/1988] p 566 N89-22445

**VORTICES**

Blade-vortex interaction p 508 A89-36905  
Swirling flows in an annular-to-rectangular transition section p 555 A89-39037  
Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188  
A physical model of the streamwise corner vortices in a compressor cascade p 515 A89-39473  
The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body p 516 N89-21765  
The aeroacoustics of the interaction between vortices and bodies in a transonic flow [MPIS-3/1988] p 566 N89-22445  
Interaction between an isolated vortex and a wing profile [ETN-89-94364] p 520 N89-22579  
Control of embedded vortices using wall jets [AD-A202606] p 558 N89-22835

**VORTICITY**  
Numerical and experimental evaluations of the flow past nested chevrons p 508 A89-36902  
Rotor vortex wake distortion and its induced velocity in ground effect at low speed p 510 A89-37779

**VORTICITY EQUATIONS**  
Convergence of discrete-vortex induced-flow calculations by optimum choice of mesh p 521 N89-22585

**W****WAKES**

Rotor vortex wake distortion and its induced velocity in ground effect at low speed p 510 A89-37779  
Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188  
Wake recontact: An experimental investigation using a ringslot parachute [DE89-008320] p 518 N89-21773  
A preliminary characterization of parachute wake recontact [DE89-006442] p 519 N89-22576

**WALL FLOW**

Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel p 520 N89-22584

**WALL PRESSURE**

The application of wall pressure method in low speed return wind tunnel with closed jet p 541 A89-37786

**WARFARE**

Fly, great sea eagle [AD-A203979] p 530 N89-21789

**WARNING SYSTEMS**

Coming to terms with TCAS p 522 A89-39088  
Ground collision warning system performance criteria for high maneuverability aircraft [AD-A204390] p 523 N89-21779

**WATER VAPOR**

Condensation phenomena in a turbine blade passage p 511 A89-37939

**WAVE PROPAGATION**

On the three families of instability waves of high-speed jets p 513 A89-38624

**WAVE SCATTERING**

Scattering from three-dimensional cracks p 565 A89-39588

**WAVEGUIDES**

Generalized criteria for microwave breakdown in air-filled waveguides p 552 A89-36655

**WAVERIDERS**

Experimental investigation of applicability of waverider configuration to hypersonic transport and aerospace-plane p 511 A89-38123

**WEATHER**

Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system [AD-A204030] p 530 N89-21790

**WEDGE FLOW**

Investigation of Mach reflection for a planar moving shock propagating into steady supersonic flow field around wedge p 510 A89-37782

**WEDGES**

Nonstationary supersonic flow past a body p 512 A89-38437  
Numerical calculations of hypersonic nonequilibrium flow over a blunt wedge p 515 A89-39461

**WEIBULL DENSITY FUNCTIONS**

Composite failure criterion: Probabilistic formulation and geometric interpretation [AD-A205275] p 548 N89-21851  
Transmission overhaul and replacement predictions using Weibull and renewal theory [NASA-TM-102022] p 562 N89-22925

**WIND (METEOROLOGY)**

The use of DFDR information in the analysis of a turbulence incident over Greenland p 562 A89-39647  
Investigation of the effects of increased sophistication of simulation of the atmospheric wind in wind tunnels p 543 N89-22620

**WIND EFFECTS**

Effect of spatial wind gradients on airplane aerodynamics p 514 A89-39190

**WIND PROFILES**

Hazard index calculation for 31 May 1984 microburst at Erie, Colorado [NASA-CR-184968] p 562 N89-23048

**WIND SHEAR**

Effect of spatial wind gradients on airplane aerodynamics p 514 A89-39190  
Energy concepts applied to control of airplane flight in wind shear p 540 N89-21806  
Microburst simulation via vortex-ring and turbulent jet models p 562 N89-22287

**WIND TUNNEL APPARATUS**

Implementation of a two-component laser anemometer at the T2 wind tunnel [A-501-H] p 558 N89-22879

**WIND TUNNEL MODELS**

Investigation for venting test technology with large-sized model in a large wind tunnel p 541 A89-37783  
Investigation of the effects of increased sophistication of simulation of the atmospheric wind in wind tunnels p 543 N89-22620

**WIND TUNNEL STABILITY TESTS**

Investigation for venting test technology with large-sized model in a large wind tunnel p 541 A89-37783

**WIND TUNNEL TESTS**

Separation control on an airfoil by periodic forcing p 509 A89-36922  
A way for upgrading the accuracy of force measurement p 553 A89-37011  
Infrared thermography - A quantitative tool for heat study [ONERA, TP NO. 1989-3] p 553 A89-37627  
Application of infrared thermography to the interpretation of tests in an icing wind tunnel [ONERA, TP NO. 1989-28] p 554 A89-37642  
The application of wall pressure method in low speed return wind tunnel with closed jet p 541 A89-37786  
An experimental and computational study of rotor-vortex interactions p 513 A89-38553  
Buffeting criteria for a systematic series of wings p 515 A89-39197  
Development of a second generation injector driven transonic wind tunnel at BUAA p 541 A89-39469  
On the accelerating airflow problem in the test section of a transonic wind tunnel p 541 A89-39477  
Static internal performance of convergent single-expansion-ramp nozzles with various combinations of internal geometric parameters [NASA-TM-4112] p 517 N89-21768  
NASA's program on icing research and technology [NASA-TM-101989] p 507 N89-22569  
Interaction between an isolated vortex and a wing profile [ETN-89-94364] p 520 N89-22579

## WIND TUNNEL WALLS

The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack  
[FFA-141] p 520 N89-22583

Transonic and supersonic wind tunnel tests on control effectiveness on schematic missile configurations with canard controls  
[FFA-TN-1988-11] p 531 N89-22601

Microcomputer based controller for the Langley 0.3-meter Transonic Cryogenic Tunnel  
[NASA-CR-181808] p 543 N89-22616

The low-speed wind tunnel at DVFLR in Brunswick (Fed. Republic of Germany)  
[DFVLR-MITT-88-25] p 543 N89-22619

Investigation of the effects of increased sophistication of simulation of the atmospheric wind in wind tunnels  
p 543 N89-22620

Control of embedded vortices using wall jets  
[AD-A202606] p 558 N89-22835

### WIND TUNNEL WALLS

Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel  
p 520 N89-22584

Hardware and operating features of the adaptive wall test section for the 0.3-meter transonic cryogenic tunnel  
[NASA-TM-4114] p 542 N89-22614

### WIND TUNNELS

Color helium bubble flow-visualization technique  
p 556 A89-39186

Visting China's aerodynamics research and development center  
[AD-A203980] p 543 N89-22615

Investigation of the effects of increased sophistication of simulation of the atmospheric wind in wind tunnels  
p 543 N89-22620

### WIND TURBINES

Wind tunnel tests of 16 percent thick airfoil section with spoilers at different chordwise positions --- wind turbines  
[FFA-TN-1987-39] p 520 N89-22582

### WING CAMBER

AFTI (Advanced Fighter Technology Integration)/F-111 mission adaptive wing briefing to industry  
[AD-A202467] p 530 N89-21787

### WING LOADING

USAF/Lockheed F-117A has high wing sweep but low wing loading  
p 528 A89-39234

Integral rudder system for aircraft steering  
p 539 A89-39258

### WING OSCILLATIONS

Flutter of a wing with an aileron in transonic flow  
p 539 A89-37461

Influence of pitching motion on subsonic wing rock of slender delta wings  
p 514 A89-39187

### WING PLANFORMS

Note on the lifting-surface problem for a circular wing in incompressible flow  
p 514 A89-38939

### WING PROFILES

A method for shock-free wing design  
p 509 A89-36985

Note on the lifting-surface problem for a circular wing in incompressible flow  
p 514 A89-38939

Interaction between an isolated vortex and a wing profile  
[ETN-89-94364] p 520 N89-22579

### WING SLOTS

The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration  
[NASA-TM-4100] p 516 N89-21762

### WING TIP VORTICES

Extension of classical tip loss formulas --- for rotorcraft design  
p 528 A89-38652

Description of a simple rotor test rig and preliminary wake studies  
[AD-A204089] p 541 N89-21808

Convergence of discrete-vortex induced-flow calculations by optimum choice of mesh  
p 521 N89-22585

### WING-FUSELAGE STORES

Wing-store flutter analysis of an airfoil in incompressible flow  
p 528 A89-39198

### WINGS

Prediction of fatigue life under aircraft loading with and without use of material memory rules  
p 527 A89-38028

The joined wing - The benefits and drawbacks. I  
p 507 A89-38800

A computational method of aerodynamics for subsonic, fully unsteady wings at high angles of attack in time-domain  
p 515 A89-39462

Control augmented structural optimization of aeroelastically tailored fiber composite wings  
[AD-A204534] p 530 N89-21791

Investigations of the parameter reduction in the optimization of aircraft wing structures  
[ILR-MITT-203] p 531 N89-21795

Stall flutter of graphite/epoxy wings with bending-torsion coupling  
[AD-A203077] p 540 N89-21804

## X

### X RAY DIFFRACTION

XRD techniques in aero engine development --- X-ray diffraction  
p 555 A89-38632

### X RAY INSPECTION

Nondestructive volumetric CT-scan evaluation of monolithic ceramic turbine components  
p 555 A89-38954

### X-29 AIRCRAFT

Sensitivity analysis of digital flight control systems using singular-value concepts  
p 538 A89-36927

Lateral stability analysis for X-29A drop model using system identification methodology  
[NASA-TM-4108] p 539 N89-21802

### X-30 VEHICLE

Materials for the NASP  
p 547 A89-36722

## Y

### YAW

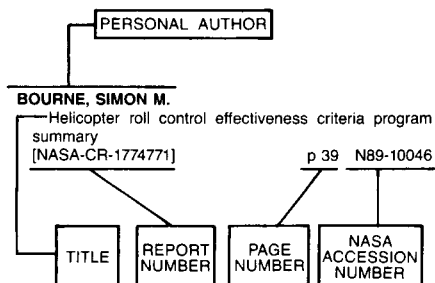
A study of unsteady turbulent flow past airfoils  
p 521 N89-22587

## Z

### ZERO ANGLE OF ATTACK

Wakes of four complex bodies of revolution at zero angle of attack  
p 508 A89-36907

## Typical Personal Author Index Listing



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.

## A

- ABE, TOSHIO**  
Simulation analysis on ceramic gas turbine  
[DE88-756469] p 548 N89-21926
- ADAMS, M. L.**  
A seal test facility for the measurement of isotropic and anisotropic linear rotordynamic characteristics p 560 N89-22905
- AKIBA, RYOJIRO**  
Fundamental aspects of an aerospaceplane p 544 A89-38234
- AKSENOVA, O. A.**  
Dependence of regime coefficients on regime parameters in local interaction theory p 512 A89-38435
- ALEKSEEV, K. B.**  
A method for determining the inertia tensor of a craft in flight p 565 A89-39819
- ALLAIRE, P. E.**  
A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 N89-22911
- ALVES, CARLOS FREDERICO ESTRADA**  
Inviscid, unsteady, transonic axisymmetric flow with shock waves - Response to time and space-time dependent perturbations p 512 A89-38129
- AN, JIGUANG**  
Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow [PB89-111470] p 518 N89-22571
- ANDERSON, D.**  
Generalized criteria for microwave breakdown in air-filled waveguides p 552 A89-36655
- ANDERSON, W. KYLE**  
Extension and application of flux-vector splitting to calculations on dynamic meshes p 508 A89-36901
- ANTONY, K. C.**  
Aircraft gas turbine blade and vane repair p 533 A89-36473
- ANTSIAKLIS, PANOS J.**  
Neural computing for numeric-to-symbolic conversion in control systems p 563 A89-37234
- ARCHAMBAUD, J. P.**  
Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel p 520 N89-22584

- Implementation of a two-component laser anemometer at the T2 wind tunnel  
[A-501-H] p 558 N89-22879
- ARMANDO, I.-A. PATRICK**  
Materials tests: Means and techniques p 548 N89-21983
- ARNDT, STEPHEN M.**  
The naval aircraft crash environment: Aircrew survivability and aircraft structural response  
[AD-A204825] p 523 N89-21780
- ASCIONE, G.**  
Design, implementation and computer aided tests of a shaped reflector for an air traffic control system  
[ETN-89-94229] p 556 N89-22014
- ASH, R. L.**  
Surface temperature measurements using a thin film thermal array  
[NASA-TM-101549] p 558 N89-22868
- ASHWORTH, D. A.**  
Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186  
Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800
- ATLI, VEYSEL**  
Wakes of four complex bodies of revolution at zero angle of attack p 508 A89-36907

## B

- BACH, R. E., JR.**  
The use of DFDR information in the analysis of a turbulence incident over Greenland p 562 A89-39647
- BAGBY, J. S.**  
Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764
- BAHREE, RAJEEVE**  
Variations of undamped rotor blade frequencies subjected to transient heat flux p 553 A89-36919
- BAI, CHANGCHENG**  
The problems of the infrared stealth of the flying vehicles p 507 A89-37003
- BAILEY, JOHN**  
Coming to terms with TCAS p 522 A89-39088
- BAILLIE, S.**  
An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft  
[AD-A202910] p 526 N89-21782
- BALAGEAS, D.**  
Infrared thermography - A quantitative tool for heat study  
[ONERA, TP NO. 1989-3] p 553 A89-37627
- BALAKRISHNA, S.**  
Microcomputer based controller for the Langley 0.3-meter Transonic Cryogenic Tunnel  
[NASA-CR-181808] p 543 N89-22616
- BAR-SEVER, A.**  
Separation control on an airfoil by periodic forcing p 509 A89-36922
- BARE, E. ANN**  
Static internal performance of convergent single-expansion-ramp nozzles with various combinations of internal geometric parameters  
[NASA-TM-4112] p 517 N89-21768
- BARRETT, L. E.**  
A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 N89-22911
- BARRON, RONALD M.**  
Lifetime aerofoil calculations using von Mises variables p 516 A89-39666
- BARTEL, H. W.**  
Near-field acoustic characteristics of a single-rotor propfan  
[AIAA PAPER 89-1055] p 533 A89-36215  
Installed propfan (SR-7L) far-field noise characteristics  
[AIAA PAPER 89-1056] p 564 A89-36216  
Lateral noise attenuation of the advanced propeller of the propfan test assessment aircraft  
[AIAA PAPER 89-1057] p 564 A89-36217
- Fluctuating pressures on wing surfaces in the slipstream of a single-rotor propfan  
[AIAA PAPER 89-1058] p 564 A89-36218
- BARTELS, HANS-HERMANN**  
The evaluation and representation of interferograms of transonic flow fields  
[MPIS-21/1987] p 518 N89-21777
- BASTOS-NETTO, DEMETRIO**  
Inviscid, unsteady, transonic axisymmetric flow with shock waves - Response to time and space-time dependent perturbations p 512 A89-38129
- BATINA, JOHN T.**  
Unsteady transonic small-disturbance theory including entropy and vorticity effects p 515 A89-39191
- BATTERSON, JAMES G.**  
Lateral stability analysis for X-29A drop model using system identification methodology  
[NASA-TM-41108] p 539 N89-21802
- BAULIN, N. N.**  
A study of shock wave radiation near models at hypersonic velocities in air p 513 A89-38445
- BEAN, DENNIS L.**  
Evaluation of barrier cable impact pad materials  
[AD-A204356] p 542 N89-21811
- BECKWITH, I. E.**  
Boundary-layer transition on a cone and flat plate at Mach 3.5 p 508 A89-36904
- BEGUIER, C.**  
Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349
- BENSON, MICHAEL**  
Flow past bluff bodies p 517 N89-21770
- BENTLY, D. E.**  
Role of circumferential flow in the stability of fluid-handling machine rotors p 561 N89-22915
- BERG, MATTHIAS**  
Consideration of environmental conditions for the fatigue evaluation of composite airframe structure p 551 A89-36304
- BERGER, HAROLD**  
Application of nondestructive inspection methods to composites p 555 A89-38951
- BERGLIND, TORSTEN**  
Compressible Euler solution around a wing canard sting configuration  
[FFA-TN-1988-62] p 519 N89-22578  
The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack  
[FFA-141] p 520 N89-22583
- BERGMAN, R.**  
Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows  
[AD-A204364] p 518 N89-21774
- BERNHART, W. D.**  
Electroimpulse deicing - Electrodynamical solution by discrete elements p 528 A89-39193
- BHAT, THONSE R. S.**  
Shock structure in non-circular jets  
[AIAA PAPER 89-1083] p 510 A89-37653
- BHOWAL, P. R.**  
Property optimization in superalloys through the use of heat treat process modelling p 546 A89-36452
- BIAN, WENKUAN**  
Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method p 553 A89-37006
- BILIMORIA, KARL D.**  
Singular trajectories in airplane cruise-dash optimization p 538 A89-36928
- BIRCH, STANLEY F.**  
Aero-optical analysis of compressible flow over an open cavity p 509 A89-36914
- BITTKER, DAVID A.**  
Investigation of low NOx staged combustor concept in high-speed civil transport engines  
[NASA-TM-101977] p 537 N89-22606



## BJORCK, ANDERS

Wind tunnel tests of 16 percent thick airfoil section with spoilers at different chordwise positions  
[FFA-TN-1987-39] p 520 N89-22582

## BLACK, T. D.

Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764

## BLEUZEN, CLAUDE

Failure analysis: Analysis of landing gear fatigue test results for mechanical and metallurgical considerations in order to determine the authorized run time p 556 N89-21984

## BLEVINS, R. D.

An approximate method for sonic fatigue analysis of plates and shells p 565 A89-39515

## BOBULA, GEORGE A.

A review and forecast of engine system research at the Army Propulsion Directorate p 533 A89-36397

## BOERSMA, J.

Note on the lifting-surface problem for a circular wing in incompressible flow p 514 A89-38939

## BOGATKO, V. I.

Nonstationary supersonic flow past a body p 512 A89-38437

## BOGDONOFF, SEYMOUR M.

The structure and control of three-dimensional shock wave turbulent boundary layer interactions  
[AD-A205923] p 558 N89-22866

## BONNET, J. L.

Implementation of a two-component laser anemometer at the T2 wind tunnel  
[A-501-H] p 558 N89-22879

## BOONZAAR, J. J.

Electromagnetic backscatter from open-ended circular cylinder with complex termination p 536 A89-39284

## BOOZE, C. F., JR.

Sudden inflight incapacitation in general aviation p 522 A89-36117

## BORETTI, A. A.

An explicit Runge-Kutta method for turbulent reacting flow calculations  
[NASA-TM-101945] p 536 N89-21799  
Transonic viscous flow calculations for a turbine cascade with a two equation turbulence model  
[NASA-TM-101944] p 537 N89-22607

## BOSCHER, D.

Infrared thermography - A quantitative tool for heat study  
[ONERA, TP NO. 1989-3] p 553 A89-37627

## BOSSLER, ROBERT B., JR.

The transmission development process at Lucas Western p 551 A89-36398

## BOUCHER, C. C.

Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise p 529 A89-39509

## BOWLES, ROLAND L.

Effect of spatial wind gradients on airplane aerodynamics p 514 A89-39190

## BRANNEY, JAMES H.

Composites - Helicopters leading the way p 528 A89-39086

## BREIL, J. F.

Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel p 520 N89-22584

## BRIDGEMAN, JOHN O.

An experimental and computational study of rotor-vortex interactions p 513 A89-38553

## BRIDGES, P. J.

Metallurgical stability of Inconel alloy 718 p 545 A89-36405

## BRODEN, GUENTER

Modern joining methods for future aircraft structures p 556 A89-39076

## BROOKS, CUYLER W., JR.

The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration  
[NASA-TM-4100] p 516 N89-21762

## BROOKS, J. W.

Metallurgical stability of Inconel alloy 718 p 545 A89-36405

## BROUSSARD, JOHN R.

Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931

## BROWN, ALAN S.

Taming ceramic fiber p 547 A89-36721

## BROWN, JENNIE H.

Environmentally induced discontinuities in transparent polymers  
[AD-A205483] p 550 N89-22768

## BRUCH, C. A.

The processing and testing of a hollow DS eutectic high pressure turbine blade p 551 A89-36436

## BRUN, R.

Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349

## BRUSNIAK, L.

Separation shock motion in fin, cylinder, and compression ramp - Induced turbulent interactions p 509 A89-36911

## BUCH, A.

Prediction of fatigue life under aircraft loading with and without use of material memory rules p 527 A89-38028

## BUETEFISCH, KARL-ALOYS

Three component laser Doppler anemometry in large wind tunnels p 555 A89-38615

## BUNIMOVICH, A. I.

Aerodynamic characteristics of arbitrarily rotating bodies in a variable-density gas p 509 A89-37355

## BURKS, JOHN S.

Helicopters and VTOL. I p 527 A89-36899

## BURROWS, C. R.

Active vibration control of flexible rotors - An experimental and theoretical study p 554 A89-37847

## C

## CAGLAYAN, ALPER K.

Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931

## CALESS, R. H.

Development of Gatorized MERL 76 for gas turbine disk applications p 545 A89-36411

## CAMPO, E.

Development of stress and lifing criteria for single crystal turbine blades p 549 N89-22663

## CAPONE, FRANCIS J.

Static internal performance of convergent single-expansion-ramp nozzles with various combinations of internal geometric parameters  
[NASA-TM-4112] p 517 N89-21768

## CARADONNA, FRANCIS X.

An experimental and computational study of rotor-vortex interactions p 513 A89-38553

## CARLYLE, J. M.

Acoustic emission testing the F-111 p 541 A89-39008

## CASSADY, PHILIP E.

Aero-optical analysis of compressible flow over an open cavity p 509 A89-36914

## CASTILLO, R.

Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474

## CASTRO, I. P.

Measurements in separating boundary layers p 552 A89-36909

## CATTOLICA, R. J.

Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements  
[NASA-CR-184896] p 517 N89-21772

## CAUGHEY, DAVID A.

Aerodynamics of engine-airframe interaction  
[NASA-CR-184824] p 517 N89-21769

## CETEL, A. D.

Second-generation nickel-base single crystal superalloy p 546 A89-36424

## CHA, P. D.

Eigensolution of periodic assemblies of multi-mode component systems p 556 A89-39519

## CHALK, C. D.

CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 N89-22658

## CHAMBERLIN, ROGER

New hypersonic facility capability at NASA Lewis Research Center  
[NASA-TM-102028] p 543 N89-22617

## CHAMBERS, F. W.

Lateral noise attenuation of the advanced propeller of the propan test assessment aircraft  
[AIAA PAPER 89-1057] p 564 A89-36217

## CHAN, Y. Y.

Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds  
[AD-A205206] p 519 N89-22575

## CHEN, F.-J.

Boundary-layer transition on a cone and flat plate at Mach 3.5 p 508 A89-36904

## CHEN, FANG

A physical model of the streamwise corner vortexes in a compressor cascade p 515 A89-39473

## CHEN, H. MING

Magnetic bearing stiffness control using frequency band filtering p 560 N89-22910

## CHEN, HONGQUAN

Nonlinear supersonic potential flow over sideslip conical bodies, delta wings and fuselages p 511 A89-37792

## CHEN, JINGSONG

The application of the two-dimensional unsteady Euler equations perturbation solutions on the supersonic rectangular wings p 511 A89-37787

## CHEN, KANGYAN

Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow  
[PB89-111470] p 518 N89-22571

## CHEN, MINGYAN

The application of wall pressure method in low speed return wind tunnel with closed jet p 541 A89-37786

## CHEN, SHILU

Coupling factor method for studying elastic motion of flight vehicles p 544 A89-37004

## CHEN, XIAORONG

GDPP - A practical CAD software package p 563 A89-37014

## CHEN, XIAOXIONG

On evaluation of aircraft propulsion system performance p 534 A89-37752

## CHENG, YIN

The analysis and prediction of the spin equilibrium point of modern aircrafts p 539 A89-39459

## CHETTY, S.

Flight control system design for an in-flight simulator p 539 A89-36934

## CHIANG, HSIAO-WEI DAVID

Aerodynamic detuning of a loaded airfoil cascade in an incompressible flow by a locally analytical method p 521 N89-22588

## CHILDS, DARA W.

Annular honeycomb seals: Test results for leakage and rotordynamic coefficients; comparisons to labyrinth and smooth configurations p 559 N89-22899  
Influence of impeller shroud forces on turbopump rotor dynamics p 560 N89-22909

## CHIMA, RODRICK C.

Explicit Runge-Kutta method for unsteady rotor/stator interaction p 509 A89-36912

## CHIU, YIH-WAN

Extension of classical tip loss formulas p 528 A89-38652

## CHIU, YIHWAN DANNY

Convergence of discrete-vortex induced-flow calculations by optimum choice of mesh p 521 N89-22585

## CHOKSI, G.

Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188

## CHRISPIN, W. J.

Future advanced aero-engines: The materials challenge p 538 N89-22659

## CHRIST, DIETMAR

The low-speed wind tunnel at DVFLR in Brunswick (Fed. Republic of Germany)  
[DFVLR-MITT-88-25] p 543 N89-22619

## CINTALA, M. J.

Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft p 544 A89-36543

## CLARK, KENNETH

The effects of plastic media blasting paint removal on the microstructure of graphite/epoxy composite materials  
[AD-A204801] p 550 N89-22688

## CLEMENS, S.

Active vibration control of flexible rotors - An experimental and theoretical study p 554 A89-37847

## CLIFF, EUGENE M.

Singular trajectories in airplane cruise-dash optimization p 538 A89-36928

## CLUKEY, PATRICIA G.

The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration  
[NASA-TM-4100] p 516 N89-21762

## COLLIER, J. P.

On developing a microstructurally and thermally stable iron-nickel base superalloy p 545 A89-36406

## COLLINS, WILLIAM E.

Studies of poststrike air traffic control specialist trainees. Part 2: Selection and screening programs  
[AD-A199177] p 526 N89-22595

## COLNAGO, GIUSEPPE

Some in-field experiences of non-synchronous vibrations in large rotating machinery p 559 N89-22894

## COLTMAN, JOSEPH W.

The naval aircraft crash environment: Aircrew survivability and aircraft structural response  
[AD-A204825] p 523 N89-21780

## CONG, SONG LIN

Anodized aluminum and aluminum alloy coatings for thermal control p 547 A89-38153

- COOKE, G. A.**  
Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596
- COOPER, G. K.**  
PARC code validation for propulsion flows [AD-A204293] p 557 N89-22066
- COSTEN, PETER A.**  
INTERFACE 2: Advanced diagnostic software [AD-A204527] p 563 N89-22366
- COWN, BARRY J.**  
Near-field scattering measurements for determining complex target RCS p 532 A89-39587
- COX, M. E.**  
Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596
- COZIAN, GILDA**  
Geodetic positioning system for flying aircraft (May 1987) [REPT-013/88] p 527 N89-22598
- CRAWLEY, EDWARD F.**  
Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916
- CRIGHTON, D. G.**  
Prediction of counter-rotation propeller noise [AIAA PAPER 89-1141] p 564 A89-36221
- CURTISS, H. C., JR.**  
Rotor vortex wake distortion and its induced velocity in ground effect at low speed p 510 A89-37779
- CUSICK, ALLAN HODGSON**  
Investigation of the effects of increased sophistication of simulation of the atmospheric wind in wind tunnels p 543 N89-22620

## D

- DADONE, LEO**  
Blade-vortex interaction p 508 A89-36905
- DALLMANN, UWE**  
Flow over a leading edge with distributed roughness [DFVLR-FB-88-45] p 520 N89-22581
- DANILECKI, STANISLAW**  
The joined wing - The benefits and drawbacks. I p 507 A89-38800
- DARRAH, SHIRLEY**  
Jet fuel deoxygenation [AD-A205006] p 548 N89-21943
- DARYABEIGI, K.**  
Surface temperature measurements using a thin film thermal array [NASA-TM-101549] p 558 N89-22868
- DAT, R.**  
Vibrations in aerospace structures - Prediction, prevention and control [ONERA, TP NO. 1989-9] p 553 A89-37631
- DAVIS, FRANK G.**  
The demonstration of monolithic and composite ceramics in aircraft gas turbine combustors p 550 N89-22665
- DAVIS, R. R.**  
Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 N89-22912  
Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 N89-22916
- DE WITT, K. J.**  
Two-dimensional simulation of electrothermal deicing of aircraft components p 528 A89-39194
- DEDE, M. M.**  
The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895
- DELIA, U. F.**  
Design, implementation and computer aided tests of a shaped reflector for an air traffic control system [ETN-89-94229] p 556 N89-22014
- DELUCCIA, J. J.**  
The fatigue in aircraft corrosion testing (FACT) programme [AGARD-R-713] p 548 N89-21873
- DEMENT, D. K.**  
AvSat - The first dedicated aeronautical satellite communications system p 524 A89-36592
- DEOM, A.**  
Infrared thermography - A quantitative tool for heat study [ONERA, TP NO. 1989-3] p 553 A89-37627
- DIANAT, M.**  
Measurements in separating boundary layers p 552 A89-36909
- DICUS, JOHN H.**  
New hypersonic facility capability at NASA Lewis Research Center [NASA-TM-102028] p 543 N89-22617

- DIETZEN, F. J.**  
Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position p 560 N89-22906
- DILLON-TOWNES, L. A.**  
Surface temperature measurements using a thin film thermal array [NASA-TM-101549] p 558 N89-22868
- DIPPOLITO, RICHARD**  
An OOD (Object-Oriented Design) paradigm for flight simulators, 2nd edition [AD-A204849] p 542 N89-21813
- DIRUSSO, ELISEO**  
Active vibration control for flexible rotor by optimal direct-output feedback control [NASA-TM-101972] p 537 N89-22605
- DOEL, DAVID L.**  
INTERFACE 2: Advanced diagnostic software [AD-A204527] p 563 N89-22366
- DOKIN, VLADIMIR F.**  
Fundamentals of aviation (4th revised and enlarged edition) p 507 A89-38514
- DOLLING, D. S.**  
Separation shock motion in fin, cylinder, and compression ramp - Induced turbulent interactions p 509 A89-36911
- DOMINEK, ALLEN K.**  
Scattering from three-dimensional cracks p 565 A89-39588
- DONALDSON, PETER**  
Voice of authority p 544 A89-37646
- DONG, B.**  
Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188
- DONG, XIAOFENG**  
F.E. simulation of crash for helicopters p 529 A89-39472
- DONG, ZHANAO**  
Investigation for venting test technology with large-sized model in a large wind tunnel p 541 A89-37783
- DONOHIE, H. G.**  
T700 - Growing to meet the challenge p 533 A89-36400
- DOR, J. B.**  
Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel p 520 N89-22584
- DORLING, C. M.**  
A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510
- DORNHEIM, MICHAEL A.**  
USAF/Lockheed F-117A has high wing sweep but low wing loading p 528 A89-39234
- DOWNNEY, DAVID A.**  
Artificial and natural icing tests of the UH-60A helicopter configured with the XM-139 multiple mine dispensing system (VOLCANO) [AD-A205031] p 531 N89-21794
- DOWNING, DAVID R.**  
Sensitivity analysis of digital flight control systems using singular-value concepts p 538 A89-36927
- DROUGGE, GEORG**  
The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack [FFA-141] p 520 N89-22583
- DRYER, F. L.**  
Aerodynamic device for generating mono-disperse fuel droplets p 554 A89-37878
- DU, YUN-TIAN**  
Some field experience with subsynchronous vibration of centrifugal compressors p 559 N89-22892
- DUAN, JIWEN**  
Fly, great sea eagle [AD-A203979] p 530 N89-21789
- DUBINSKII, A. V.**  
Aerodynamic characteristics of arbitrarily rotating bodies in a variable-density gas p 509 A89-37355
- DUCK, PETER W.**  
The inviscid axisymmetric stability of the supersonic flow along a circular cylinder [NASA-CR-181816] p 519 N89-22574
- DUOMAN, A. E.**  
Gust analysis of an aircraft with highly non-linear systems interaction [AIAA PAPER 89-1377] p 527 A89-37650
- DUGUNDJI, JOHN**  
Stall flutter of graphite/epoxy wings with bending-torsion coupling [AD-A203077] p 540 N89-21804
- DUHL, D. N.**  
Second-generation nickel-base single crystal superalloy p 546 A89-36424
- DUNCAN, DAVID**  
Privatization of the air traffic control system - Its rationale, implementation and implications p 566 A89-38877

- DUNN, PETER**  
Stall flutter of graphite/epoxy wings with bending-torsion coupling [AD-A203077] p 540 N89-21804
- DUNSTON, MARY COTTRELL**  
A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance [AD-A204856] p 531 N89-21793
- DUPONT, O.**  
The optical bidirectional accelerometer p 553 A89-36966
- DURYEA, G.**  
Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows [AD-A204364] p 518 N89-21774

## E

- EATWELL, G. P.**  
A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510
- EBERT, ELIZABETH E.**  
Test of a calibration device for airborne Lyman-alpha hygrometers p 532 A89-37537
- EDWARDS, THOMAS ALAN**  
The effect of exhaust plume/afterbody on installed scramjet performance p 536 N89-21797
- ELDER, J. E.**  
Degradation of aluminide coated directionally solidified superalloy turbine blades in an aero gas turbine engine p 546 A89-36480
- ELIASSON, PETER**  
The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack [FFA-141] p 520 N89-22583
- ELLINGSON, W. A.**  
Nondestructive volumetric CT-scan evaluation of monolithic ceramic turbine components p 555 A89-38954
- ELLIOTT, I. C.**  
Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK50 p 546 A89-36440
- ELLIOTT, S. J.**  
Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise p 529 A89-39509
- ELORANTA, EDWIN W.**  
Test of a calibration device for airborne Lyman-alpha hygrometers p 532 A89-37537
- ELROD, DAVID**  
Annular honeycomb seals: Test results for leakage and rotordynamic coefficients; comparisons to labyrinth and smooth configurations p 559 N89-22899
- ELZEBDA, J. M.**  
Influence of pitching motion on subsonic wing rock of slender delta wings p 514 A89-39187
- ERMAKOV, A. I.**  
Dynamical calculations of engine components based on elasticity equations p 553 A89-37421
- EROGLU, HASAN**  
LDV measurements and investigation of flow field through radial turbine guide vanes p 538 N89-22609
- EVANS, M. D.**  
Causes and effects of center segregation in electro-slag remelted alloy 718 for critical rotating part applications p 545 A89-36410
- EWING, B. A.**  
Development of Inconel alloy MA 6000 turbine blades for advanced gas turbine engine designs p 545 A89-36414

## F

- FARMER, T. E.**  
Damage tolerance concepts for advanced materials and engines p 549 N89-22661
- FIELD, S. P.**  
CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 N89-22658
- FISCHER, MARK**  
Aeroballistic Research Facility Data Analysis System (ARFDAS) [AD-A204308] p 542 N89-21810
- FITZGIBBON, K. T.**  
Aircraft automatic landing systems using GPS p 525 A89-39827

## FLEETER, SANFORD

Research as part of the Air Force Research in Aero Propulsion Technology (AFRAPT) Program  
[AD-A204968] p 537 N89-21801

## FLEMING, DAVID P.

Active vibration control for flexible rotor by optimal direct-output feedback control  
[NASA-TM-101972] p 537 N89-22605

## FLORYAN, JERZY M.

Flow over a leading edge with distributed roughness  
[DFVLR-FB-88-45] p 520 N89-22581

## FORGET, P.

Laser drilling of a superalloy coated with ceramic  
p 551 A89-36455

## FORNEY, L. J.

Supersonic particle probes: Measurement of internal wall losses  
[AD-A205863] p 521 N89-22589

## FOSS, J. F.

Numerical and experimental evaluations of the flow past nested chevrons  
p 508 A89-36902

## FOSS, J. K.

Numerical and experimental evaluations of the flow past nested chevrons  
p 508 A89-36902

## FOSTER, S. M.

Enhanced rupture properties in advanced single crystal alloys  
p 546 A89-36425

## FOURNIER, J.

Infrared thermography - A quantitative tool for heat study  
[ONERA, TP NO. 1989-3] p 553 A89-37627

## FREER, DUANE W.

The maturing of commercial aviation  
p 507 A89-36900

## FRIDMAN, L. I.

Dynamical calculations of engine components based on elasticity equations  
p 553 A89-37421

## FRIDMAN, M. M.

Application of the theory of fuzzy sets to the two-criterion stochastic optimization of ribbed shells  
p 556 A89-39823

## FRIEDBERG, R. A.

Electro-impulse de-icing research: Fatigue and electromagnetic interference tests  
[DOT/FAA/CT-88/27] p 524 N89-22594

## FRIEDMANN, PERETZ

Control augmented structural optimization of aeroelastically tailored fiber composite wings  
[AD-A204534] p 530 N89-21791

## FRIGERI, CLAUDIO

Some in-field experiences of non-synchronous vibrations in large rotating machinery  
p 559 N89-22894

## FU, CAIGAO

Experimental investigation of sudden imbalance response on a flexible rotor system with squeeze-film damper  
p 554 A89-37768

## FUJII, KOZO

Numerical simulation of supersonic flows past a space-plane  
p 511 A89-38124

## FUJIWARA, TOSHI

Highly-resolved flowfield induced by Mach reflection  
p 512 A89-38125

## G

## GABARA, VLODEK

Polymers for advanced structures - An overview  
p 545 A89-36335

## GANY, ALON

Investigation of a small solid fuel ramjet combustor  
p 544 A89-39028

## GARANKIN, V. A.

Motion of a three-degrees-of-freedom gyroscope with a dynamically unbalanced rotor in the case of contact between the internal frame and an elastic limiter  
p 565 A89-39816

## GARCIA-FOGEDA, PABLO

Potential flow over bodies of revolution in unsteady motion  
p 508 A89-36910

## GARG, SANJAY

Model-based analysis and cooperative synthesis of control and display augmentation for piloted flight vehicles  
p 540 N89-22610

## GARRARD, G. D.

PARC code validation for propulsion flows  
[AD-A204293] p 557 N89-22066

## GARRARD, WILLIAM L.

Calculated and experimental stresses in solid and ring slot parachutes  
p 523 A89-39200

## GAUGLER, RAYMOND E.

A perspective on future directions in aerospace propulsion system simulation  
[NASA-TM-102038] p 536 N89-21798

## GEIDEL

Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency  
[MTU-TB-87/010] p 537 N89-22608

## GERHARZ, JOHANN J.

Consideration of environmental conditions for the fatigue evaluation of composite airframe structure  
p 551 A89-36304

## GIGLIOTTI, M. F.

The processing and testing of a hollow DS eutectic high pressure turbine blade  
p 551 A89-36436

## GOEBEL, O.

Simulation of optimal flight paths of dynamical soaring flight and the design of a model aircraft  
p 529 A89-39259

## GOKGOL, OGUZ

Consideration of environmental conditions for the fatigue evaluation of composite airframe structure  
p 551 A89-36304

## GOWARD, G. W.

Aircraft gas turbine blade and vane repair  
p 533 A89-36473

## GREEN, G. J.

Aerodynamic device for generating mono-disperse fuel droplets  
p 554 A89-37878

## GROENEWEG, J. F.

High-speed propeller performance and noise predictions at takeoff/landing conditions  
p 565 A89-39195

## GU, JIN-CHU

Some field experience with subsynchronous vibration of centrifugal compressors  
p 559 N89-22892

## GU, QITAI

Robust control of an active vibration isolation system for helicopters  
p 539 A89-39458

## GUDMUNDSON, SVEN ERIK

Transonic and supersonic wind tunnel tests on control effectiveness on schematic missile configurations with canard controls  
[FFA-TN-1988-11] p 531 N89-22601

## GUFFOND, D.

Application of infrared thermography to the interpretation of tests in an icing wind tunnel  
[ONERA, TP NO. 1989-28] p 554 A89-37642

## GUMUCIO

Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency  
[MTU-TB-87/010] p 537 N89-22608

## GUO, Y. P.

A note on sound from the interruption of a cylindrical flow by a semi-infinite aerofoil of subsonic speed  
p 565 A89-39506

## GURUSWAMY, GURU P.

Integrated approach for active coupling of structures and fluids  
p 552 A89-36917

## GUSEV, BORIS K.

Fundamentals of aviation (4th revised and enlarged edition)  
p 507 A89-38514

## H

## HAAS, JEFFREY E.

New hypersonic facility capability at NASA Lewis Research Center  
[NASA-TM-102028] p 543 N89-22617

## HAFIZ, A.

Visualization of aerodynamic flow fields using photorefractive crystals  
p 555 A89-38764

## HAGIWARA, E.

NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results  
p 552 A89-36585

## HALE, KEITH

Annular honeycomb seals: Test results for leakage and rotordynamic coefficients; comparisons to labyrinth and smooth configurations  
p 559 N89-22899

## HALL, KENNETH C.

Calculation of unsteady flows in turbomachinery using the linearized Euler equations  
p 552 A89-36916

## HALYO, NESIM

Application of precomputed control laws in a reconfigurable aircraft flight control system  
p 538 A89-36931

## HAMAMATSU, TERUHIDE

Simulation analysis on ceramic gas turbine  
[DE88-756469] p 548 N89-21926

## HAMDAN, A. M. A.

Measures of modal controllability and observability for first- and second-order linear systems  
p 563 A89-36943

## HAMED, A.

J85 surge transient simulation  
p 536 A89-39044

## HAMMOND, DARYL

Multivariable control law design for the Control Reconfigurable Combat Aircraft (CRCA)  
[AD-A202697] p 540 N89-21803

## HAN, ZHAOYUAN

Investigation of Mach reflection for a planar moving shock propagating into steady supersonic flow field around wedge  
p 510 A89-37782

## HANKS, MARVIN L.

Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system  
[AD-A204030] p 530 N89-21790

Artificial and natural icing tests of the EH-60A quick fix helicopter  
[AD-A204589] p 530 N89-21792

## HARRIS, CHARLES D.

The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration  
[NASA-TM-4100] p 516 N89-21762

## HARTMANN, KLAUS

Transonic and supersonic flow past a 65 deg delta wing with rounded leading edges: Analysis of experimental data  
[DFVLR-FB-88-44] p 520 N89-22580

## HARVEY, J.

Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows  
[AD-A204364] p 518 N89-21774

## HASIUK, JAN FRANCISZEK

Primitive numerical simulation of circular Couette flow  
p 516 N89-21764

## HATHAWAY, WAYNE

Aeroballistic Research Facility Data Analysis System (ARFAS)  
[AD-A204308] p 542 N89-21810

## HAUBERT, R. C.

The processing and testing of a hollow DS eutectic high pressure turbine blade  
p 551 A89-36436

## HAYMAN, C.

CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors  
p 549 N89-22658

## HAZARIKA, NEEP

An efficient inverse method for the design of blended wing-body configurations  
p 532 N89-22603

## HEDMAN, SVEN G.

Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds  
[FFA-TN-1988-44] p 532 N89-22602

## HEINRICH, W.

Integral rudder system for aircraft steering  
p 539 A89-39258

## HENRY, R.

Infrared thermography - A quantitative tool for heat study  
[ONERA, TP NO. 1989-3] p 553 A89-37627

Application of infrared thermography to the interpretation of tests in an icing wind tunnel  
[ONERA, TP NO. 1989-28] p 554 A89-37642

## HENSCHER, F.

Flight control system design for an in-flight simulator  
p 539 A89-36934

## HERBST, MICHAEL K.

Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system  
[AD-A204030] p 530 N89-21790

## HICKS, M. A.

New metallic materials for gas turbines  
p 549 N89-22660

## HIGHTON, D. R.

Future advanced aero-engines: The materials challenge  
p 538 N89-22659

## HIRATA, Y.

Technical design and performance analysis of aeronautical satellite communication systems  
p 524 A89-36594

## HISAMATSU, TORU

Simulation analysis on ceramic gas turbine  
[DE88-756469] p 548 N89-21926

## HOCKENHULL, M.

Gust analysis of an aircraft with highly non-linear systems interaction  
[AIAA PAPER 89-1377] p 527 A89-37650

## HODGES, DEWEY H.

Analytical modeling of helicopter static and dynamic induced velocity in GRASP  
p 513 A89-38555

## HOH, R.

An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft  
[AD-A202910] p 526 N89-21782

**HOLDEN, MICHAEL S.**

Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows  
[AD-A204364] p 518 N89-21774

**HOLMES, JOHN W.**

Influence of thermal fatigue on hot corrosion of an intermetallic Ni-aluminide coating p 547 A89-36484

**HOLMES, R.**

The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895

**HOQUE, M. S.**

An electroviscous damper p 559 N89-22898

**HORZ, F.**

Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft p 544 A89-36543

**HOWE, M. S.**

On sound generated when a vortex is chopped by a circular airfoil p 565 A89-39514

**HOZUMI, KOICHI**

Experimental investigation of applicability of waverider configuration to hypersonic transport and aerospace-plane p 511 A89-38123

**HSIEH, ALEX J.**

Environmentally induced discontinuities in transparent polymers  
[AD-A205483] p 550 N89-22768

**HU, FANG Q.**

On the three families of instability waves of high-speed jets p 513 A89-38624

**HU, YONGDAI**

Visiting China's aerodynamics research and development center  
[AD-A203980] p 543 N89-22615

**HUA, YONG-LI**

Some field experience with subsynchronous vibration of centrifugal compressors p 559 N89-22892

**HUANG, MINGKE**

Nonlinear supersonic potential flow over sideslip conical bodies, delta wings and fuselages p 511 A89-37792

**HUANG, SONGHUI**

A hafnium-free directionally solidified nickel-base superalloy p 546 A89-36435

**HUANG, YUN**

GDPP - A practical CAD software package p 563 A89-37014

**HUDSON, DALE A.**

The demonstration of monolithic and composite ceramics in aircraft gas turbine combustors p 550 N89-22665

**HUDSON, MAURICE G.**

Airport technology international 1988 p 541 A89-38582

**HUMPHRIS, R. R.**

A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 N89-22911

**HUNGERFORD, K.**

Combining the use of geostationary and inclined orbit satellites for integrated communications and navigation applications p 544 A89-36611

**HUSBANDS, TONY B.**

Evaluation of barrier cable impact pad materials  
[AD-A204356] p 542 N89-21811

**HUTCHINS, S. M.**

A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510

**I****IMBERT, M.**

Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349

**IMMARIGEON, J.-P.**

Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474

**ISAEV, V. A.**

Motion of a three-degrees-of-freedom gyroscope with a dynamically unbalanced rotor in the case of contact between the internal frame and an elastic limiter p 565 A89-39816

**ISHIDE, A.**

Communication and ranging systems for navigation experiment using Engineering Test Satellite V p 525 A89-36618

**ISHIHARA, TSUYOSHI**

Mach number effects on high-angles-of-attack aerodynamic characteristics of a cone-cylinder with various nose shapes p 511 A89-38122

**ISHIKAWA, HIROSHI**

Simulation analysis on ceramic gas turbine  
[DE88-756469] p 548 N89-21926

**IVANOV, VIKTOR M.**

Synthesis of systems for the motion control of nonstationary objects p 563 A89-38512

**IVIE, J. J.**

Supersonic particle probes: Measurement of internal wall losses  
[AD-A205863] p 521 N89-22589

**J****JAIN, S. K.**

Development of Inconel alloy MA 6000 turbine blades for advanced gas turbine engine designs p 545 A89-36414

**JANG, JINSEOK**

Ground and air resonance of bearingless rotors in hover and forward flight p 529 N89-21786

**JEANDIN, M.**

Laser drilling of a superalloy coated with ceramic p 551 A89-36455

**JIANG, WENGLONG**

A study on GH169 crack propagation under creep-fatigue interaction p 547 A89-37756

**JING, ZHANG**

Performance analysis of a propulsion system p 534 A89-37753

**JOHNSON, DONALD W.**

Testing of a new recovery parachute system for the F111 aircraft crew escape module: An update  
[DE89-007139] p 524 N89-22592

**JOHNSON, M. W.**

Stress tensor measurements within the vaneless diffuser of a centrifugal compressor p 556 A89-39050

**JOHNSON, P. B.**

Surface temperature measurements using a thin film thermal array  
[NASA-TM-101549] p 558 N89-22868

**JONES, THOMAS S.**

Application of nondestructive inspection methods to composites p 555 A89-38951

**JORGENSEN, PHILIP C. E.**

Explicit Runge-Kutta method for unsteady rotor/stator interaction p 509 A89-36912

**K****KANE, RUSSELL F.**

Accident investigation and the public interest - A pilot's view p 523 A89-39224

**KANKI, H.**

High stability design for new centrifugal compressor p 561 N89-22917

**KASARDA, M. E. F.**

A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 N89-22911

**KASHIWABARA, S.**

Field trials of aeronautical satellite communication system p 524 A89-36595

**KATAYAMA, K.**

High stability design for new centrifugal compressor p 561 N89-22917

**KAUSCHE, GERHARD**

The low-speed wind tunnel at DVFLR in Brunswick (Fed. Republic of Germany)  
[DFVLR-MITT-88-25] p 543 N89-22619

**KAVSAOGLU, M. S.**

Effects of swirl and high turbulence on a jet in a crossflow p 515 A89-39192

**KEGG, PAMELA S.**

Studies of poststrike air traffic control specialist trainees. Part 2: Selection and screening programs  
[AD-A199177] p 526 N89-22595

**KEITH, T. G., JR.**

Two-dimensional simulation of electrothermal deicing of aircraft components p 528 A89-39194

**KELLEY, MICHAEL N.**

Structures for hypervelocity flight p 552 A89-36723

**KERELIUK, S.**

An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft  
[AD-A202910] p 526 N89-21782

**KHABALOV, V. D.**

Consideration of the effect of surface roughness on regime coefficients in local interaction theory p 512 A89-38432

**KIKUCHI, KAZUO**

Navier-Stokes computations of two- and three-dimensional cascade flowfields p 514 A89-39035

**KILGORE, W. ALLEN**

Microcomputer based controller for the Langley 0.3-meter Transonic Cryogenic Tunnel  
[NASA-CR-181808] p 543 N89-22616

**KINAL, G.**

Combining the use of geostationary and inclined orbit satellites for integrated communications and navigation applications p 544 A89-36611

**KLEIN, VLADISLAV**

Estimation of aircraft aerodynamic parameters from flight data p 513 A89-38614

**KNIGHT, DOYLE**

Theoretical investigation of 3-D shock wave-turbulent boundary layer interactions, part 7  
[AD-A204482] p 557 N89-22070

**KOBEL'KOV, VIKTOR N.**

Variable-cycle turbojet engines for multiple-regime aircraft p 535 A89-38510

**KOBLAX, M.**

Development and testing of critical components for technological preparation of an Airbus-CFRP-fuselage, phase 2  
[MBB-UT-129/87] p 531 N89-22600

**KOCHENDOERFER, R.**

Monolithic and fiber ceramic components for turboengines and rockets p 549 N89-22657

**KOCKA, VILEM**

Validation of nonstationary aerodynamics models for longitudinal aeroplane motion on the basis of flight measurements p 539 A89-37524

**KOLTON, G. A.**

Nonstationary supersonic flow past a body p 512 A89-38437

**KONICKE, MICHAEL L.**

Calculated and experimental stresses in solid and ring slot parachutes p 523 A89-39200

**KOSAKA, K.**

Field trials of aeronautical satellite communication system p 524 A89-36595

**KOUL, A. K.**

Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474

**KOUTMOS, P.**

Isothermal flow in a gas turbine combustor - A benchmark experimental study p 514 A89-38873

**KOVALEV, E. D.**

A numerical method for the analysis of a flight vehicle with a solid fuselage p 509 A89-37460

**KOZOL, JOSEPH**

The effects of plastic media blasting paint removal on the microstructure of graphite/epoxy composite materials  
[AD-A204801] p 550 N89-22688

**KRISHNAKUMAR, KALMANJE**

Energy concepts applied to control of airplane flight in wind shear p 540 N89-21806

**KROPFLI, R. A.**

Hazard index calculation for 31 May 1984 microburst at Erie, Colorado  
[NASA-CR-184968] p 562 N89-23048

**KRUZYNSKI, G. E.**

Causes and effects of center segregation in electro-slag remelted alloy 718 for critical rotating part applications p 545 A89-36410

**KUBOTA, HIROTOSHI**

Mach number effects on high-angles-of-attack aerodynamic characteristics of a cone-cylinder with various nose shapes p 511 A89-38122

**KUKHTEVICH, S. E.**

Motion of a three-degrees-of-freedom gyroscope with a dynamically unbalanced rotor in the case of contact between the internal frame and an elastic limiter p 565 A89-39816

**KUMAR, AJAY**

Numerical simulation of flow through a two-strut scramjet inlet p 514 A89-39038

**KUNZ, DONALD L.**

Analytical modeling of helicopter static and dynamic induced velocity in GRASP p 513 A89-38555

**KUZ'MIN, A. G.**

Stability of gas flows in Laval nozzles p 512 A89-38438

**KUZ'MIN, MARSELI P.**

Nonstationary thermal duty of the structural elements of flight vehicles p 535 A89-38502

**KUZNETSOV, N. D.**

Dynamical calculations of engine components based on elasticity equations p 553 A89-37421

**L****LAGACE, PAUL A.**

Fracture of pressurized composite cylinders with a high strain-to-failure matrix system p 551 A89-36319

**LAGRAFF, J. E.**

Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186

## LAGUN, IRINA M.

Nonstationary thermal duty of the structural elements of flight vehicles p 535 A89-38502

## LALLMAN, FREDERICK J.

Eigenstructure assignment for the control of highly augmented aircraft p 538 A89-36930

## LAN, C. EDWARD

Experimental investigation of dynamic ground effect p 514 A89-39185

## LANG, XIANZHONG

Color helium bubble flow-visualization technique p 556 A89-39186

## LAPIERRE, LEE R.

INTERFACE 2: Advanced diagnostic software [AD-A204527] p 563 N89-22366

## LE BALLEUR, J. C.

New possibilities of viscous-inviscid numerical techniques for solving viscous flow equations with massive separation [ONERA, TP NO. 1989-24] p 554 A89-37640

## LECHERVY, P.

Laser drilling of a superalloy coated with ceramic p 551 A89-36455

## LEE, B. H. K.

Flutter analysis of the CF-18 aircraft at supersonic speeds p 528 A89-39199

## LEE, KENNETH J.

An OOD (Object-Oriented Design) paradigm for flight simulators, 2nd edition [AD-A204849] p 542 N89-21813

## LEE, PAI-HUNG

Experimental investigation of dynamic ground effect p 514 A89-39185

## LEGROS, J. C.

The optical bidirectional accelerometer p 553 A89-36966

## LESTER, PETER F.

The use of DFDR information in the analysis of a turbulence incident over Greenland p 562 A89-39647

## LEVANON, N.

Interferometry against differential Doppler - Performance comparison of two emitter location airborne systems p 525 A89-39203

## LEVY, YESHAYAHOU

Investigation of a small solid fuel ramjet combustor p 544 A89-39028

## LEWICKI, D. G.

Transmission overhaul and replacement predictions using Weibull and renewal theory [NASA-TM-102022] p 562 N89-22925

## LEWIN, T.

Generalized criteria for microwave breakdown in air-filled waveguides p 552 A89-36655

## LEWIS, WILLIAM D.

Artificial and natural icing tests of the EH-60A quick fix helicopter [AD-A204589] p 530 N89-21792

## LI, BEN-WEI

Application of a fuzzy controller in the fuel system of a turbojet engine p 536 A89-39043

## LI, CHUNJIN

Equivalent systems method to evaluate the flight qualities p 539 A89-36998

## LI, JIBAO

A study on exit radial temperature profile of 2D experimental combustor p 535 A89-37759

## LI, XIFAN

Experimental investigation of sudden imbalance response on a flexible rotor system with squeeze-film damper p 554 A89-37768

## LI, YAN

A study on GH169 crack propagation under creep-fatigue interaction p 547 A89-37756  
Variation of critical speed of a rotor-bearing system with slight relocation of bearing p 554 A89-37766

## LI, YAPING

Visiting China's aerodynamics research and development center [AD-A203980] p 543 N89-22615

## LI, ZHENHAO

On the unsteady leading edge suction of a sweptback wing p 510 A89-37776

## LIANG, FENG

Equivalent systems method to evaluate the flight qualities p 539 A89-36998

## LIBURDI, J.

Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474

## LIFANOV, I. K.

A numerical method for the analysis of a flight vehicle with a solid fuselage p 509 A89-37460

## LIM, JONG C.

Composite failure criterion: Probabilistic formulation and geometric interpretation [AD-A205275] p 548 N89-21851

## LIN, DONGLIANG

A hafnium-free directionally solidified nickel-base superalloy p 546 A89-36435

## LINDBLAD, INGEMAR A. A.

Asymptotic analysis of the transonic region of a high-speed propeller [AIAA PAPER 89-1077] p 565 A89-37652

## LING, YUNPEI

Development of a second generation injector driven transonic wind tunnel at BUAA p 541 A89-39469

## LISAK, M.

Generalized criteria for microwave breakdown in air-filled waveguides p 552 A89-36655

## LISKER, BERNARD

A procedure for operating dependent instrument approaches to converging runways [AD-A204723] p 526 N89-21784

## LIU, D. D.

Potential flow over bodies of revolution in unsteady motion p 508 A89-36910

## LIU, JIAN

Development of a second generation injector driven transonic wind tunnel at BUAA p 541 A89-39469

## LIU, JUNHUI

Transfinite interpolation method for 3-D grid generations p 509 A89-36986

## LIU, ZUNXIAO

Study of the real emulation of the electronic integrated system [PB89-116271] p 557 N89-22016

## LLEWELYN-DAVIES, D. I. T. P.

The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body p 516 N89-21765

## LOEHR, KARSTEN

The aeroacoustics of the interaction between vortices and bodies in a transonic flow [MPIS-3/1988] p 566 N89-22445

## LOU, WUJIANG

The constraint wake analysis for hovering rotors p 511 A89-37790

## LOWDEN, P.

Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474

## LU, QIXIN

Investigation on simulation of foreign object impact damage to compressor blade p 534 A89-37757

## LU, ZEHUA

Computation of dynamic process with large disturbance for split-shaft gas turbine p 535 A89-37772

## LUO, SHIJUN

AF-2 scheme for solution of axial symmetric transonic inlet-flowfield p 511 A89-37791

## LUTZ, STEVEN A.

Modeling of density fluctuations in supersonic turbulent boundary layer p 509 A89-36923

## M

## MA, HUIYANG

The effects of vortex breakdown on the aerodynamic properties of a wing and the engineering predicting method p 510 A89-37780

## MA, TIEYOU

Transfinite interpolation method for 3-D grid generations p 509 A89-36986

## MABEY, D. G.

Buffeting criteria for a systematic series of wings p 515 A89-39197

## MACHA, J. MICHAEL

Wake recontact: An experimental investigation using a ringslot parachute [DE89-008320] p 518 N89-21773

A preliminary characterization of parachute wake recontact [DE89-006442] p 519 N89-22576

## MAEKITA, K.

Field trials of aeronautical satellite communication system p 524 A89-36595

## MAGNUSSON, R.

Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764

## MAIOROV, VITALII A.

Hydrodynamics and heat transfer in the porous elements of flight vehicle structures p 554 A89-38499

## MAKITA, F.

Field trials of aeronautical satellite communication system p 524 A89-36595

## MAKSOU, T. M. A.

Stress tensor measurements within the vaneless diffuser of a centrifugal compressor p 556 A89-39050

## MALHERBE, J. A. G.

Electromagnetic backscatter from open-ended circular cylinder with complex termination p 536 A89-39284

## MALIK, M. R.

Boundary-layer transition on a cone and flat plate at Mach 3.5 p 508 A89-36904

## MANNING, CAROL A.

Studies of poststrike air traffic control specialist trainees. Part 2: Selection and screening programs [AD-A199177] p 526 N89-22595

## MARBLE, FRANK E.

Swirling flows in an annular-to-rectangular transition section p 555 A89-39037

## MARRISON, CLAIRE

Human factors in cabin safety p 522 A89-36069

## MATHIOULAKIS, D. S.

Pulsating flow over an ellipse at an angle of attack p 513 A89-38620

## MATHRE, JOHN M.

Computational investigation of incompressible airfoil flows at high angles of attack [AD-A205885] p 522 N89-22590

## MATSUSHIMA, KISA

Numerical simulation of supersonic flows past a space-plane p 511 A89-38124

## MCCLINTOCK, FRANK A.

Influence of thermal fatigue on hot corrosion of an intermetallic Ni-aluminide coating p 547 A89-36484

## MCCREARY, STEPHEN D.

The Chicago Convention - Article 33 and the SFAR 40 episode p 566 A89-38876

## MCGINLEY, CATHERINE B.

Riblet drag at flight conditions p 515 A89-39196

## MCGUIRK, J. J.

Isothermal flow in a gas turbine combustor - A benchmark experimental study p 514 A89-38873

## MCKILLIP, ROBERT, JR.

Experimental studies in system identification of helicopter rotor dynamics p 528 A89-38554

## MEETHAM, G. W.

Material/manufacturing process interaction in advanced material technologies p 549 N89-22662

## MENZIES, R. G.

The processing and testing of a hollow DS eutectic high pressure turbine blade p 551 A89-36436

## MERRICK, V. K.

Simulation evaluation of an advanced control concept for a V/STOL aircraft p 539 A89-36932

## MEYERS, B. C.

Functional performance specification for an inertial navigation system [AD-A204850] p 526 N89-21785

## MIGNOSI, A.

Implementation of a two-component laser anemometer at the T2 wind tunnel [A-501-H] p 558 N89-22879

## MIKHAILOV, A. A.

A numerical method for the analysis of a flight vehicle with a solid fuselage p 509 A89-37460

## MILLER, BRENT A.

A perspective on future directions in aerospace propulsion system simulation [NASA-TM-102038] p 536 N89-21798

## MIMAKI, TOSHIO

Simulation analysis on ceramic gas turbine [DE88-756469] p 548 N89-21926

## MINECK, RAYMOND E.

Hardware and operating features of the adaptive wall test section for the 0.3-meter transonic cryogenic tunnel [NASA-TM-4114] p 542 N89-22614

## MISHIMA, H.

NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results p 552 A89-36585

## MOERDER, DANIEL D.

Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931

## MOODY, E. S.

Single channel test controllers [AD-A204088] p 541 N89-22611

## MOOK, D. T.

Influence of pitching motion on subsonic wing rock of slender delta wings p 514 A89-39187

Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188

## MOORE, JOHN R.

Trajectory optimization with risk minimization for military aircraft p 538 A89-36929

## MOORE, JOSEPH B.

Application of advanced materials for turbomachinery and rocket propulsion p 549 N89-22656

## MOORE, RICHARD MCCREA

Numerical solutions of unsteady inviscid transonic turbine cascade flows p 516 N89-21767

## MORALEZ, E.

Simulation evaluation of an advanced control concept for a V/STOL aircraft p 539 A89-36932

- MORII, S.**  
High stability design for new centrifugal compressor  
p 561 N89-22917
- MORRIS, PHILIP J.**  
Shock structure in non-circular jets  
[AIAA PAPER 89-1083] p 510 A89-37653
- MOSELLE, J.**  
Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows  
[AD-A204364] p 518 N89-21774
- MOULY, M. C. CHANDRA**  
Formulation of gain and impedance relations for corner reflectors employed in conjunction with localizer antenna arrays  
p 525 A89-39500
- MOURI, Y.**  
High stability design for new centrifugal compressor  
p 561 N89-22917
- MUIR, HELEN C.**  
Human factors in cabin safety p 522 A89-36069
- MUIRHEAD, VINCENT U.**  
Experimental investigation of dynamic ground effect  
p 514 A89-39185
- MUNAKATA, YOSHIYUKI**  
Effect of crack size on the tensile strength of ceramics in a high-temperature corrosive environment  
p 547 A89-38021
- MURRELL, REGINALD C.**  
Artificial and natural icing tests of the UH-60A helicopter configured with the XM-139 multiple mine dispensing system (VOLCANO)  
[AD-A205031] p 531 N89-21794
- MUSZYNSKA, A.**  
Role of circumferential flow in the stability of fluid-handling machine rotors p 561 N89-22915
- N**
- NAEEM, R. K.**  
Lifetime aerofoil calculations using von Mises variables p 516 A89-39666
- NAGY, P.**  
Enhanced rupture properties in advanced single crystal alloys p 546 A89-36425
- NAKAHASHI, KAZUHIRO**  
Navier-Stokes computations of two- and three-dimensional cascade flowfields p 514 A89-39035
- NAKAMURA, H.**  
Field trials of aeronautical satellite communication system p 524 A89-36595
- NALLASAMY, M.**  
High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 A89-39195
- NARAYAN, KRISHNASWAMI YEGNA**  
Transonic and supersonic flow past a 65 deg delta wing with rounded leading edges: Analysis of experimental data  
[DFVLR-FB-88-44] p 520 N89-22580
- NAYFEH, A. H.**  
Measures of modal controllability and observability for first- and second-order linear systems p 563 A89-36943
- Influence of pitching motion on subsonic wing rock of slender delta wings p 514 A89-39187
- NEBBACHE, A.**  
Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349
- NECHAEV, IULIAN N.**  
Variable-cycle turbojet engines for multiple-regime aircraft p 535 A89-38510
- NELSON, P. A.**  
Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise p 529 A89-39509
- NEWMAN, NED D.**  
Materials for the NASP p 547 A89-36722
- NGUYEN, HUNG LEE**  
Investigation of low NOx staged combustor concept in high-speed civil transport engines  
[NASA-TM-101977] p 537 N89-22606
- NIEDZWIECKI, RICHARD W.**  
Investigation of low NOx staged combustor concept in high-speed civil transport engines  
[NASA-TM-101977] p 537 N89-22606
- NIELSEN, T. A.**  
Enhanced rupture properties in advanced single crystal alloys p 546 A89-36425
- NIKOLAEV, N. V.**  
A method for determining the inertia tensor of a craft in flight p 565 A89-39819
- NIKOLAJSEN, JORGEN L.**  
An electroviscous damper p 559 N89-22898
- Experimental verification of an eddy-current bearing p 561 N89-22913
- NILSSON, SOREN**  
A survey of poly-ether-ether-ketone and its advanced composites  
[FFA-TN-1988-37] p 550 N89-22707
- NISHT, M. I.**  
A numerical method for the analysis of a flight vehicle with a solid fuselage p 509 A89-37460
- NONAMI, KENZOU**  
Active vibration control for flexible rotor by optimal direct-output feedback control  
[NASA-TM-101972] p 537 N89-22605
- NORDMANN, R.**  
Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 N89-22900
- Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position p 560 N89-22906
- NOTTEBAUM, TH.**  
Simulation of optimal flight paths of dynamical soaring flight and the design of a model aircraft p 529 A89-39259
- NOZAKI, OSAMU**  
Navier-Stokes computations of two- and three-dimensional cascade flowfields p 514 A89-39035
- NUSHTAEV, I. U. P.**  
Flutter of a wing with an aileron in transonic flow p 539 A89-37461
- O**
- ODA, T.**  
High stability design for new centrifugal compressor p 561 N89-22917
- ODEN, J. T.**  
Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating  
[AD-A205077] p 518 N89-21775
- ODORICO, J.**  
Tests of new materials with second generation carbon fibers, test report  
[REPT-47-188/F] p 550 N89-22702
- CSPC test 319.30: Study on impact tolerance of preimpregnated carbon-epoxy systems  
[REPT-47-323/F] p 550 N89-22703
- OFFUTT, C. J.**  
Nondestructive volumetric CT-scan evaluation of monolithic ceramic turbine components p 555 A89-38954
- OHASHI, M.**  
Technical design and performance analysis of aeronautical satellite communication systems p 524 A89-36594
- OHNSTAD, ELLIS**  
Eligibility of noise abatement proposals for grants-in-aid under the Airport Improvement Program  
[AD-A204724] p 542 N89-21812
- OLANDER, NILS**  
Fusion of multisensor data: A summary of the JASMIN project  
[FOA-C-30498-3.3] p 563 N89-23213
- ONN, SHING-CHUNG**  
Numerical study of a multipurpose transonic wind tunnel with an adaptable injection-suction system p 543 N89-22621
- OTTO, HORST**  
The low-speed wind tunnel at DVFLR in Brunswick (Fed. Republic of Germany)  
[DFVLR-MITT-88-25] p 543 N89-22619
- OVCHARENKO, V. N.**  
Input signal selection in the identification of linear continuous dynamic systems from discrete observations p 563 A89-39777
- OZAWA, U.**  
High stability design for new centrifugal compressor p 561 N89-22917
- P**
- PACE, S. E.**  
A seal test facility for the measurement of isotropic and anisotropic linear rotordynamic characteristics p 560 N89-22905
- PADUANO, JAMES D.**  
Sensitivity analysis of digital flight control systems using singular-value concepts p 538 A89-36927
- PALMER, R. E.**  
Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements  
[NASA-CR-184896] p 517 N89-21772
- PAPAMOSCHOU, D.**  
A two-spark schlieren system for very-high velocity measurement p 555 A89-38874
- PARKINSON, B. W.**  
Aircraft automatic landing systems using GPS p 525 A89-39827
- PARRY, A. B.**  
Prediction of counter-rotation propeller noise  
[AIAA PAPER 89-1141] p 564 A89-36221
- PASSINO, KEVIN M.**  
Neural computing for numeric-to-symbolic conversion in control systems p 563 A89-37234
- PATEL, S.**  
Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK50 p 546 A89-36440
- PATNAIK, P. C.**  
Degradation of aluminide coated directionally solidified superalloy turbine blades in an aero gas turbine engine p 546 A89-36480
- PAULONIS, D. F.**  
Development of Gatorized MERL 76 for gas turbine disk applications p 545 A89-36411
- PAVLENKO, KONSTANTIN I.**  
Fundamentals of the maintenance of the radio-electronic equipment of aircraft p 525 A89-38513
- PEARSON, CARL E.**  
Development of a streamline method  
[AD-A205146] p 557 N89-22078
- PELLAN, G.**  
Tests of new materials with second generation carbon fibers, test report  
[REPT-47-188/F] p 550 N89-22702
- PERRIER, R.**  
Tests of new materials with second generation carbon fibers, test report  
[REPT-47-188/F] p 550 N89-22702
- PETERS, DAVID A.**  
Extension of classical tip loss formulas p 528 A89-38652
- PHARES, W. J.**  
PARC code validation for propulsion flows  
[AD-A204293] p 557 N89-22066
- PIERRE, C.**  
Eigensolution of periodic assemblies of multi-mode component systems p 556 A89-39519
- PILIUGIN, N. N.**  
A study of shock wave radiation near models at hypersonic velocities in air p 513 A89-38445
- PINCKERT, RICHARD E.**  
Materials for the NASP p 547 A89-36722
- PLANT, M.**  
XRD techniques in aero engine development p 555 A89-38632
- PLINTA, CHARLES**  
An OOD (Object-Oriented Design) paradigm for flight simulators, 2nd edition  
[AD-A204849] p 542 N89-21813
- PLOTKIN, KENNETH J.**  
Review of sonic boom theory  
[AIAA PAPER 89-1105] p 564 A89-36219
- POCHTMAN, I. U. M.**  
Application of the theory of fuzzy sets to the two-criterion stochastic optimization of ribbed shells p 556 A89-39823
- POLEV, ANATOLII S.**  
Variable-cycle turbojet engines for multiple-regime aircraft p 535 A89-38510
- POLIAEV, VLADIMIR M.**  
Hydrodynamics and heat transfer in the porous elements of flight vehicle structures p 554 A89-38499
- POLIKARPOV, G. G.**  
A numerical method for the analysis of a flight vehicle with a solid fuselage p 509 A89-37460
- POLING, DAVID R.**  
Blade-vortex interaction p 508 A89-36905
- POLKOVNIKOV, VITALII A.**  
Calculation of the principal parameters of the actuating mechanisms of aircraft slave drives p 555 A89-38500
- PONG, MIAN**  
F.E. simulation of crash for helicopters p 529 A89-39472
- PONIATOWSKI, EDWARD M.**  
The effects of incidence angle and free stream turbulence on the performance of a variable geometry two-dimensional compressor cascade at high Reynolds numbers  
[AD-A202650] p 557 N89-22052
- POWLESLAND, I.**  
Single channel test controllers  
[AD-A204088] p 541 N89-22611

**PRASAD, P. S. K. SATYA**

Formulation of gain and impedance relations for corner reflectors employed in conjunction with localizer antenna arrays p 525 A89-39500

**PRASAD, V. V. RAM**

Formulation of gain and impedance relations for corner reflectors employed in conjunction with localizer antenna arrays p 525 A89-39500

**PROUTY, RAY W.**

More helicopter aerodynamics p 513 A89-38578

**PRUNTY, JACK**

Structures for hypervelocity flight p 552 A89-36723

**PURCELL, TIMOTHY W.**

A prediction of high-speed rotor noise [AIAA PAPER 89-1132] p 564 A89-36220

**Q**

**QIN, JIALIN**

Color helium bubble flow-visualization technique p 556 A89-39186

**QIU, CHUANREN**

Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow [PB89-111470] p 518 A89-22571

**QU, ZHANGHUA**

Numerical calculations of hypersonic nonequilibrium flow over a blunt wedge p 515 A89-39461

**R**

**RAGAB, SAAD A.**

Linear instability waves in supersonic turbulent mixing layers p 508 A89-36903

**RAGHAVAN, VENKATRAMAN**

Unsteady force calculations on circular cylinders and elliptical airfoils with circulation control p 516 A89-21766

**RAI, MAN MOHAN**

Three-dimensional Navier-Stokes simulations of turbine rotor-stator interaction. I - Methodology p 514 A89-39034

**RAMBONE, JAMES D.**

Instrument landing system mathematical modeling study for Orlando International Airport Runway 17R localizer, Orlando, Florida, revised airside docking plan (Scheme 3A) [AD-A204722] p 526 A89-21783

**RAMNATH, RUDRAPATNA V.**

Stability and control of hypervelocity vehicles [AD-A205160] p 540 A89-21807

**RANAUDO, RICHARD J.**

NASA's program on icing research and technology [NASA-TM-101989] p 507 A89-22569

**RANEY, DAVID L.**

Lateral stability analysis for X-29A drop model using system identification methodology [NASA-TM-4108] p 539 A89-21802

**RANKE, H.**

Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK50 p 546 A89-36440

**RATCLIFFE, S.**

Automatic conflict detection logic for future air traffic control p 525 A89-39829

**REDDY, K. R.**

Description of a simple rotor test rig and preliminary wake studies [AD-A204089] p 541 A89-21808

**REDDY, N. N.**

Installed propfan (SR-7L) far-field noise characteristics [AIAA PAPER 89-1056] p 564 A89-36216  
Lateral noise attenuation of the advanced propeller of the propfan test assessment aircraft [AIAA PAPER 89-1057] p 564 A89-36217

**REINMANN, JOHN J.**

NASA's program on icing research and technology [NASA-TM-101989] p 507 A89-22569

**RESTALL, J. E.**

CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 A89-22658

**RICHIE, JOSEPH M.**

Description of the derivation of the collision risk model used in the vertical separation simulation risk model [AD-A205109] p 523 A89-21781

**RISSMAN, MICHAEL S.**

An OOD (Object-Oriented Design) paradigm for flight simulators, 2nd edition [AD-A204849] p 542 A89-21813

**RIZK, MAGDI H.**

Optimizing advanced propeller designs by simultaneously updating flow variables and design parameters p 514 A89-39189

**ROACH, R. L.**

Supersonic particle probes: Measurement of internal wall losses [AD-A205863] p 521 A89-22589

**ROBBINS, ROBERT D.**

Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system [AD-A204030] p 530 A89-21790

**ROSEN, BENGT**

Fusion of multisensor data: A summary of the JASMIN project [FOA-C-30498-3.3] p 563 A89-23213

**ROSS, C. F.**

A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510

**ROY, S.**

Numerical simulation of the unsteady wake behind an airfoil p 514 A89-39188

**RUFFLES, PHILIP C.**

Aircraft engines. IV p 534 A89-36898

**RUMSEY, CHRISTOPHER L.**

Extension and application of flux-vector splitting to calculations on dynamic meshes p 508 A89-36901

**RUSO, M. T.**

The fatigue in aircraft corrosion testing (FACT) programme [AGARD-R-713] p 548 A89-21873

**RUTKOVSII, VLADISLAV IU.**

Adaptive automatic control systems for flight vehicles p 563 A89-38511

**RYAN, CHARLES E., JR.**

Near-field scattering measurements for determining complex target RCS p 532 A89-39587

**S**

**SAEGER, KEVIN J.**

Fracture of pressurized composite cylinders with a high strain-to-failure matrix system p 551 A89-36319

**SAHINKAYA, M. N.**

Active vibration control of flexible rotors - An experimental and theoretical study p 554 A89-37847

**SAKAI, T.**

NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results p 552 A89-36585

**SALIKUDDIN, M.**

Installed propfan (SR-7L) far-field noise characteristics [AIAA PAPER 89-1056] p 564 A89-36216

**SALVANO, S.**

Development of stress and lifing criteria for single crystal turbine blades p 549 A89-22663

**SANDSTEDT, PER**

Experiences of rocket seat ejections in the Swedish Air Force - 1967-1987 p 522 A89-36122

**SARTORI, MICHAEL A.**

Neural computing for numeric-to-symbolic conversion in control systems p 563 A89-37234

**SATO, KIYOSHI**

Mach number effects on high-angles-of-attack aerodynamic characteristics of a cone-cylinder with various nose shapes p 511 A89-38122

**SATOH, K.**

NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results p 552 A89-36585

**SAVAGE, M.**

Transmission overhaul and replacement predictions using Weibull and renewal theory [NASA-TM-102022] p 562 A89-22925

**SCHAEFGEN, JOHN R.**

Polymers for advanced structures - An overview p 545 A89-36335

**SCHARRER, JOSEPH K.**

Rotordynamic coefficients for stepped labyrinth gas seals p 560 A89-22901

**SCHETZ, J. A.**

Effects of swirl and high turbulence on a jet in a crossflow p 515 A89-39192

**SCHILL**

Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency [MTU-TB-87/010] p 537 A89-22608

**SCHMIED, J.**

Rotordynamic stability problems and solutions in high pressure turbocompressors p 561 A89-22914

**SCHMIT, LUCIEN A.**

Control augmented structural optimization of aeroelastically tailored fiber composite wings [AD-A204534] p 530 A89-21791

**SCHMITT, R. L.**

Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements [NASA-CR-184896] p 517 A89-21772

**SCHRAG, R. L.**

Electroimpulse deicing - Electrodynamic solution by discrete elements p 528 A89-39193

**SCHROEDER, J. A.**

Simulation evaluation of an advanced control concept for a V/STOL aircraft p 539 A89-36932

**SCHULTZ, D. L.**

Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186

**SCHWARTZ, GEOFFREY E.**

Control of embedded vortices using wall jets [AD-A202606] p 558 A89-22835

**SCHWARTZ, J. A.**

Electro-impulse de-icing research: Fatigue and electromagnetic interference tests [DOT/FAA/CT-88/27] p 524 A89-22594

**SEE, T. H.**

Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft p 544 A89-36543

**SELIUS, A. O.**

On developing a microstructurally and thermally stable iron-nickel base superalloy p 545 A89-36406

**SELLERS, WILLIAM L., III**

Riblet drag at flight conditions p 515 A89-39196

**SEN, ORHAN**

The use of DFDR information in the analysis of a turbulence incident over Greenland p 562 A89-39647

**SENDA, TETSUYA**

Effect of crack size on the tensile strength of ceramics in a high-temperature corrosive environment p 547 A89-38021

**SERAUDIE, A.**

Implementation of a two-component laser anemometer at the T2 wind tunnel [A-501-H] p 558 A89-22879

**SERGEEV, ANDREI V.**

Calculation of the principal parameters of the actuating mechanisms of aircraft slave drives p 555 A89-38500

**SHAH, DIANE S.**

Ground collision warning system performance criteria for high maneuverability aircraft [AD-A204390] p 523 A89-21779

**SHAH, RASIK P.**

INTERFACE 2: Advanced diagnostic software [AD-A204527] p 563 A89-22366

**SHAMANSKY, HARRY T.**

Scattering from three-dimensional cracks p 565 A89-39588

**SHARAN, ANAND M.**

Variations of undamped rotor blade frequencies subjected to transient heat flux p 553 A89-36919

**SHAW, ROBERT J.**

NASA's program on icing research and technology [NASA-TM-101989] p 507 A89-22569

**SHEN, HUILI**

AF-2 scheme for solution of axial symmetric transonic inlet-flowfield p 511 A89-37791

**SHEN, JIANWEI**

Numerical calculations of hypersonic nonequilibrium flow over a blunt wedge p 515 A89-39461

**SHEN, QIN-GEN**

Some field experience with subsynchronous vibration of centrifugal compressors p 559 A89-22892

**SHIFRIN, CAROLE A.**

V-22 prepared for further expansion of flight envelope p 527 A89-36575

**SHIH, PETER K.**

Structures for hypervelocity flight p 552 A89-36723

**SHINGU, HIROKIMI**

Configuration of tuned dry gyro redundant system p 554 A89-38189

**SHURTLEFF, J. S.**

LEADER - An automatic, real-time diagnostic knowledge system [SAE PAPER 881443] p 534 A89-37651

**SIEBERT, RUEDIGER**

The low-speed wind tunnel at DVFLR in Brunswick (Fed. Republic of Germany) [DFVLR-MITT-88-25] p 543 A89-22619

**SIMS, CHESTER T.**

Beyond superalloys - The goals, the materials and some reality p 546 A89-36418

**SINGH, JATINDER**

Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions p 521 A89-22586

**SKILLINGS, S. A.**

Condensation phenomena in a turbine blade passage p 511 A89-37939



**SKRIPNICHENKO, STANISLAV I.**

Optimization of flight regimes according to economic criteria (2nd revised and enlarged edition)  
p 528 A89-38498

**SMITH, J. A.**

The processing and testing of a hollow DS eutectic high pressure turbine blade  
p 551 A89-36436

**SNIDER, C.**

Pre and post modification electromagnetic compatibility test report for the C-130H self contained navigation system with MLS A-kit, revision  
[AD-A205167]  
p 533 N89-22604

**SOBEL, KENNETH M.**

Eigenstructure assignment for the control of highly augmented aircraft  
p 538 A89-36930

**SOBOTA, THOMAS H.**

Swirling flows in an annular-to-rectangular transition section  
p 555 A89-39037

**SOKOLOV, NIKOLAI I.**

Adaptive automatic control systems for flight vehicles  
p 563 A89-38511

**SOULEZELLE, B.**

CSPC test 319.30: Study on impact tolerance of preimpregnated carbon-epoxy systems  
[REPT-47-323/F]  
p 550 N89-22703

**SPALART, P. R.**

Numerical and experimental evaluations of the flow past nested chevrons  
p 508 A89-36902

**SPINA, ERIC FRANCIS**

Organized structures in a supersonic turbulent boundary layer  
p 517 N89-21771

**STACK, JOHN P.**

The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration  
[NASA-TM-4100]  
p 516 N89-21762

**STANAWAY, SHARON KAY**

A numerical study of viscous vortex rings using a spectral method  
p 518 N89-22572

**STANISCI, M.**

Development of stress and lifting criteria for single crystal turbine blades  
p 549 N89-22663

**STEWART, ERIC C.**

Evaluation of the ride quality of a light twin engine airplane using a ride quality meter  
[NASA-TP-2913]  
p 507 N89-22568

**STOCKBRIDGE, RICHARD D.**

Experimental investigation of shock wave/boundary-layer interactions in an annular duct  
p 514 A89-39039

**STOTHERS, I. M.**

Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise  
p 529 A89-39509

**STRAWN, ROGER C.**

An experimental and computational study of rotor-vortex interactions  
p 513 A89-38553

**STREBY, GARY D.**

Combustor flow visualization using innovative infrared thermographics techniques  
[AD-A205905]  
p 550 N89-22718

**STRICKLAND, JAMES H.**

Wake recontact: An experimental investigation using a ringslot parachute  
[DE89-008320]  
p 518 N89-21773

A preliminary characterization of parachute wake recontact  
[DE89-006442]  
p 519 N89-22576

A vortex panel analysis of circular-arc bluff-bodies in unsteady flow  
[DE89-007141]  
p 558 N89-22845

**STULL, ROLAND B.**

Test of a calibration device for airborne Lyman-alpha hygrometers  
p 532 A89-37537

**STUMPP, H.**

Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK50  
p 546 A89-36440

**SUDZILOVSKII, NIKITA B.**

Adaptive automatic control systems for flight vehicles  
p 563 A89-38511

**SUGAYA, F.**

Technical design and performance analysis of aeronautical satellite communication systems  
p 524 A89-36594

**SUGIMOTO, KENJI**

Scramjet combustion with an aid of silane  
p 547 A89-38387

**SUGIMURA, TADAYOSHI**

Highly-resolved flowfield induced by Mach reflection  
p 512 A89-38125

**SUGIYAMA, Y.**

J85 surge transient simulation  
p 536 A89-39044

**SUN, CHUANQI**

A hafnium-free directionally solidified nickel-base superalloy  
p 546 A89-36435

**SUN, HONGJIN**

Fly, great sea eagle  
[AD-A203979]  
p 530 N89-21789

**SUN, MAO**

Rotor vortex wake distortion and its induced velocity in ground effect at low speed  
p 510 A89-37779

**SUN, XIANCHAI**

Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow  
[PB89-111470]  
p 518 N89-22571

**SUN, ZHENDE**

Investigation on simulation of foreign object impact damage to compressor blade  
p 534 A89-37757

**SUTCLIFFE, S. G. C.**

A demonstration of active noise reduction in an aircraft cabin  
p 529 A89-39510

**SUZUKI, KOJIRO**

Mach number effects on high-angles-of-attack aerodynamic characteristics of a cone-cylinder with various nose shapes  
p 511 A89-38122

**SWIFT, G.**

Near-field acoustic characteristics of a single-rotor propfan  
[AIAA PAPER 89-1055]  
p 533 A89-36215

Fluctuating pressures on wing surfaces in the slipstream of a single-rotor propfan  
[AIAA PAPER 89-1058]  
p 564 A89-36218

**SZUCH, JOHN R.**

A perspective on future directions in aerospace propulsion system simulation  
[NASA-TM-102038]  
p 536 N89-21798

**T****TABAKOFF, W.**

J85 surge transient simulation  
p 536 A89-39044

**TAKAHASHI, F.**

Aerodynamic device for generating mono-disperse fuel droplets  
p 554 A89-37878

**TAKANASHI, SUSUMU**

Numerical simulation of supersonic flows past a space-plane  
p 511 A89-38124

**TAKEUCHI, YOSHINORI**

Some mathematical considerations on views of the ground surface in flight  
p 562 A89-36351

**TALLAN, NORMAN M.**

Technical evaluation report  
p 548 N89-22655

**TAM, CHRISTOPHER K. W.**

On the three families of instability waves of high-speed jets  
p 513 A89-38624

**TAMURA, ATSUSHIRO**

Navier-Stokes computations of two- and three-dimensional cascade flowfields  
p 514 A89-39035

**TANG, GUIMING**

Experimental investigation of aerodynamic heating by flow through control surface gaps  
p 510 A89-37785

**TANIKATSU, TATSUYA**

Mach number effects on high-angles-of-attack aerodynamic characteristics of a cone-cylinder with various nose shapes  
p 511 A89-38122

**TANNER, DAVID**

Polymers for advanced structures - An overview  
p 545 A89-36335

**TAO, ZENGYUAN**

On evaluation of aircraft propulsion system performance  
p 534 A89-37752

**TAO, ZHIQIANG**

Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method  
p 553 A89-37006

**TELIONIS, D. P.**

Pulsating flow over an ellipse at an angle of attack  
p 513 A89-38620

**TELIONIS, DEMETRI P.**

Blade-vortex interaction  
p 508 A89-36905

**TERRY, P. JOHN**

Aero-optical analysis of compressible flow over an open cavity  
p 509 A89-36914

**THAMBURAJ, R.**

Degradation of aluminide coated directionally solidified superalloy turbine blades in an aero gas turbine engine  
p 546 A89-36480

**THOMAN, STEVEN**

The effects of plastic media blasting paint removal on the microstructure of graphite/epoxy composite materials  
[AD-A204801]  
p 550 N89-22688

**THOMAS, JAMES L.**

Extension and application of flux-vector splitting to calculations on dynamic meshes  
p 508 A89-36901

**THORNTON, E. A.**

Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating  
[AD-A205077]  
p 518 N89-21775

**TIEN, J. K.**

On developing a microstructurally and thermally stable iron-nickel base superalloy  
p 545 A89-36406

**TIKHOМИРОВ, S. G.**

A study of shock wave radiation near models at hypersonic velocities in air  
p 513 A89-38445

**TNAG, YANPING**

A physical model of the streamwise corner vortexes in a compressor cascade  
p 515 A89-39473

**TOMS, R. DAVID, JR.**

T800/A129 flight program  
p 533 A89-36399

**TORNGREN, LARS**

Transonic and supersonic wind tunnel tests on control effectiveness on schematic missile configurations with canard controls  
[FFA-TN-1988-11]  
p 531 N89-22601

**TRACKSDORF**

Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency  
[MTU-TB-87/010]  
p 537 N89-22608

**U****UKHOV, V. N.**

Dynamic calculations of engine components based on elasticity equations  
p 553 A89-37421

**UMEMURA, S.**

High stability design for new centrifugal compressor  
p 561 N89-22917

**V****VAL'KO, A. D.**

Motion of a three-degrees-of-freedom gyroscope with a dynamically unbalanced rotor in the case of contact between the internal frame and an elastic limiter  
p 565 A89-39816

**VALLANCE, C. S.**

Incorporating general race and housing flexibility and deadband in rolling element bearing analysis  
p 561 N89-22912

**VALLINI, ANDREA**

Some in-field experiences of non-synchronous vibrations in large rotating machinery  
p 559 N89-22894

**VANCE, JOHN M.**

Cavitation effects on the pressure distribution of a squeeze film damper bearing  
p 559 N89-22897

**VANDERVEGT, JAAP**

Transition to turbulence in laminar hypersonic flow  
p 522 N89-22830

**VANEK, VACLAV**

Contribution to centrifugal impeller design  
p 553 A89-37525

**VANIURIKHIN, GENNADI I.**

Synthesis of systems for the motion control of nonstationary objects  
p 563 A89-38512

**VANNIER, M. W.**

Nondestructive volumetric CT-scan evaluation of monolithic ceramic turbine components  
p 555 A89-38954

**VANSOY, ROGER**

An OOD (Object-Oriented Design) paradigm for flight simulators, 2nd edition  
[AD-A204849]  
p 542 N89-21813

**VANSELOW, JANICE J.**

Environmentally induced discontinuities in transparent polymers  
[AD-A205483]  
p 550 N89-22768

**VANWANDERHAM, M. C.**

Damage tolerance concepts for advanced materials and engines  
p 549 N89-22661

**VARELA, D.**

Laser drilling of a superalloy coated with ceramic  
p 551 A89-36455

**VASIL'EV, LEONARD L.**

Hydrodynamics and heat transfer in the porous elements of flight vehicle structures  
p 554 A89-38499

**VIAN, JOHN L.**

Trajectory optimization with risk minimization for military aircraft  
p 538 A89-36929

**VICROY, DAN D.**

Effect of spatial wind gradients on airplane aerodynamics  
p 514 A89-39190

**VILENSKII, G. G.**

Some properties of nonisentropic transonic flows  
p 512 A89-38426

## VINNICOMBE, G.

Gust analysis of an aircraft with highly non-linear systems interaction  
[AIAA PAPER 89-1377] p 527 A89-37650

## VONGLAHN, U. H.

Rectangular nozzle plume velocity modeling for use in jet noise prediction  
[NASA-TM-102047] p 519 N89-22577

## VOROB'EV, IURII S.

Vibrations of the blades of turbomachines p 535 A89-38504

## W

## WADA, KATSUO

Simulation analysis on ceramic gas turbine  
[DE88-756469] p 548 N89-21926

## WALLACE, D. M.

Benefits of 'area navigation' in regional aviation p 525 A89-39830

## WALLIS, R. A.

Property optimization in superalloys through the use of heat treat process modelling p 546 A89-36452

## WALLS, JOHN E.

Instrument landing system mathematical modeling study for Orlando International Airport Runway 17R localizer, Orlando, Florida, revised airside docking plan (Scheme 3A)  
[AD-A204722] p 526 N89-21783

## WALSH, D. E.

Aerodynamic device for generating mono-disperse fuel droplets p 554 A89-37878

## WALSH, MICHAEL J.

Riblet drag at flight conditions p 515 A89-39196

## WALTERS, ROBERT W.

Computational fluid dynamics research in three-dimensional zonal techniques  
[NASA-CR-181406] p 558 N89-22838

## WAN, TUNG

Microburst simulation via vortex-ring and turbulent jet models p 562 N89-22287

## WANG, CHICUN

The constraint wake analysis for hovering rotors p 511 A89-37790

## WANG, DIEQIAN

Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds  
[FFA-TN-1988-44] p 532 N89-22602

## WANG, JINGCHUN

Study of the real emulation of the electronic integrated system  
[PB89-116271] p 557 N89-22016

## WANG, LEI

An explicit multistage finite-area method for 2D transonic flow calculations p 510 A89-37778

## WANG, NAN

Scattering from three-dimensional cracks p 565 A89-39588

## WANG, RONG TYAI

Dynamics and control of truss structures with extending members p 523 N89-21778

## WANG, SHICUN

Lateral induced velocity distribution of a helicopter rotor p 509 A89-36987

## WANG, SHOUMEI

F.E. simulation of crash for helicopters p 529 A89-39472

## WANG, XI-XUAN

Some field experience with subsynchronous vibration of centrifugal compressors p 559 N89-22892

## WANG, ZHENGPING

Computer simulation of the movement of loading door retraction mechanism with slide tracks p 527 A89-37019

## WANG, ZHONGQI

Color helium bubble flow-visualization technique p 556 A89-39186

## WANG, ZICAI

Selection of weighting matrices for linear optimal regulator p 563 A89-36990

## WANHILL, R. J. H.

The fatigue in aircraft corrosion testing (FACT) programme  
[AGARD-R-713] p 548 N89-21873

## WANSTALL, BRIAN

Good prospects for LET's 40-seater p 528 A89-39226  
HUD on the head for combat pilots p 532 A89-39227

## WARRICK, PETER ANDREW

The aviation wire strike problem - The duty to warn of this aerial hazard p 522 A89-38878

## WATANABE, SHIGEYA

Experimental investigation of applicability of waverider configuration to hypersonic transport and aerospace-plane p 511 A89-38123

## WEIDERMAN, NELSON H.

Functional performance specification for an inertial navigation system  
[AD-A204850] p 526 N89-21785

## WEISER, P.

Rotorodynamic coefficients for labyrinth seals calculated by means of a finite difference technique p 560 N89-22900

## WHIPPLE, J. C.

Surface temperature measurements using a thin film thermal array  
[NASA-TM-101549] p 558 N89-22868

## WILDNER

Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency  
[MTU-TB-87/010] p 537 N89-22608

## WILLIAMS, J. E. D.

Air navigation systems. I - Astronomical navigation in the air 1919-1969. Part II - Instruments p 532 A89-39828

## WILLIAMS, JIM P.

Influence of impeller shroud forces on turbopump rotor dynamics p 560 N89-22909

## WILLIAMS, M. J.

Description of a simple rotor test rig and preliminary wake studies  
[AD-A204089] p 541 N89-21808

## WILSON, D. R.

Visualization of aerodynamic flow fields using photorefractive crystals p 555 A89-38764

## WOOD, JERRY R.

A perspective on future directions in aerospace propulsion system simulation  
[NASA-TM-102038] p 536 N89-21798

## WOOD, P.

Inmarsat's aeronautical satellite communication system p 552 A89-36593

## WOODWARD, R. P.

High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 A89-39195

## WRIGHT, MAURICE A.

A proposal for funding to purchase a high-temperature furnace to enable determination of the high temperature mechanical properties of structural carbon materials  
[AD-A204103] p 542 N89-21809

## WRIGHT, W. B.

Two-dimensional simulation of electrothermal deicing of aircraft components p 528 A89-39194

## WU, CHI-HUA

Application of a fuzzy controller in the fuel system of a turbojet engine p 536 A89-39043

## WU, J. L.

Linear instability waves in supersonic turbulent mixing layers p 508 A89-36903

## WU, JIUNN-CHI

A study of unsteady turbulent flow past airfoils p 521 N89-22587

## WU, MING-SHIN

Potential flow over bodies of revolution in unsteady motion p 508 A89-36910

## WU, QIHUA

Study on exchange operation between two microcomputers in aeroengine digital control p 535 A89-37774

## WU, ZIZHONG

Adjustment of ratio of rotation speed difference in a twin-spool turbojet engine p 534 A89-37754

## X

## XIAO, SHUNDA

The analysis and prediction of the spin equilibrium point of modern aircrafts p 539 A89-39459

## XIE, DEKANG

Computer simulation of the movement of loading door retraction mechanism with slide tracks p 527 A89-37019

## XU, LIPING

The application of dynamic schlieren-photon correlation technique to a supersonic shear layer p 515 A89-39474

## XU, QIHUA

Study on exchange operation between two microcomputers in aeroengine digital control p 535 A89-37774

## XU, QISHAN

On evaluation of aircraft propulsion system performance p 534 A89-37752

## XU, SHANGFA

Fly, great sea eagle  
[AD-A203979] p 530 N89-21789

## XU, YUN-HUA

Application of a fuzzy controller in the fuel system of a turbojet engine p 536 A89-39043

## Y

## YAN, MING

Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow  
[PB89-111470] p 518 N89-22571

## YAN, ZHEN

Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow  
[PB89-111470] p 518 N89-22571

## YANG, SHENGFA

Optimizing design for turboengine digital speed controller p 535 A89-37773

## YANG, T.

A seal test facility for the measurement of isotropic and anisotropic linear rotorodynamic characteristics p 560 N89-22905

## YANG, YIHE

The problems of the infrared stealth of the flying vehicles p 507 A89-37003

## YANG, YINGKAI

AF-2 scheme for solution of axial symmetric transonic inlet-flowfield p 511 A89-37791

## YANG, YONGNIAN

A computational method of aerodynamics for subsonic, fully unsteady wings at high angles of attack in time-domain p 515 A89-39462

## YANG, ZHI-CHUN

Wing-store flutter analysis of an airfoil in incompressible flow p 528 A89-39198

## YASUDA, Y.

Technical design and performance analysis of aeronautical satellite communication systems p 524 A89-36594

## YE, BOSHENG

Computation of dynamic process with large disturbance for split-shaft gas turbine p 535 A89-37772

## YE, XIAOMU

GDPP - A practical CAD software package p 563 A89-37014

## YE, ZHENGYIN

A computational method of aerodynamics for subsonic, fully unsteady wings at high angles of attack in time-domain p 515 A89-39462

## YI, SHANG

Adjustment of ratio of rotation speed difference in a twin-spool turbojet engine p 534 A89-37754

## YIN, XIEZHEN

Investigation of Mach reflection for a planar moving shock propagating into steady supersonic flow field around wedge p 510 A89-37782

## YIN, ZEYONG

Variation of critical speed of a rotor-bearing system with slight relocation of bearing p 554 A89-37766

## YOUNG, CHRISTOPHER J.

Artificial and natural icing tests of the EH-60A quick fix helicopter  
[AD-A204589] p 530 N89-21792

Artificial and natural icing tests of the UH-60A helicopter configured with the XM-139 multiple mine dispensing system (VOLCANO)  
[AD-A205031] p 531 N89-21794

## YU, GUANGZHI

A way for upgrading the accuracy of force measurement p 553 A89-37011

## YUAN, JIANPING

Coupling factor method for studying elastic motion of flight vehicles p 544 A89-37004

## YUN, DAZHEN

Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method p 553 A89-37006

## Z

## ZANETTA, GIAN ANTONIO

Some in-field experiences of non-synchronous vibrations in large rotating machinery p 559 N89-22894

## ZEIDAN, FOUDAY

Cavitation effects on the pressure distribution of a squeeze film damper bearing p 559 N89-22897

## ZEITOUN, D.

Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349

## ZHANG, BAOCHENG

Research on temperature profile factor at exit in an annular combustor p 535 A89-37769

# PERSONAL AUTHOR INDEX

ZWAN, ALLEN D.

## ZHANG, HUA

Development of a second generation injector driven  
transonic wind tunnel at BUAA p 541 A89-39469

## ZHANG, LINCHANG

Equivalent systems method to evaluate the flight  
qualities p 539 A89-36998

## ZHANG, LINGMI

Multi-input/multi-output frequency domain modal  
identification method and its application in ground vibration  
testing p 529 A89-39454

## ZHANG, XIAODI

Color helium bubble flow-visualization technique  
p 556 A89-39186

## ZHANG, ZHUFENG

Acceleration test for aircraft low-pass filter  
[PB89-116263] p 557 N89-22807

## ZHAO, DONG

Color helium bubble flow-visualization technique  
p 556 A89-39186

## ZHAO, JIANHUA

Selection of weighting matrices for linear optimal  
regulator p 563 A89-36990

## ZHAO, LING-CHENG

Wing-store flutter analysis of an airfoil in incompressible  
flow p 528 A89-39198

## ZHAO, LINGCHENG

A computational method of aerodynamics for subsonic,  
fully unsteady wings at high angles of attack in  
time-domain p 515 A89-39462

## ZHAO, XIN

A flight dynamic study of the helicopter including blade  
dynamics p 531 N89-21796

## ZHENG, GUOFENG

On the accelerating airflow problem in the test section  
of a transonic wind tunnel p 541 A89-39477

## ZHI, BAOSEN

A research experiment of discrete fuel injection in  
aero-engine combustion chamber p 536 A89-39480

## ZHIGALKO, E. F.

Approximate calculation of supersonic flow past bodies  
of revolution with a front separation zone at a small angle  
of attack p 512 A89-38427

## ZHOU, HONGFAN

A study on GH169 crack propagation under creep-fatigue  
interaction p 547 A89-37756

## ZHOU, WENBO

Unsteady aerodynamic computational method of  
non-coplanar wing-tail combinations in subsonic flow  
[PB89-111470] p 518 N89-22571

## ZHU, LAN-SHENG

Some field experience with subsynchronous vibration  
of centrifugal compressors p 559 N89-22892

## ZHU, ZIQIANG

A method for shock-free wing design  
p 509 A89-36985  
The computation of the viscous/inviscid interaction  
p 510 A89-37777

## ZHUANG, FENGGAN

An explicit multistage finite-area method for 2D transonic  
flow calculations p 510 A89-37778

## ZIEGLER, BERND

Investigations of the parameter reduction in the  
optimization of aircraft wing structures  
[ILR-MITT-203] p 531 N89-21795

## ZUMWALT, G. W.

Electro-impulse de-icing research: Fatigue and  
electromagnetic interference tests  
[DOT/FAA/CT-88/27] p 524 N89-22594

## ZVEREV, O. V.

A study of shock wave radiation near models at  
hypersonic velocities in air p 513 A89-38445

## ZVULONI, RONI

Investigation of a small solid fuel ramjet combustor  
p 544 A89-39028

## ZWAN, ALLEN D.

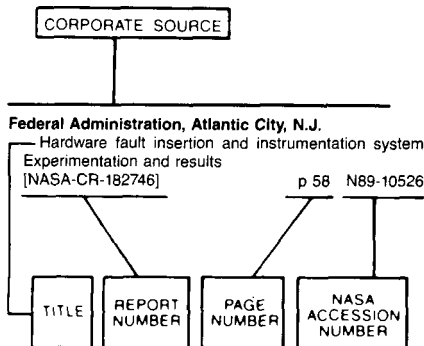
Structures for hypervelocity flight p 552 A89-36723

# CORPORATE SOURCE INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 243)

September 1989

## 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.

## A

### Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

- The fatigue in aircraft corrosion testing (FACT) programme [AGARD-R-713] p 548 N89-21873
- Application of Advanced Material for Turbomachinery and Rocket Propulsion [AGARD-CP-449] p 548 N89-22654
- Calendar of selected aeronautical and space meetings [AGARD-CAL-88/2] p 566 N89-23361
- AGARD highlights 88/2 p 566 N89-23403

### Aerojet TechSystems Co., Sacramento, CA.

- Incorporating general race and housing flexibility and deadband in rolling element bearing analysis p 561 N89-22912
- Enhanced rotor modeling tailored for rub dynamic stability analysis and simulation p 561 N89-22916

### Aeronautical Research Inst. of Sweden, Stockholm.

- Compressible Euler solution around a wing canard sting configuration [FFA-TN-1988-62] p 519 N89-22578
- Wind tunnel tests of 16 percent thick airfoil section with spoilers at different chordwise positions [FFA-TN-1987-39] p 520 N89-22582
- The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack [FFA-141] p 520 N89-22583
- Transonic and supersonic wind tunnel tests on control effectiveness on schematic missile configurations with canard controls [FFA-TN-1988-11] p 531 N89-22601
- Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds [FFA-TN-1988-44] p 532 N89-22602
- A survey of poly-ether-ether-ketone and its advanced composites [FFA-TN-1988-37] p 550 N89-22707

### Aeronautical Research Labs., Melbourne (Australia).

- Description of a simple rotor test rig and preliminary wake studies [AD-A204089] p 541 N89-21808
- Single channel test controllers [AD-A204088] p 541 N89-22611

### Aeronautical Systems Div., Wright-Patterson AFB, OH.

- Ground collision warning system performance criteria for high maneuverability aircraft [AD-A204390] p 523 N89-21779

### Aerospatiale, Suresnes (France).

- Tests of new materials with second generation carbon fibers, test report [REPT-47-188/F] p 550 N89-22702
- CSPC test 319.30: Study on impact tolerance of preimpregnated carbon-epoxy systems [REPT-47-323/F] p 550 N89-22703

### Air Force Inst. of Tech., Wright-Patterson AFB, OH.

- Multivariable control law design for the Control Reconfigurable Combat Aircraft (CRCA) [AD-A202697] p 540 N89-21803
- The effects of incidence angle and free stream turbulence on the performance of a variable geometry two-dimensional compressor cascade at high Reynolds numbers [AD-A202650] p 557 N89-22052

### Air Force Materials Lab., Wright-Patterson AFB, OH.

- Technical evaluation report p 548 N89-22655

### Air Force Systems Command, Wright-Patterson AFB, OH.

- Fly, great sea eagle [AD-A203979] p 530 N89-21789
- Acta Aeronautica et Astronautica Sinica (selected articles) [AD-A205128] p 508 N89-22570
- Visting China's aerodynamics research and development center [AD-A203980] p 543 N89-22615

### Alabama Univ., University.

- Energy concepts applied to control of airplane flight in wind shear p 540 N89-21806

### Army Aviation Engineering Flight Activity, Edwards AFB, CA.

- Evaluation of the production CH-47D Adverse Weather Cockpit (AWC) aerial refueling system [AD-A204030] p 530 N89-21790
- Artificial and natural icing tests of the EH-60A quick fix helicopter [AD-A204589] p 530 N89-21792
- Artificial and natural icing tests of the UH-60A helicopter configured with the XM-139 multiple mine dispensing system (VOLCANO) [AD-A205031] p 531 N89-21794

### Army Aviation Systems Command, Moffett Field, CA.

- A prediction of high-speed rotor noise [AIAA PAPER 89-1132] p 564 A89-36220
- An experimental and computational study of rotor-vortex interactions p 513 A89-38553
- Analytical modeling of helicopter static and dynamic induced velocity in GRASP p 513 A89-38555

### Army Engineer Waterways Experiment Station, Vicksburg, MS.

- Evaluation of barrier cable impact pad materials [AD-A204356] p 542 N89-21811

### Army Materials Technology Lab., Watertown, MA.

- Environmentally induced discontinuities in transparent polymers [AD-A205483] p 550 N89-22768

### Army Propulsion Lab., Cleveland, OH.

- A review and forecast of engine system research at the Army Propulsion Directorate p 533 A89-36397

### Arnold Engineering Development Center, Arnold Air Force Station, TN.

- PARC code validation for propulsion flows [AD-A204293] p 557 N89-22066

## B

### Bentley Rotor Dynamics Research Corp., Minden, NV.

- Role of circumferential flow in the stability of fluid-handling machine rotors p 561 N89-22915

### Boeing Helicopter Co., Philadelphia, PA.

- Blade-vortex interaction p 508 A89-36905

## C

### California Univ., Los Angeles.

- Control augmented structural optimization of aeroelastically tailored fiber composite wings [AD-A204534] p 530 N89-21791

### Calspan-Buffalo Univ. Research Center, NY.

- Studies of the structure of attached and separated regions of viscous/inviscid interaction and the effects of combined surface roughness and blowing in high Reynolds number hypersonic flows [AD-A204364] p 518 N89-21774

### Carnegie-Mellon Univ., Pittsburgh, PA.

- Functional performance specification for an inertial navigation system [AD-A204850] p 526 N89-21785
- An OOD (Object-Oriented Design) paradigm for flight simulators, 2nd edition [AD-A204849] p 542 N89-21813

### Case Western Reserve Univ., Cleveland, OH.

- A seal test facility for the measurement of isotropic and anisotropic linear rotordynamic characteristics p 560 N89-22905

### Central Research Inst. of Electric Power Industry, Tokyo (Japan).

- Simulation analysis on ceramic gas turbine [DE88-756469] p 548 N89-21926

### Centre d'Essais Aeronautique Toulouse (France).

- Materials tests: Means and techniques p 548 N89-21983
- Failure analysis: Analysis of landing gear fatigue test results for mechanical and metallurgical considerations in order to determine the authorized run time p 556 N89-21984

### Centre d'Etudes Aerodynamiques et Thermiques, Poitiers (France).

- Interaction between an isolated vortex and a wing profile [ETN-89-94364] p 520 N89-22579
- Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel p 520 N89-22584
- Implementation of a two-component laser anemometer at the T2 wind tunnel [A-501-H] p 558 N89-22879

### CESI, Milan (Italy).

- Some in-field experiences of non-synchronous vibrations in large rotating machinery p 559 N89-22894

### Charles River Analytics, Inc., Cambridge, MA.

- Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931

### China Aeronautical Establishment, Beijing.

- Study of the real emulation of the electronic integrated system [PB89-116271] p 557 N89-22016
- Acceleration test for aircraft low-pass filter [PB89-116263] p 557 N89-22807

### Cincinnati Univ., OH.

- LDV measurements and investigation of flow field through radial turbine guide vanes p 538 N89-22609

### City Coll. of the City Univ. of New York, NY.

- Eigenstructure assignment for the control of highly augmented aircraft p 538 A89-36930

### Civil Aeromedical Inst., Oklahoma City, OK.

- Studies of poststrike air traffic control specialist trainees. Part 2: Selection and screening programs [AD-A199177] p 526 N89-22595

### Colorado Univ., Boulder.

- Numerical study of a multipurpose transonic wind tunnel with an adaptable injection-suction system p 543 N89-22621

### Computational Mechanics Co., Austin, TX.

- Analysis of flow-, thermal- and structural-interaction of hypersonic structures subjected to severe aerodynamic heating [AD-A205077] p 518 N89-21775

SOURCE

## Cornell Univ.

### Cornell Univ., Ithaca, NY.

Aerodynamics of engine-airframe interaction  
[NASA-CR-184824] p 517 N89-21769

### Council for National Academic Awards (England).

Investigation of the effects of increased sophistication of simulation of the atmospheric wind in wind tunnels  
p 543 N89-22620

### Cranfield Inst. of Tech., Bedford (England).

The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body  
p 516 N89-21765

## D

### Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).

The low-speed wind tunnel at DVFLR in Brunswick (Fed. Republic of Germany)  
[DFVLR-MITT-88-25] p 543 N89-22619

### Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.).

Transonic and supersonic flow past a 65 deg delta wing with rounded leading edges: Analysis of experimental data  
[DFVLR-FB-88-44] p 520 N89-22580

Flow over a leading edge with distributed roughness  
[DFVLR-FB-88-45] p 520 N89-22581

### Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (Germany, F.R.).

Monolithic and fiber ceramic components for turboengines and rockets  
p 549 N89-22657

## E

### Engineering Management Concepts, Camarillo, CA.

Plastic media blasting recycling equipment study  
[AD-A202463] p 556 N89-21987

## F

### Federal Aviation Administration, Atlantic City, NJ.

Description of the derivation of the collision risk model used in the vertical separation simulation risk model  
[AD-A205109] p 523 N89-21781

Instrument landing system mathematical modeling study for Orlando International Airport Runway 17R localizer, Orlando, Florida, revised airside docking plan (Scheme 3A)  
[AD-A204722] p 526 N89-21783

### Federal Aviation Administration, Washington, DC.

Eligibility of noise abatement proposals for grants-in-aid under the Airport Improvement Program  
[AD-A204724] p 542 N89-21812

National airspace system plan: Facilities, equipment, associated development and other capital needs  
[AD-A202615] p 526 N89-22596

### Ferranti Defense Systems, Inc., Binghamton, NY.

AFTI (Advanced Fighter Technology Integration)/F-111 mission adaptive wing briefing to industry  
[AD-A202467] p 530 N89-21787

### Fiat Aviazione S.p.A., Turin (Italy).

Development of stress and lifting criteria for single crystal turbine blades  
p 549 N89-22663

### Florida State Univ., Tallahassee.

On the three families of instability waves of high-speed jets  
p 513 N89-38624

### Flow Research, Inc., Kent, WA.

Optimizing advanced propeller designs by simultaneously updating flow variables and design parameters  
p 514 N89-39189

## G

### Garrett Turbine Engine Co., Phoenix, AZ.

The demonstration of monolithic and composite ceramics in aircraft gas turbine combustors  
p 550 N89-22665

### General Electric Co., Burlington, VT.

Aeroballistic Research Facility Data Analysis System (ARFAS)  
[AD-A204308] p 542 N89-21810

### General Electric Co., Cincinnati, OH.

INTERFACE 2: Advanced diagnostic software  
[AD-A204527] p 563 N89-22366

### Geo-Centers, Inc., Newton, MA.

Jet fuel deoxygenation  
[AD-A205006] p 548 N89-21943

### George Washington Univ., Hampton, VA.

Estimation of aircraft aerodynamic parameters from flight data  
p 513 N89-38614

### Georgia Inst. of Tech., Atlanta.

Analytical modeling of helicopter static and dynamic induced velocity in GRASP  
p 513 N89-38555

Convergence of discrete-vortex induced-flow calculations by optimum choice of mesh  
p 521 N89-22585

Aerodynamics of nonrigid bodies undergoing large amplitude time-dependent motions  
p 521 N89-22586

A study of unsteady turbulent flow past airfoils  
p 521 N89-22587

An efficient inverse method for the design of blended wing-body configurations  
p 532 N89-22603

### Georgia Tech Research Inst., Atlanta.

Supersonic particle probes: Measurement of internal wall losses  
[AD-A205863] p 521 N89-22589

## H

### High Technology Corp., Hampton, VA.

Boundary-layer transition on a cone and flat plate at Mach 3.5  
p 508 N89-36904

## I

### Information and Control Systems, Inc., Hampton, VA.

Application of precomputed control laws in a reconfigurable aircraft flight control system  
p 538 N89-36931

### Institute for Computer Applications in Science and Engineering, Hampton, VA.

The inviscid axisymmetric stability of the supersonic flow along a circular cylinder  
[NASA-CR-181816] p 519 N89-22574

### Iowa State Univ. of Science and Technology, Ames.

Primitive numerical simulation of circular Couette flow  
p 516 N89-21764

## J

### Jiaotong Univ., Shanghai (China).

Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow  
[PB89-111470] p 518 N89-22571

## K

### Kaiserslautern Univ. (Germany, F.R.).

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique  
p 560 N89-22900

Finite difference analysis of rotordynamic seal coefficients for an eccentric shaft position  
p 560 N89-22906

### Kansas Univ., Lawrence.

Sensitivity analysis of digital flight control systems using singular-value concepts  
p 538 N89-36927

Experimental investigation of dynamic ground effect  
p 514 N89-39185

## L

### Lockheed Aeronautical Systems Co., Marietta, GA.

Near-field acoustic characteristics of a single-rotor propfan  
[AIAA PAPER 89-1055] p 533 N89-36215

Installed propfan (SR-7L) far-field noise characteristics  
[AIAA PAPER 89-1056] p 564 N89-36216

Lateral noise attenuation of the advanced propeller of the propfan test assessment aircraft  
[AIAA PAPER 89-1057] p 564 N89-36217

Fluctuating pressures on wing surfaces in the slipstream of a single-rotor propfan  
[AIAA PAPER 89-1058] p 564 N89-36218

Lockheed Engineering and Sciences Co., Houston, TX.

Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft  
p 544 N89-36543

## M

### Manchester Univ. (England).

Flow past bluff bodies  
p 517 N89-21770

### Maryland Univ., College Park.

Unsteady force calculations on circular cylinders and elliptical airfoils with circulation control  
p 516 N89-21766

Ground and air resonance of bearingless rotors in hover and forward flight  
p 529 N89-21786

### Massachusetts Inst. of Tech., Cambridge.

Calculation of unsteady flows in turbomachinery using the linearized Euler equations  
p 552 N89-36916

Stall flutter of graphite/epoxy wings with bending-torsion coupling  
[AD-A203077] p 540 N89-21804

### Max-Planck-Institut fuer Stroemungsforschung, Goettingen (Germany, F.R.).

The evaluation and representation of interferograms of transonic flow fields  
[MPIS-21/1987] p 518 N89-21777

The aeroacoustics of the interaction between vortices and bodies in a transonic flow  
[MPIS-3/1988] p 566 N89-22445

### Mechanical Technology, Inc., Latham, NY.

Magnetic bearing stiffness control using frequency band filtering  
p 560 N89-22910

### Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.).

Development and testing of critical components for technological preparation of an Airbus-CFRP-luselage, phase 2  
[MBB-UT-129/87] p 531 N89-22600

### Michigan State Univ., East Lansing.

Numerical and experimental evaluations of the flow past nested chevrons  
p 508 N89-36902

### Ministry of Defence, London (England).

Future advanced aero-engines: The materials challenge  
p 538 N89-22659

### Mitre Corp., McLean, VA.

A procedure for operating dependent instrument approaches to converging runways  
[AD-A204723] p 526 N89-21784

### Mitsubishi Heavy-Industries Ltd., Takasago (Japan).

High stability design for new centrifugal compressor  
p 561 N89-22917

### Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).

Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency  
[MTU-TB-87/010] p 537 N89-22608

## N

### National Aeronautical Establishment, Ottawa (Ontario).

An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft  
[AD-A202910] p 526 N89-21782

Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds  
[AD-A205206] p 519 N89-22575

### National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.

A prediction of high-speed rotor noise  
[AIAA PAPER 89-1132] p 564 N89-36220

Helicopters and VTOL I  
p 527 N89-36899

Numerical and experimental evaluations of the flow past nested chevrons  
p 508 N89-36902

Integrated approach for active coupling of structures and fluids  
p 552 N89-36917

Simulation evaluation of an advanced control concept for a V/STOL aircraft  
p 539 N89-36932

An experimental and computational study of rotor-vortex interactions  
p 513 N89-38553

Analytical modeling of helicopter static and dynamic induced velocity in GRASP  
p 513 N89-38555

Three-dimensional Navier-Stokes simulations of turbine rotor-stator interaction. I - Methodology  
p 514 N89-39034

The use of DFDR information in the analysis of a turbulence incident over Greenland  
p 562 N89-39647

### National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, TX.

Impact cratering in low-gravity environments - Results of reconnaissance experimentation on the NASA KC-135A reduced-gravity aircraft  
p 544 N89-36543

### National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

Extension and application of flux-vector splitting to calculations on dynamic meshes  
p 508 N89-36901

Boundary-layer transition on a cone and flat plate at Mach 3.5  
p 508 N89-36904

Separation control on an airfoil by periodic forcing  
p 509 N89-36922

Eigenstructure assignment for the control of highly augmented aircraft  
p 538 N89-36930

Application of precomputed control laws in a reconfigurable aircraft flight control system  
p 538 N89-36931

Estimation of aircraft aerodynamic parameters from flight data  
p 513 N89-38614

- Numerical simulation of flow through a two-strut scramjet inlet p 514 A89-39038
- Effect of spatial wind gradients on airplane aerodynamics p 514 A89-39190
- Unsteady transonic small-disturbance theory including entropy and vorticity effects p 515 A89-39191
- Riblet drag at flight conditions p 515 A89-39196
- The NASA Langley laminar-flow-control experiment on a swept supercritical airfoil: Basic results for slotted configuration [NASA-TM-4100] p 516 N89-21762
- Static internal performance of convergent single-expansion-ramp nozzles with various combinations of internal geometric parameters [NASA-TM-4112] p 517 N89-21768
- Lateral stability analysis for X-29A drop model using system identification methodology [NASA-TM-4108] p 539 N89-21802
- Evaluation of the ride quality of a light twin engine airplane using a ride quality meter [NASA-TP-2913] p 507 N89-22568
- Hardware and operating features of the adaptive wall test section for the 0.3-meter transonic cryogenic tunnel [NASA-TM-4114] p 542 N89-22614
- Surface temperature measurements using a thin film thermal array [NASA-TM-101549] p 558 N89-22868
- National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH.**
- A review and forecast of engine system research at the Army Propulsion Directorate p 533 A89-36397
- Explicit Runge-Kutta method for unsteady rotor/stator interaction p 509 A89-36912
- High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 A89-39195
- A perspective on future directions in aerospace propulsion system simulation [NASA-TM-102038] p 536 N89-21798
- An explicit Runge-Kutta method for turbulent reacting flow calculations [NASA-TM-101945] p 536 N89-21799
- NASA's program on icing research and technology [NASA-TM-101989] p 507 N89-22569
- Rectangular nozzle plume velocity modeling for use in jet noise prediction [NASA-TM-102047] p 519 N89-22577
- Active vibration control for flexible rotor by optimal direct-output feedback control [NASA-TM-101972] p 537 N89-22605
- Investigation of low NOx staged combustor concept in high-speed civil transport engines [NASA-TM-101977] p 537 N89-22606
- Transonic viscous flow calculations for a turbine cascade with a two equation turbulence model [NASA-TM-101944] p 537 N89-22607
- New hypersonic facility capability at NASA Lewis Research Center [NASA-TM-102028] p 543 N89-22617
- Rotordynamic Instability Problems in High-Performance Turbomachinery, 1988 [NASA-CP-3026] p 558 N89-22891
- Transmission overhaul and replacement predictions using Weibull and renewal theory [NASA-TM-102022] p 562 N89-22925
- Structural dynamics branch research and accomplishments for FY 1988 [NASA-TM-101406] p 562 N89-22939
- National Oceanic and Atmospheric Administration, Boulder, CO.**
- Hazard index calculation for 31 May 1984 microburst at Erie, Colorado [NASA-CR-184968] p 562 N89-23048
- National Transportation Safety Board, Washington, DC.**
- Aircraft accident report: Trans-Colorado Airlines, Inc., Flight 2286, Fairchild Metro 3, SA227 AC, N68TC Bayfield, Colorado, January 19, 1988 [PB89-910401] p 524 N89-22593
- Naval Air Development Center, Warminster, PA.**
- The effects of plastic media blasting paint removal on the microstructure of graphite/epoxy composite materials [AD-A204801] p 550 N89-22688
- Naval Postgraduate School, Monterey, CA.**
- A study of the effect of design parameter variation on predicted tilt-rotor aircraft performance [AD-A204856] p 531 N89-21793
- Composite failure criterion: Probabilistic formulation and geometric interpretation [AD-A205275] p 548 N89-21851
- Computational investigation of incompressible airfoil flows at high angles of attack [AD-A205885] p 522 N89-22590
- Control of embedded vortices using wall jets [AD-A202606] p 558 N89-22835

**Notre Dame Univ., IN.**

- Neural computing for numeric-to-symbolic conversion in control systems p 563 A89-37234

**O****Office of Technology Assessment, Washington, DC.**

- Safe skies for tomorrow: Aviation safety in a competitive environment [PB89-114318] p 524 N89-22591

**Oxford Univ. (England).**

- Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800

**P****Pennsylvania State Univ., University Park.**

- Shock structure in non-circular jets [AIAA PAPER 89-1083] p 510 A89-37653

**Pratt and Whitney Aircraft, West Palm Beach, FL.**

- Application of advanced materials for turbomachinery and rocket propulsion p 549 N89-22656
- Damage tolerance concepts for advanced materials and engines p 549 N89-22661

**Princeton Univ., NJ.**

- Experimental studies in system identification of helicopter rotor dynamics p 528 A89-38554
- Organized structures in a supersonic turbulent boundary layer p 517 N89-21771
- A flight dynamic study of the helicopter including blade dynamics p 531 N89-21796
- The structure and control of three-dimensional shock wave turbulent boundary layer interactions [AD-A205923] p 558 N89-22866

**Purdue Univ., West Lafayette, IN.**

- Numerical solutions of unsteady inviscid transonic turbine cascade flows p 516 N89-21767
- Dynamics and control of truss structures with extending members p 523 N89-21778
- Research as part of the Air Force Research in Aero Propulsion Technology (AFRAPT) Program [AD-A204968] p 537 N89-21801
- Aerodynamic detuning of a loaded airfoil cascade in an incompressible flow by a locally analytical method p 521 N89-22588
- Model-based analysis and cooperative synthesis of control and display augmentation for piloted flight vehicles p 540 N89-22610

**R****Rockwell International Corp., Canoga Park, CA.**

- Rotordynamic coefficients for stepped labyrinth gas seals p 560 N89-22901

**Rolls-Royce Ltd., Derby (England).**

- New metallic materials for gas turbines p 549 N89-22660
- Material/manufacturing process interaction in advanced material technologies p 549 N89-22662

**Rotor Bearing Dynamics, Inc., Wellsville, NY.**

- A magnetic damper for first mode vibration reduction in multimass flexible rotors p 561 N89-22911

**Royal Aircraft Establishment, Farnborough (England).**

- CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 N89-22658

**Rutgers - The State Univ., New Brunswick, NJ.**

- Theoretical investigation of 3-D shock wave-turbulent boundary layer interactions, part 7 [AD-A204482] p 557 N89-22070

**S****San Jose State Univ., CA.**

- The use of DFDR information in the analysis of a turbulence incident over Greenland p 562 A89-39647

**Sandia National Labs., Albuquerque, NM.**

- Wake recontact: An experimental investigation using a ringslot parachute [DE89-008320] p 518 N89-21773
- A preliminary characterization of parachute wake recontact [DE89-006442] p 519 N89-22576
- Testing of a new recovery parachute system for the F111 aircraft crew escape module: An update [DE89-007139] p 524 N89-22592
- A vortex panel analysis of circular-arc bluff-bodies in unsteady flow [DE89-007141] p 558 N89-22845

**Sandia National Labs., Livermore, CA.**

- Feasibility of flight experiments and instrumentation hardware for in-flight hypersonic boundary-layer measurements [NASA-CR-184896] p 517 N89-21772

**Selenia S.p.A., Naples (Italy).**

- Design, implementation and computer aided tests of a shaped reflector for an air traffic control system [ETN-89-94229] p 556 N89-22014

**Service Hydrographique et Oceanographique de la Marine, Paris (France).**

- Geodetic positioning system for flying aircraft (May 1987) [REPT-013/88] p 527 N89-22598

**Simula, Inc., Phoenix, AZ.**

- The naval aircraft crash environment: Aircrew survivability and aircraft structural response [AD-A204825] p 523 N89-21780

**SLI Avionic Systems Corp., Grand Rapids, MI.**

- Pre and post modification electromagnetic compatibility test report for the C-130H self contained navigation system with MLS A-kit, revision [AD-A205167] p 533 N89-22604

**Southampton Univ. (England).**

- The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895

**Sparta, Inc., Lexington, MA.**

- Stability and control of hypervelocity vehicles [AD-A205160] p 540 N89-21807

**Stanford Univ., CA.**

- The effect of exhaust plume/afterbody on installed scramjet performance p 536 N89-21797
- A numerical study of viscous vortex rings using a spectral method p 518 N89-22572
- Transition to turbulence in laminar hypersonic flow p 522 N89-22830

**Sulzer-Escher Wyss Ltd., Zurich (Switzerland).**

- Rotordynamic stability problems and solutions in high pressure turbocompressors p 561 N89-22914

**Sverdrup Technology, Inc., Arnold Air Force Station, TN.**

- PARC code validation for propulsion flows [AD-A204293] p 557 N89-22066

**Sverdrup Technology, Inc., Cleveland, OH.**

- High-speed propeller performance and noise predictions at takeoff/landing conditions p 565 A89-39195

**Swedish Defence Research Establishment, Linköping.**

- Fusion of multisensor data: A summary of the JASMIN project [FOA-C-30498-3.3] p 563 N89-23213

**T****Technische Univ., Berlin (Germany, F.R.).**

- Investigations of the parameter reduction in the optimization of aircraft wing structures [ILR-MITT-203] p 531 N89-21795

**Texas A&M Univ., College Station.**

- Cavitation effects on the pressure distribution of a squeeze film damper bearing p 559 N89-22897
- An electroviscous damper p 559 N89-22898
- Annular honeycomb seals: Test results for leakage and rotordynamic coefficients; comparisons to labyrinth and smooth configurations p 559 N89-22899
- Experimental verification of an eddy-current bearing p 561 N89-22913

**Texas Instruments, Inc., Lewisville.**

- Application of precomputed control laws in a reconfigurable aircraft flight control system p 538 A89-36931

**Texas Univ., Arlington.**

- Microburst simulation via vortex-ring and turbulent jet models p 562 N89-22287

**Texas Univ., Austin.**

- Separation shock motion in fin, cylinder, and compression ramp - Induced turbulent interactions p 509 A89-36911

**Textron Bell Helicopter, Fort Worth, TX.**

- Influence of impeller shroud forces on turbopump rotor dynamics p 560 N89-22909

**Toledo Univ., OH.**

- Two-dimensional simulation of electrothermal deicing of aircraft components p 528 A89-39194

**U****United Technologies Research Center, East Hartford, CT.**

- Calculation of unsteady flows in turbomachinery using the linearized Euler equations p 552 A89-36916

## Universal Energy Systems, Inc.

CORPORATE SOURCE

### Universal Energy Systems, Inc., Dayton, OH.

Combustor flow visualization using innovative infrared thermographics techniques  
[AD-A205905] p 550 N89-22718

### University of Southern California, Los Angeles.

Numerical and experimental evaluations of the flow past nested chevrons p 508 A89-36902

### University of Southern Illinois, Carbondale.

A proposal for funding to purchase a high-temperature furnace to enable determination of the high temperature mechanical properties of structural carbon materials  
[AD-A204103] p 542 N89-21809

## V

### Vigyan Research Associates, Inc., Hampton, VA.

Microcomputer based controller for the Langley 0.3-meter Transonic Cryogenic Tunnel  
[NASA-CR-181808] p 543 N89-22616

### Virginia Polytechnic Inst. and State Univ., Blacksburg.

Blade-vortex interaction p 508 A89-36905  
Singular trajectories in airplane cruise-dash optimization p 538 A89-36928  
Effects of swirl and high turbulence on a jet in a crossflow p 515 A89-39192  
Computational fluid dynamics research in three-dimensional zonal techniques  
[NASA-CR-181406] p 558 N89-22838

## W

### Washington Univ., Seattle.

Development of a streamline method  
[AD-A205146] p 557 N89-22078

### Wichita State Univ., KS.

Electroimpulse deicing - Electrodynamic solution by discrete elements p 528 A89-39193  
Electro-impulse de-icing research: Fatigue and electromagnetic interference tests  
[DOT/FAA/CT-88/27] p 524 N89-22594

### Woodside Summit Group, Inc., Mountain View, CA.

An experimental and computational study of rotor-vortex interactions p 513 A89-38553

## Z

### Zhejiang Univ. (China).

Some field experience with subsynchronous vibration of centrifugal compressors p 559 N89-22892

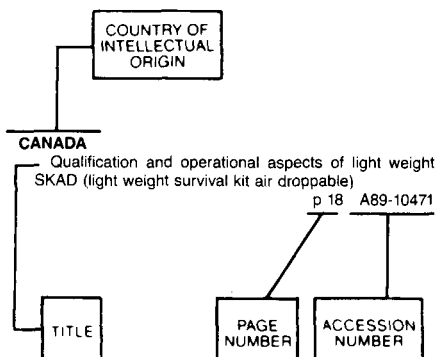


# FOREIGN TECHNOLOGY INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 243)

September 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.

## A

### ALGERIA

Numerical study of turbulence model in a supersonic nozzle p 515 A89-39349

### AUSTRALIA

Description of a simple rotor test rig and preliminary wake studies [AD-A204089] p 541 N89-21808  
Single channel test controllers [AD-A204088] p 541 N89-22611

## B

### BELGIUM

The optical bidirectional accelerometer p 553 A89-36966

### BRAZIL

Inviscid, unsteady, transonic axisymmetric flow with shock waves - Response to time and space-time dependent perturbations p 512 A89-38129

## C

### CANADA

Rejuvenation of service-exposed IN 738 turbine blades p 533 A89-36474  
Degradation of aluminide coated directionally solidified superalloy turbine blades in an aero gas turbine engine p 546 A89-36480  
The maturing of commercial aviation p 507 A89-36900  
Variations of undamped rotor blade frequencies subjected to transient heat flux p 553 A89-36919  
Flutter analysis of the CF-18 aircraft at supersonic speeds p 528 A89-39199  
Lifetime aerofoil calculations using von Mises variables p 516 A89-39666

An investigation of lateral tracking techniques, flight directors and automatic control coupling on decelerating IFR approaches for rotorcraft [AD-A202910] p 526 N89-21782

Comparison of boundary layer trips of disk and grit types on airfoil performance at transonic speeds [AD-A205206] p 519 N89-22575

### CHINA, PEOPLE'S REPUBLIC OF

A hafnium-free directionally solidified nickel-base superalloy p 546 A89-36435  
A method for shock-free wing design p 509 A89-36985

Transfinite interpolation method for 3-D grid generations p 509 A89-36986  
Lateral induced velocity distribution of a helicopter rotor p 509 A89-36987

Selection of weighting matrices for linear optimal regulator p 563 A89-36990  
Equivalent systems method to evaluate the flight qualities p 539 A89-36998

The problems of the infrared stealth of the flying vehicles p 507 A89-37003  
Coupling factor method for studying elastic motion of flight vehicles p 544 A89-37004

Experimental investigation on buckling of aircraft shell by the curved grating shadow moire method p 553 A89-37006

A way for upgrading the accuracy of force measurement p 553 A89-37011  
GDPP - A practical CAD software package p 563 A89-37014

Computer simulation of the movement of loading door retraction mechanism with slide tracks p 527 A89-37019

On evaluation of aircraft propulsion system performance p 534 A89-37752  
Performance analysis of a propulsion system p 534 A89-37753

Adjustment of ratio of rotation speed difference in a twin-spool turbojet engine p 534 A89-37754  
A study on GH169 crack propagation under creep-fatigue interaction p 547 A89-37756

Investigation on simulation of foreign object impact damage to compressor blade p 534 A89-37757  
A study on exit radial temperature profile of 2D experimental combustor p 535 A89-37759

Variation of critical speed of a rotor-bearing system with slight relocation of bearing p 554 A89-37766  
Experimental investigation of sudden imbalance response on a flexible rotor system with squeeze-film damper p 554 A89-37768

Research on temperature profile factor at exit in an annular combustor p 535 A89-37769  
Computation of dynamic process with large disturbance for split-shaft gas turbine p 535 A89-37772

Optimizing design for turboengine digital speed controller p 535 A89-37773  
Study on exchange operation between two microcomputers in aeroengine digital control p 535 A89-37774

On the unsteady leading edge suction of a sweptback wing p 510 A89-37776  
The computation of the viscous/inviscid interaction p 510 A89-37777

An explicit multistage finite-area method for 2D transonic flow calculations p 510 A89-37778  
Rotor vortex wake distortion and its induced velocity in ground effect at low speed p 510 A89-37779

The effects of vortex breakdown on the aerodynamic properties of a wing and the engineering predicting method p 510 A89-37780  
Investigation of Mach reflection for a planar moving shock propagating into steady supersonic flow field around wedge p 510 A89-37782

Investigation for venting test technology with large-sized model in a large wind tunnel p 541 A89-37783  
Experimental investigation of aerodynamic heating by flow through control surface gaps p 510 A89-37785

The application of wall pressure method in low speed return wind tunnel with closed jet p 541 A89-37786

The application of the two-dimensional unsteady Euler equations perturbation solutions on the supersonic rectangular wings p 511 A89-37787

The constraint wake analysis for hovering rotors p 511 A89-37790  
AF-2 scheme for solution of axial symmetric transonic inlet-flowfield p 511 A89-37791

Nonlinear supersonic potential flow over sideslip conical bodies, delta wings and fuselages p 511 A89-37792  
Anodized aluminum and aluminum alloy coatings for thermal control p 547 A89-38153

Application of a fuzzy controller in the fuel system of a turbojet engine p 536 A89-39043  
Color helium bubble flow-visualization technique p 556 A89-39186

Wing-store flutter analysis of an airfoil in incompressible flow p 528 A89-39198  
Multi-input/multi-output frequency domain modal identification method and its application in ground vibration testing p 529 A89-39454

Robust control of an active vibration isolation system for helicopters p 539 A89-39458  
The analysis and prediction of the spin equilibrium point of modern aircrafts p 539 A89-39459

Numerical calculations of hypersonic nonequilibrium flow over a blunt wedge p 515 A89-39461  
A computational method of aerodynamics for subsonic, fully unsteady wings at high angles of attack in time-domain p 515 A89-39462

Development of a second generation injector driven transonic wind tunnel at BUAA p 541 A89-39469  
F.E. simulation of crash for helicopters p 529 A89-39472

A physical model of the streamwise corner vortices in a compressor cascade p 515 A89-39473  
The application of dynamic schlieren-photon correlation technique to a supersonic shear layer p 515 A89-39474

On the accelerating airflow problem in the test section of a transonic wind tunnel p 541 A89-39477  
A research experiment of discrete fuel injection in aero-engine combustion chamber p 536 A89-39480

Fly, great sea eagle [AD-A203979] p 530 N89-21789  
Study of the real emulation of the electronic integrated system [PB89-116271] p 557 N89-22016

Acta Aeronautica et Astronautica Sinica (selected articles) [AD-A205128] p 508 N89-22570  
Unsteady aerodynamic computational method of non-coplanar wing-tail combinations in subsonic flow [PB89-111470] p 518 N89-22571

Visting China's aerodynamics research and development center [AD-A203980] p 543 N89-22615  
Acceleration test for aircraft low-pass filter [PB89-116263] p 557 N89-22807

### CZECHOSLOVAKIA

Validation of nonstationary aerodynamics models for longitudinal aeroplane motion on the basis of flight measurements p 539 A89-37524  
Contribution to centrifugal impeller design p 553 A89-37525

## F

### FRANCE

Laser drilling of a superalloy coated with ceramic p 551 A89-36455  
Infrared thermography - A quantitative tool for heat study [ONERA, TP NO. 1989-3] p 553 A89-37827

Vibrations in aerospace structures - Prediction, prevention and control [ONERA, TP NO. 1989-9] p 553 A89-37631  
New possibilities of viscous-inviscid numerical techniques for solving viscous flow equations with massive separation [ONERA, TP NO. 1989-24] p 554 A89-37640

FOREIGN

Application of infrared thermography to the interpretation of tests in an icing wind tunnel

[ONERA, TP NO. 1989-28] p 554 A89-37642

The fatigue in aircraft corrosion testing (FACT) programme

[AGARD-R-713] p 548 N89-21873

Materials tests: Means and techniques

p 548 N89-21983

Failure analysis: Analysis of landing gear fatigue test results for mechanical and metallurgical considerations in order to determine the authorized run time

p 556 N89-21984

Interaction between an isolated vortex and a wing profile

[ETN-89-94364] p 520 N89-22579

Sidewall boundary layer study, with and without suction, for the 150 mm chord CAST 7 airfoil at the T2 wind tunnel

p 520 N89-22584

Geodetic positioning system for flying aircraft (May 1987)

[REPT-013/88] p 527 N89-22598

Application of Advanced Material for Turbomachinery and Rocket Propulsion

[AGARD-CP-449] p 548 N89-22654

Tests of new materials with second generation carbon fibers, test report

[REPT-47-188/F] p 550 N89-22702

CSPC test 319.30: Study on impact tolerance of prepregged carbon-epoxy systems

[REPT-47-323/F] p 550 N89-22703

Implementation of a two-component laser anemometer at the T2 wind tunnel

[A-501-H] p 558 N89-22879

Calendar of selected aeronautical and space meetings [AGARD-CAL-88/2]

p 566 N89-23361

AGARD highlights 88/2

p 566 N89-23403

## G

### GERMANY, FEDERAL REPUBLIC OF

Consideration of environmental conditions for the fatigue evaluation of composite airframe structure

p 551 A89-36304

Flight control system design for an in-flight simulator

p 539 A89-36934

Three component laser Doppler anemometry in large wind tunnels

p 555 A89-38615

Modern joining methods for future aircraft structures

p 556 A89-39076

Integral rudder system for aircraft steering

p 539 A89-39258

Simulation of optimal flight paths of dynamical soaring flight and the design of a model aircraft

p 529 A89-39259

The evaluation and representation of interferograms of transonic flow fields

[MPIS-21/1987] p 518 N89-21777

Investigations of the parameter reduction in the optimization of aircraft wing structures

[ILR-MITT-203] p 531 N89-21795

The aeroacoustics of the interaction between vortices and bodies in a transonic flow

[MPIS-3/1988] p 566 N89-22445

Transonic and supersonic flow past a 65 deg delta wing with rounded leading edges: Analysis of experimental data

[DFVLR-FB-88-44] p 520 N89-22580

Flow over a leading edge with distributed roughness [DFVLR-FB-88-45]

p 520 N89-22581

Development and testing of critical components for technological preparation of an Airbus-CFRP-fuselage, phase 2

[MBB-UT-129/87] p 531 N89-22600

Propulsion systems with improved efficiency for future passenger aircraft. Main task A: Conceptual investigations of future propulsion systems with enhanced propulsive efficiency

[MTU-TB-87/010] p 537 N89-22608

The low-speed wind tunnel at DVFLR in Brunswick (Fed. Republic of Germany)

[DFVLR-MITT-88-25] p 543 N89-22619

Monolithic and fiber ceramic components for turboengines and rockets

p 549 N89-22657

Rotordynamic coefficients for labyrinth seals calculated by means of a finite difference technique

p 560 N89-22900

## I

### INDIA

Formulation of gain and impedance relations for corner reflectors employed in conjunction with localizer antenna arrays

p 525 A89-39500

## D-2

### INTERNATIONAL ORGANIZATION

Inmarsat's aeronautical satellite communication system

p 552 A89-36593

Combining the use of geostationary and inclined orbit satellites for integrated communications and navigation applications

p 544 A89-36611

### IRELAND

Accident investigation and the public interest - A pilot's view

p 523 A89-39224

### ISRAEL

Prediction of fatigue life under aircraft loading with and without use of material memory rules

p 527 A89-38028

Investigation of a small solid fuel ramjet combustor

p 544 A89-39028

Interferometry against differential Doppler - Performance comparison of two emitter location airborne systems

p 525 A89-39203

### ITALY

Design, implementation and computer aided tests of a shaped reflector for an air traffic control system

[ETN-89-94229] p 556 N89-22014

Development of stress and lifting criteria for single crystal turbine blades

p 549 N89-22663

Some in-field experiences of non-synchronous vibrations in large rotating machinery

p 559 N89-22894

## J

### JAPAN

Some mathematical considerations on views of the ground surface in flight

p 562 A89-36351

NTT's program of experimental mobile satellite system (EMSS) using ETS-V and preliminary results

p 552 A89-36585

Technical design and performance analysis of aeronautical satellite communication systems

p 524 A89-36594

Field trials of aeronautical satellite communication system

p 524 A89-36595

Communication and ranging systems for navigation experiment using Engineering Test Satellite V

p 525 A89-36618

Effect of crack size on the tensile strength of ceramics in a high-temperature corrosive environment

p 547 A89-38021

Mach number effects on high-angles-of-attack aerodynamic characteristics of a cone-cylinder with various nose shapes

p 511 A89-38122

Experimental investigation of applicability of waverider configuration to hypersonic transport and aerospace-plane

p 511 A89-38123

Numerical simulation of supersonic flows past a space-plane

p 511 A89-38124

Highly-resolved flowfield induced by Mach reflection

p 512 A89-38125

Configuration of tuned dry gyro redundant system

p 554 A89-38189

Fundamental aspects of an aerospaceplane

p 544 A89-38234

Scramjet combustion with an aid of silane

p 547 A89-38387

Navier-Stokes computations of two- and three-dimensional cascade flowfields

p 514 A89-39035

J85 surge transient simulation

p 536 A89-39044

Simulation analysis on ceramic gas turbine [DE88-756469]

p 548 N89-21926

High stability design for new centrifugal compressor

p 561 N89-22917

## N

### NETHERLANDS

Note on the lifting-surface problem for a circular wing in incompressible flow

p 514 A89-38939

## P

### POLAND

The joined wing - The benefits and drawbacks. I

p 507 A89-38800

## S

### SOUTH AFRICA, REPUBLIC OF

Electromagnetic backscatter from open-ended circular cylinder with complex termination

p 536 A89-39284

### SWEDEN

Experiences of rocket seat ejections in the Swedish Air Force - 1967-1987

p 522 A89-36122

Generalized criteria for microwave breakdown in air-filled waveguides

p 552 A89-36655

Asymptotic analysis of the transonic region of a high-speed propeller

[AIAA PAPER 89-1077] p 565 A89-37652

Compressible Euler solution around a wing canard sting configuration

[FFA-TN-1988-62] p 519 N89-22578

Wind tunnel tests of 16 percent thick airfoil section with spoilers at different chordwise positions

[FFA-TN-1987-39] p 520 N89-22582

The influence of the leading edge geometry on the wave drag for a 65 degree delta wing at low supersonic speed and small angles of attack

[FFA-141] p 520 N89-22583

Transonic and supersonic wind tunnel tests on control effectiveness on schematic missile configurations with canard controls

[FFA-TN-1988-11] p 531 N89-22601

Prediction of loads on wing/body/external store/fins pylon-configurations at transonic speeds

[FFA-TN-1988-44] p 532 N89-22602

A survey of poly-ether-ether-ketone and its advanced composites

[FFA-TN-1988-37] p 550 N89-22707

Fusion of multisensor data: A summary of the JASMIN project

[FOA-C-30498-3.3] p 563 N89-23213

Good prospects for LET's 40-seater

p 528 A89-39226

HUD on the head for combat pilots

p 532 A89-39227

## T

### TURKEY

Wakes of four complex bodies of revolution at zero angle of attack

p 508 A89-36907

## U

### U.S.S.R.

Aerodynamic characteristics of arbitrarily rotating bodies in a variable-density gas

p 509 A89-37355

Dynamical calculations of engine components based on elasticity equations

p 553 A89-37421

A numerical method for the analysis of a flight vehicle with a solid fuselage

p 509 A89-37460

Flutter of a wing with an aileron in transonic flow

p 539 A89-37461

Some properties of nonisentropic transonic flows

p 512 A89-38426

Approximate calculation of supersonic flow past bodies of revolution with a front separation zone at a small angle of attack

p 512 A89-38427

Consideration of the effect of surface roughness on regime coefficients in local interaction theory

p 512 A89-38432

Dependence of regime coefficients on regime parameters in local interaction theory

p 512 A89-38435

Nonstationary supersonic flow past a body

p 512 A89-38437

Stability of gas flows in Laval nozzles

p 512 A89-38438

A study of shock wave radiation near models at hypersonic velocities in air

p 513 A89-38445

Optimization of flight regimes according to economic criteria (2nd revised and enlarged edition)

p 528 A89-38498

Hydrodynamics and heat transfer in the porous elements of flight vehicle structures

p 554 A89-38499

Calculation of the principal parameters of the actuating mechanisms of aircraft slave drives

p 555 A89-38500

Nonstationary thermal duty of the structural elements of flight vehicles

p 535 A89-38502

Vibrations of the blades of turbomachines

p 535 A89-38504

Variable-cycle turbojet engines for multiple-regime aircraft

p 535 A89-38510

Adaptive automatic control systems for flight vehicles

p 563 A89-38511

Synthesis of systems for the motion control of nonstationary objects

p 563 A89-38512

Fundamentals of the maintenance of the radio-electronic equipment of aircraft

p 525 A89-38513

Fundamentals of aviation (4th revised and enlarged edition)

p 507 A89-38514

Input signal selection in the identification of linear continuous dynamic systems from discrete observations

p 563 A89-39777

Motion of a three-degrees-of-freedom gyroscope with a dynamically unbalanced rotor in the case of contact between the internal frame and an elastic limiter

p 565 A89-39816

- A method for determining the inertia tensor of a craft in flight p 565 A89-39819  
 Application of the theory of fuzzy sets to the two-criterion stochastic optimization of ribbed shells p 556 A89-39823

## UNITED KINGDOM

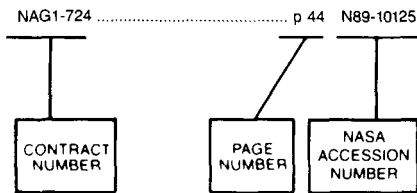
- Human factors in cabin safety p 522 A89-36069  
 Unsteady interaction effects on a transitional turbine blade boundary layer p 508 A89-36186  
 Prediction of counter-rotation propeller noise [AIAA PAPER 89-1141] p 564 A89-36221  
 Metallurgical stability of Inconel alloy 718 p 545 A89-36405  
 Electron beam cold hearth refinement processing of Inconel alloy 718 and Nimonic alloy PK50 p 546 A89-36440  
 International Conference on Satellite Systems for Mobile Communications and Navigation, 4th, London, England, Oct. 17-19, 1988, Proceedings p 552 A89-36576  
 Collaborative experiments involving a satellite based data link for air traffic services p 525 A89-36596  
 Aircraft engines. IV p 534 A89-36898  
 Measurements in separating boundary layers p 552 A89-36909  
 Voice of authority p 544 A89-37646  
 Gust analysis of an aircraft with highly non-linear systems interaction p 527 A89-37650  
 Active vibration control of flexible rotors - An experimental and theoretical study p 554 A89-37847  
 Condensation phenomena in a turbine blade passage p 511 A89-37939  
 Airport technology international 1988 p 541 A89-38582  
 XRD techniques in aero engine development p 555 A89-38632  
 Isothermal flow in a gas turbine combustor - A benchmark experimental study p 514 A89-38873  
 Stress tensor measurements within the vaneless diffuser of a centrifugal compressor p 556 A89-39050  
 Coming to terms with TCAS p 522 A89-39088  
 Buffeting criteria for a systematic series of wings p 515 A89-39197  
 A note on sound from the interruption of a cylindrical flow by a semi-infinite aerofoil of subsonic speed p 565 A89-39506  
 Preliminary results of in-flight experiments on the active control of propeller-induced cabin noise p 529 A89-39509  
 A demonstration of active noise reduction in an aircraft cabin p 529 A89-39510  
 Air navigation systems. I - Astronomical navigation in the air 1919-1969. Part II - Instruments p 532 A89-39828  
 Automatic conflict detection logic for future air traffic control p 525 A89-39829  
 Benefits of 'area navigation' in regional aviation p 525 A89-39830  
 The use of the College of Aeronautics Whirling Arm facility to determine the effect of flow curvature on the aerodynamic characteristics of an ogive-cylinder body p 516 N89-21765  
 Flow past bluff bodies p 517 N89-21770  
 Unsteady aerodynamics and heat transfer in a transonic turbine stage p 537 N89-21800  
 Investigation of the effects of increased sophistication of simulation of the atmospheric wind in wind tunnels p 543 N89-22620  
 CVD and diffusion coatings for high temperature applications in turbomachinery and rocket motors p 549 N89-22658  
 Future advanced aero-engines: The materials challenge p 538 N89-22659  
 New metallic materials for gas turbines p 549 N89-22660  
 Material/manufacturing process interaction in advanced material technologies p 549 N89-22662  
 The spectral analysis of an aero-engine assembly incorporating a squeeze-film damper p 559 N89-22895

# CONTRACT NUMBER INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 243)

September 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.

NAG1-724 .....	p 44	N89-10125
F49620-87-K-0003 .....	p 530	N89-21791
F49620-88-C-0001 .....	p 518	N89-21775
JPL-957856 .....	p 563	A89-37234
MIPR-F-83-73 .....	p 542	N89-21811
MIPR-N-90-29 .....	p 542	N89-21811
NAG1-203 .....	p 538	A89-36928
NAG1-421 .....	p 513	A89-38624
NAG1-616 .....	p 514	A89-39185
NAG1-657 .....	p 510	A89-37653
NAG1-866 .....	p 558	N89-22838
NAG2-373 .....	p 517	N89-21769
NAG2-415 .....	p 528	A89-38554
NAG3-181 .....	p 559	N89-22899
NAG3-284 .....	p 528	A89-39193
NAG3-72 .....	p 528	A89-39194
NASA ORDER L-96920-B .....	p 517	N89-21772
NAS1-17919 .....	p 543	N89-22616
NAS1-17993 .....	p 558	N89-22868
NAS1-18107 .....	p 519	N89-22574
NAS1-18605 .....	p 519	N89-22574
NAS3-24339 .....	p 533	A89-36215
	p 564	A89-36216
	p 564	A89-36217
	p 564	A89-36218
NAS3-24855 .....	p 514	A89-39189
NCC2-293 .....	p 538	A89-36927
NCC2-315 .....	p 562	A89-39647
NGT-47-004-801 .....	p 508	A89-36905
NSERC-A-5549 .....	p 553	A89-36919
NSF ATM-85-11196 .....	p 532	A89-37537
NSF DMR-84-18718 .....	p 547	A89-36484
NSF MSM-87-00820 .....	p 556	A89-39519
NSG-3079 .....	p 552	A89-36916
N00014-85-K-0646 .....	p 555	A89-38874
N00014-87-K-0168 .....	p 508	A89-36903
N00039-87-C-5301 .....	p 509	A89-36923
	p 514	A89-39039
N00123-85-D-0901 .....	p 556	N89-21987
N0014-87-J-1130 .....	p 513	A89-38624
N62269-82-C-0275 .....	p 523	N89-21780
PHASE-3075-AN-225-D .....	p 520	N89-22584
STPA-83-96-003 .....	p 550	N89-22702
505-60-31-03 .....	p 516	N89-21762
505-61-01-05 .....	p 558	N89-22868
505-61-01-09 .....	p 543	N89-22616
505-61-21-03 .....	p 542	N89-22614
505-61-41-02 .....	p 507	N89-22568
505-62-21 .....	p 536	N89-21798
	p 536	N89-21799
	p 537	N89-22607
505-62-3B .....	p 543	N89-22617
505-62-61 .....	p 537	N89-22606
505-62-91 .....	p 519	N89-22577
505-63-1B .....	p 537	N89-22605
	p 562	N89-22939
505-63-51 .....	p 562	N89-22925
505-66-01-02 .....	p 539	N89-21802
505-68-11 .....	p 507	N89-22569
505-68-91-06 .....	p 517	N89-21768
505-90-21-01 .....	p 519	N89-22574
553-13 .....	p 558	N89-22891
AF PROJ. SM-MMK-87-10-324 .....	p 524	N89-22592
AF PROJ. 2104 .....	p 542	N89-21811
AF PROJ. 2306 .....	p 542	N89-21809
AF PROJ. 2307 .....	p 557	N89-22070
	p 557	N89-22078
AF PROJ. 2308 .....	p 537	N89-21801
AF-AFOSR-0111-84 .....	p 557	N89-22078
AF-AFOSR-0266-86 .....	p 557	N89-22070
AF-AFOSR-0305-86 .....	p 537	N89-21801
AF-AFOSR-0397-87 .....	p 542	N89-21809
AF-AFOSR-82-0228 .....	p 513	A89-38620
AF-AFOSR-85-0158 .....	p 514	A89-39187
	p 514	A89-39188
AF-AFOSR-85-0295 .....	p 508	A89-36186
AF-AFOSR-86-0112 .....	p 509	A89-36911
BMFT-LFT-8510/4 .....	p 537	N89-22608
BMFT-LKF-8652/7 .....	p 531	N89-22600
DA PROJ. 1L1-62209-A-47-A .....	p 562	N89-22925
DAAL03-86-K-0149 .....	p 555	A89-38764
DAAL03-88-K-0144 .....	p 563	A89-37234
DE-AC04-76DP-00789 .....	p 518	N89-21773
	p 519	N89-22576
	p 524	N89-22592
	p 558	N89-22845
DE-AC04-76DR-00789 .....	p 517	N89-21772
DRET-85-092 .....	p 520	N89-22579
DTFA01-84-C-0001 .....	p 526	N89-21784
FMV-FFL-82250-86-169-25-001 .....	p 550	N89-22707
FMV-FLYGL-82223-78-170-21-001 .....	p 531	N89-22601
FMV-FLYGL-82260-88-061-73-001 .....	p 519	N89-22578
	p 532	N89-22602
F08635-87-C-0005 .....	p 542	N89-21810
F09603-85-C-1224 .....	p 533	N89-22604
F19628-85-C-0003 .....	p 526	N89-21785
	p 542	N89-21813
F33615-77-C-5200 .....	p 551	A89-36436
F33615-78-C-3027 .....	p 530	N89-21787
F33615-84-C-2412 .....	p 548	N89-21943
F33615-84-C-3608 .....	p 538	A89-36931
F33615-86-C-2670 .....	p 550	N89-22718
F33615-86-C-3616 .....	p 540	N89-21807
F33657-85-C-2131 .....	p 563	N89-22366
F40600-86-K-0004 .....	p 521	N89-22589
F41-400 .....	p 523	N89-21780
F49620-82-K-0033 .....	p 559	N89-22899
F49620-85-C-0130 .....	p 518	N89-21774
F49620-86-C-0066 .....	p 540	N89-21804
F49620-86-C-0094 .....	p 558	N89-22866
F49620-87-C-0088 .....	p 563	A89-36943
F49620-87-C-0116 .....	p 538	A89-36928
F49620-87-C-0122 .....	p 507	A89-37875

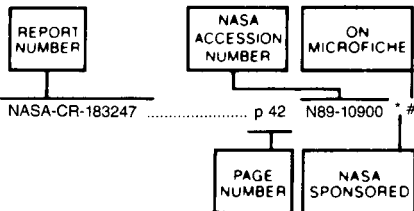
CONTRACT

# REPORT NUMBER INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 243)

September 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.

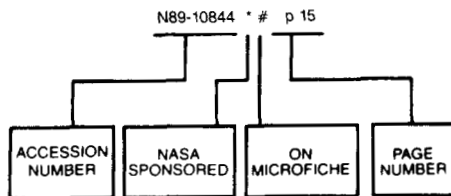
NASA-CR-183247	p 42	N89-10900	* #
A-501-H	p 558	N89-22879	#
AD-A199177	p 526	N89-22595	#
AD-A202463	p 556	N89-21987	#
AD-A202467	p 530	N89-21787	#
AD-A202606	p 558	N89-22835	#
AD-A202615	p 526	N89-22596	#
AD-A202650	p 557	N89-22052	#
AD-A202697	p 540	N89-21803	#
AD-A202910	p 526	N89-21782	#
AD-A203077	p 540	N89-21804	#
AD-A203979	p 530	N89-21789	#
AD-A203980	p 543	N89-22615	#
AD-A204030	p 530	N89-21790	#
AD-A204088	p 541	N89-22611	#
AD-A204089	p 541	N89-21808	#
AD-A204103	p 542	N89-21809	#
AD-A204293	p 557	N89-22066	#
AD-A204308	p 542	N89-21810	#
AD-A204356	p 542	N89-21811	#
AD-A204364	p 518	N89-21774	#
AD-A204390	p 523	N89-21779	#
AD-A204482	p 557	N89-22070	#
AD-A204527	p 563	N89-22366	#
AD-A204534	p 530	N89-21791	#
AD-A204589	p 530	N89-21792	#
AD-A204722	p 526	N89-21783	#
AD-A204723	p 526	N89-21784	#
AD-A204724	p 542	N89-21812	#
AD-A204801	p 550	N89-22688	#
AD-A204825	p 523	N89-21780	#
AD-A204849	p 542	N89-21813	#
AD-A204850	p 526	N89-21785	#
AD-A204856	p 531	N89-21793	#
AD-A204968	p 537	N89-21801	#
AD-A205006	p 548	N89-21943	#
AD-A205031	p 531	N89-21794	#
AD-A205077	p 518	N89-21775	#
AD-A205109	p 523	N89-21781	#
AD-A205128	p 508	N89-22570	#
AD-A205146	p 557	N89-22078	#
AD-A205160	p 540	N89-21807	#
AD-A205167	p 533	N89-22604	#
AD-A205206	p 519	N89-22575	#
AD-A205275	p 548	N89-21851	#
AD-A205483	p 550	N89-22768	#
AD-A205863	p 521	N89-22589	#
AD-A205885	p 522	N89-22590	#
AD-A205905	p 550	N89-22718	#
AD-A205923	p 558	N89-22866	#
AD-E801786	p 542	N89-21810	#
AD-E900870	p 557	N89-22052	#
AD-E900870	p 526	N89-22596	#
AD-E900870	p 558	N89-22835	#
AEDC-TR-88-32	p 557	N89-22066	#
AEDC-TR-88-37	p 521	N89-22589	#
AFATL-TR-88-48	p 542	N89-21810	#
AFESC/ESL-TR-87-33	p 542	N89-21811	#
AFIT/GAE/AA/88D-31	p 557	N89-22052	#
AFIT/GE/ENG/88D-14	p 540	N89-21803	#
AFOSR-88-1289TR	p 540	N89-21804	#
AFOSR-88-1315TR	p 542	N89-21809	#
AFOSR-89-0033TR	p 518	N89-21774	#
AFOSR-89-0089TR	p 518	N89-21775	#
AFOSR-89-0094TR	p 530	N89-21791	#
AFOSR-89-0133TR	p 557	N89-22078	#
AFOSR-89-0139TR	p 557	N89-22070	#
AFOSR-89-0199TR	p 537	N89-21801	#
AFOSR-89-0285TR	p 558	N89-22866	#
AFWAL-TR-88-2081	p 548	N89-21943	#
AFWAL-TR-88-2096	p 563	N89-22366	#
AFWAL-TR-88-3082	p 530	N89-21787	#
AFWAL-TR-89-3019	p 540	N89-21807	#
AGARD-CAL-88/2	p 566	N89-23361	#
AGARD-CP-449	p 548	N89-22654	#
AGARD-R-713	p 548	N89-21873	#
AIAA PAPER 89-1055	p 533	A89-36215	* #
AIAA PAPER 89-1056	p 564	A89-36216	* #
AIAA PAPER 89-1057	p 564	A89-36217	* #
AIAA PAPER 89-1058	p 564	A89-36218	* #
AIAA PAPER 89-1077	p 565	A89-37652	* #
AIAA PAPER 89-1083	p 510	A89-37653	* #
AIAA PAPER 89-1105	p 564	A89-36219	* #
AIAA PAPER 89-1132	p 564	A89-36220	* #
AIAA PAPER 89-1141	p 564	A89-36221	* #
AIAA PAPER 89-1377	p 527	A89-37650	* #
AIAA-89-0930	p 558	N89-22845	#
AIAA-89-2357	p 519	N89-22577	#
AIAA-89-2534	p 543	N89-22617	* #
AIAA-89-2919	p 562	N89-22925	#
AIAA-89-2942	p 537	N89-22606	* #
ARL-AERO-TM-397	p 541	N89-21808	#
ARL-STRUC-TM-488	p 541	N89-22611	#
ASD-TR-88-5034	p 523	N89-21779	#
AVSCOM-TR-89-C-007	p 562	N89-22925	* #
CMU/SEI-88-TR-23	p 526	N89-21785	#
CMU/SEI-88-TR-30	p 542	N89-21813	#
CONF-8904118-2	p 558	N89-22845	#
CONF-8904118-3	p 519	N89-22576	#
CONF-8904118-4	p 524	N89-22592	#
CRIE-W-87002	p 548	N89-21926	#
CUBRC-88682	p 518	N89-21774	#
DE88-756469	p 548	N89-21926	#
DE89-006442	p 519	N89-22576	#
DE89-007139	p 524	N89-22592	#
DE89-007141	p 558	N89-22845	#
DE89-007943	p 517	N89-21772	* #
DE89-008320	p 518	N89-21773	#
DFVLR-FB-88-44	p 520	N89-22580	#
DFVLR-FB-88-45	p 520	N89-22581	#
DFVLR-MITT-88-25	p 543	N89-22619	#
DODA-AR-005-525	p 541	N89-22611	#
DODA-AR-005-527	p 541	N89-21808	#
DOT/FAA/AM-88/3	p 526	N89-22595	#
DOT/FAA/CT-TN88/38	p 523	N89-21781	#
DOT/FAA/CT-TN89/1	p 526	N89-21783	#
DOT/FAA/CT-88/27	p 524	N89-22594	#
DOT/FAA/DS-88/09	p 526	N89-21784	#
DOT/FAA/PP-89/2	p 542	N89-21812	#
E-4071	p 537	N89-22606	* #
E-4227	p 558	N89-22891	* #
E-4498	p 562	N89-22939	* #
E-4608	p 536	N89-21798	* #
E-4634	p 537	N89-22607	* #
E-4635	p 536	N89-21799	* #
E-4672	p 537	N89-22605	* #
E-4692	p 507	N89-22569	* #
E-4739	p 519	N89-22577	* #
E-4756	p 562	N89-22925	* #
E-4760	p 543	N89-22617	* #
ESD-TR-88-024	p 526	N89-21785	#
ESD-TR-88-031	p 542	N89-21813	#
ETN-89-93765	p 537	N89-22608	#
ETN-89-93769	p 531	N89-22600	#
ETN-89-93786	p 531	N89-21795	#
ETN-89-93808	p 518	N89-21777	#
ETN-89-93811	p 566	N89-22445	#
ETN-89-94126	p 563	N89-23213	#
ETN-89-94229	p 556	N89-22014	#
ETN-89-94314	p 531	N89-22601	#
ETN-89-94316	p 519	N89-22578	#
ETN-89-94355	p 550	N89-22702	#
ETN-89-94356	p 550	N89-22703	#
ETN-89-94358	p 527	N89-22598	#
ETN-89-94364	p 520	N89-22579	#
ETN-89-94371	p 543	N89-22619	#
ETN-89-94378	p 520	N89-22580	#
ETN-89-94379	p 520	N89-22581	#
ETN-89-94544	p 520	N89-22582	#
ETN-89-94545	p 550	N89-22707	#
ETN-89-94547	p 532	N89-22602	#
ETN-89-94550	p 520	N89-22583	#
FFA-TN-1987-39	p 520	N89-22582	#
FFA-TN-1988-11	p 531	N89-22601	#
FFA-TN-1988-37	p 550	N89-22707	#
FFA-TN-1988-44	p 532	N89-22602	#
FFA-TN-1988-62	p 519	N89-22578	#
FFA-141	p 520	N89-22583	#
FOA-C-30496-3.3	p 563	N89-23213	#
FTD-ID(RS)-T-0639-88	p 543	N89-22615	#
FTD-ID(RS)-T-0782-88	p 530	N89-21789	#
FTD-ID(RS)-T-0912-88	p 508	N89-22570	#
GC-TR-88-1416-013	p 548	N89-21943	#
HJB-850281	p 557	N89-22016	#
HJB-860367	p 557	N89-22807	#
ICASE-89-19	p 519	N89-22574	* #
ILR-MITT-203	p 531	N89-21795	#
ISBN-92-835-0470-4	p 566	N89-23361	#
ISBN-92-835-0495-X	p 548	N89-21873	#
ISBN-92-835-0498-4	p 548	N89-22654	#
ISSN-0081-5640	p 520	N89-22583	#
ISSN-0171-1342	p 520	N89-22580	#
ISSN-0171-1342	p 520	N89-22581	#
ISSN-0176-7739	p 543	N89-22619	#
ISSN-0347-3708	p 563	N89-23213	#
ISSN-0436-1199	p 518	N89-21777	#
ISSN-0436-1199	p 566	N89-22445	#
ISTIC-TR-C-000196	p 518	N89-22571	#

REPORT

L-16471	p 539	N89-21802 * #	PB89-116263	p 557	N89-22807 #
L-16474	p 516	N89-21762 * #	PB89-116271	p 557	N89-22016 #
L-16524	p 507	N89-22568 * #	PB89-127831	p 562	N89-23048 * #
L-16535	p 517	N89-21768 * #	PB89-910401	p 524	N89-22593 #
L-16548	p 542	N89-22614 * #			
LC-88-600550	p 524	N89-22591 #	REPT-013/88	p 527	N89-22598 #
MAE-1851	p 558	N89-22866 #	REPT-47-188/F	p 550	N89-22702 #
MBB-UT-129/87	p 531	N89-22600 #	REPT-47-323/F	p 550	N89-22703 #
MPIS-21/1987	p 518	N89-21777 #	REPT-6216-055-REV	p 533	N89-22604 #
MPIS-3/1988	p 566	N89-22445 #	RU-TR-172-MAE-F-PT-7	p 557	N89-22070 #
MTL-TR-89-11	p 550	N89-22768 #	SAE AIR 4023	p 547	A89-37658
MTR-88W125	p 526	N89-21784 #	SAE AIR 784	p 534	A89-37654
MTU-TB-87/010	p 537	N89-22608	SAE ARP 750	p 527	A89-37660
NADC-88106-60	p 523	N89-21780 #	SAE ARP 841	p 534	A89-37661
NADC-88109-60	p 550	N89-22688 #	SAE AS 1852	p 544	A89-37659
NAE-AN-55	p 526	N89-21782 #	SAE PAPER 881443	p 534	A89-37651
NAE-AN-56	p 519	N89-22575 #	SAND-88-3058C	p 519	N89-22576 #
NAS 1.15:101406	p 562	N89-22939 * #	SAND-88-3058	p 518	N89-21773 #
NAS 1.15:101549	p 558	N89-22868 * #	SAND-89-0366C	p 558	N89-22845 #
NAS 1.15:101944	p 537	N89-22607 * #	SAND-89-0410C	p 524	N89-22592 #
NAS 1.15:101945	p 536	N89-21799 * #	SAND-89-8204	p 517	N89-21772 * #
NAS 1.15:101972	p 537	N89-22605 * #	T-114-A	p 558	N89-22879 #
NAS 1.15:101977	p 537	N89-22606 * #	TELAC-88-11	p 540	N89-21804 #
NAS 1.15:101989	p 507	N89-22569 * #	TR-88-12	p 518	N89-21775 #
NAS 1.15:102022	p 562	N89-22925 * #	TR-88490	p 523	N89-21780 #
NAS 1.15:102028	p 543	N89-22617 * #	USAAEFA-85-15	p 531	N89-21794 #
NAS 1.15:102038	p 536	N89-21798 * #	WRDC-TR-89-2015	p 550	N89-22718 #
NAS 1.15:102047	p 519	N89-22577 * #			
NAS 1.15:4100	p 516	N89-21762 * #			
NAS 1.15:4108	p 539	N89-21802 * #			
NAS 1.15:4112	p 517	N89-21768 * #			
NAS 1.15:4114	p 542	N89-22614 * #			
NAS 1.26:181406	p 558	N89-22838 * #			
NAS 1.26:181808	p 543	N89-22616 * #			
NAS 1.26:181816	p 519	N89-22574 * #			
NAS 1.26:184824	p 517	N89-21769 * #			
NAS 1.26:184896	p 517	N89-21772 * #			
NAS 1.26:184968	p 562	N89-23048 * #			
NAS 1.55:3026	p 558	N89-22891 * #			
NAS 1.60:2913	p 507	N89-22568 * #			
NASA-CP-3026	p 558	N89-22891 * #			
NASA-CR-181406	p 558	N89-22838 * #			
NASA-CR-181808	p 543	N89-22616 * #			
NASA-CR-181816	p 519	N89-22574 * #			
NASA-CR-184824	p 517	N89-21769 * #			
NASA-CR-184896	p 517	N89-21772 * #			
NASA-CR-184968	p 562	N89-23048 * #			
NASA-TM-101406	p 562	N89-22939 * #			
NASA-TM-101549	p 558	N89-22868 * #			
NASA-TM-101944	p 537	N89-22607 * #			
NASA-TM-101945	p 536	N89-21799 * #			
NASA-TM-101972	p 537	N89-22605 * #			
NASA-TM-101977	p 537	N89-22606 * #			
NASA-TM-101989	p 507	N89-22569 * #			
NASA-TM-102022	p 562	N89-22925 * #			
NASA-TM-102028	p 543	N89-22617 * #			
NASA-TM-102038	p 536	N89-21798 * #			
NASA-TM-102047	p 519	N89-22577 * #			
NASA-TM-4100	p 516	N89-21762 * #			
NASA-TM-4108	p 539	N89-21802 * #			
NASA-TM-4112	p 517	N89-21768 * #			
NASA-TM-4114	p 542	N89-22614 * #			
NASA-TP-2913	p 507	N89-22568 * #			
NCEL-CR-89.001	p 556	N89-21987 #			
NOAA-TM-ERL-WPL-155	p 562	N89-23048 * #			
NRC-29604	p 526	N89-21782 #			
NRC-29908	p 519	N89-22575 #			
NTSB/AAR-89/01	p 524	N89-22593 #			
ONERA, TP NO. 1989-24	p 554	A89-37640 #			
ONERA, TP NO. 1989-28	p 554	A89-37642 #			
ONERA, TP NO. 1989-3	p 553	A89-37627 #			
ONERA, TP NO. 1989-9	p 553	A89-37631 #			
OTA-SET-381	p 524	N89-22591 #			
PB89-111470	p 518	N89-22571 #			
PB89-114318	p 524	N89-22591 #			

# ACCESSION NUMBER INDEX

### Typical Accession Number Index Listing



Listings in 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.

A89-36069	p 522	A89-36902	* # p 508	A89-37847	p 554	A89-39203	p 525	N89-21806	# p 542
A89-36117	p 522	A89-36903	# p 508	A89-37875	# p 507	A89-39224	p 523	N89-21809	# p 542
A89-36122	p 522	A89-36904	* # p 508	A89-37878	p 554	A89-39226	p 528	N89-21810	# p 542
A89-36186	# p 508	A89-36905	# p 508	A89-37939	p 511	A89-39227	p 532	N89-21811	# p 542
A89-36215	* # p 533	A89-36907	# p 508	A89-38021	p 547	A89-39234	p 528	N89-21812	# p 542
A89-36216	* # p 564	A89-36909	# p 552	A89-38028	p 527	A89-39258	p 539	N89-21813	# p 542
A89-36217	* # p 564	A89-36910	# p 508	A89-38122	p 511	A89-39259	p 529	N89-21851	# p 548
A89-36218	* # p 564	A89-36911	* # p 509	A89-38123	p 511	A89-39284	p 536	N89-21873	# p 548
A89-36219	# p 564	A89-36912	* # p 509	A89-38124	p 511	A89-39349	p 515	N89-21926	# p 548
A89-36220	# p 564	A89-36914	# p 509	A89-38125	p 512	A89-39454	# p 529	N89-21943	# p 548
A89-36221	* # p 564	A89-36916	# p 552	A89-38129	p 512	A89-39458	# p 539	N89-21983	p 548
A89-36304	p 551	A89-36917	* # p 552	A89-38153	p 547	A89-39459	# p 539	N89-21984	p 556
A89-36319	p 551	A89-36919	# p 553	A89-38189	p 554	A89-39461	# p 515	N89-21987	# p 556
A89-36335	p 545	A89-36922	* # p 509	A89-38234	p 544	A89-39462	# p 515	N89-22014	# p 556
A89-36351	# p 562	A89-36923	# p 509	A89-38387	p 547	A89-39469	# p 541	N89-22016	# p 557
A89-36397	* p 533	A89-36927	* # p 538	A89-38426	p 512	A89-39472	# p 529	N89-22052	# p 557
A89-36398	p 551	A89-36928	* # p 538	A89-38427	p 512	A89-39473	# p 515	N89-22066	# p 557
A89-36399	p 533	A89-36929	# p 538	A89-38432	p 512	A89-39474	# p 515	N89-22070	# p 557
A89-36400	p 533	A89-36930	* # p 538	A89-38435	p 512	A89-39477	# p 541	N89-22078	# p 557
A89-36405	p 545	A89-36931	* # p 538	A89-38437	p 512	A89-39478	# p 536	N89-22287	p 562
A89-36406	p 545	A89-36932	* # p 539	A89-38438	p 512	A89-39480	# p 536	N89-22366	# p 563
A89-36410	p 545	A89-36934	# p 539	A89-38445	p 513	A89-39500	# p 525	N89-22445	# p 566
A89-36411	p 545	A89-36943	# p 563	A89-38498	p 528	A89-39506	p 565	N89-22568	* # p 507
A89-36414	p 545	A89-36966	p 553	A89-38499	p 554	A89-39509	p 529	N89-22569	# p 507
A89-36418	p 546	A89-36985	# p 509	A89-38500	p 555	A89-39510	p 529	N89-22570	# p 508
A89-36424	p 546	A89-36986	# p 509	A89-38502	p 535	A89-39514	p 565	N89-22571	# p 518
A89-36425	p 546	A89-36987	# p 509	A89-38504	p 535	A89-39515	p 565	N89-22572	# p 518
A89-36435	p 546	A89-36990	# p 563	A89-38510	p 535	A89-39519	p 556	N89-22574	* # p 519
A89-36436	p 551	A89-36998	# p 539	A89-38511	p 563	A89-39587	p 532	N89-22575	# p 519
A89-36440	p 546	A89-37003	# p 507	A89-38512	p 563	A89-39588	p 565	N89-22576	# p 519
A89-36440	p 546	A89-37004	# p 544	A89-38513	p 525	A89-39666	p 516	N89-22577	* # p 519
A89-36452	p 546	A89-37006	# p 553	A89-38514	p 507	A89-39777	p 563	N89-22578	# p 519
A89-36455	p 551	A89-37006	# p 553	A89-38553	* # p 513	A89-39816	p 565	N89-22579	# p 520
A89-36473	p 533	A89-37011	# p 553	A89-38554	* # p 528	A89-39819	p 565	N89-22580	# p 520
A89-36474	p 533	A89-37014	# p 563	A89-38555	* # p 51	A89-39823	p 556	N89-22581	# p 520
A89-36480	p 546	A89-37019	# p 527	A89-38578	p 513	A89-39827	p 525	N89-22582	# p 520
A89-36484	p 547	A89-37234	* p 563	A89-38578	p 513	A89-39828	p 532	N89-22583	# p 520
A89-36543	* # p 544	A89-37355	p 509	A89-38582	p 541	A89-39829	p 525	N89-22584	# p 520
A89-36575	p 527	A89-37421	p 553	A89-38614	* p 513	A89-39830	p 525	N89-22585	# p 521
A89-36576	p 552	A89-37460	p 509	A89-38615	p 555			N89-22586	p 521
A89-36585	p 552	A89-37461	p 539	A89-38620	p 513			N89-22587	p 521
A89-36592	p 524	A89-37461	p 539	A89-38624	* p 513	N89-21762	* # p 516	N89-22588	p 521
A89-36593	p 552	A89-37524	p 539	A89-38632	p 555	N89-21764	p 516	N89-22589	# p 521
A89-36594	p 524	A89-37525	p 553	A89-38652	p 528	N89-21765	p 516	N89-22590	# p 522
A89-36595	p 524	A89-37537	p 532	A89-38764	p 555	N89-21766	p 516	N89-22591	# p 524
A89-36596	p 524	A89-37627	p 553	A89-38800	# p 507	N89-21767	p 516	N89-22592	# p 524
A89-36599	p 525	A89-37631	# p 553	A89-38873	p 514	N89-21768	* # p 517	N89-22593	# p 524
A89-36611	p 544	A89-37640	# p 554	A89-38874	p 555	N89-21769	* # p 517	N89-22594	# p 524
A89-36618	p 525	A89-37642	# p 554	A89-38876	p 566	N89-21770	p 517	N89-22595	# p 526
A89-36655	p 552	A89-37646	p 544	A89-38877	p 566	N89-21771	p 517	N89-22596	# p 526
A89-36721	# p 547	A89-37650	# p 527	A89-38878	p 566	N89-21772	* # p 517	N89-22598	# p 527
A89-36722	# p 547	A89-37651	p 534	A89-38878	p 522	N89-21773	# p 518	N89-22600	# p 531
A89-36723	# p 552	A89-37652	# p 565	A89-38879	p 514	N89-21774	# p 518	N89-22601	# p 531
A89-36898	p 534	A89-37653	* # p 510	A89-38894	p 532	N89-21775	# p 518	N89-22602	# p 532
A89-36899	* p 527	A89-37654	p 534	A89-38950	p 535	N89-21777	# p 518	N89-22603	p 532
A89-36900	p 507	A89-37658	p 547	A89-38951	p 555	N89-21778	p 523	N89-22604	# p 533
A89-36901	* # p 508	A89-37659	p 544	A89-38954	p 555				
				A89-39008	p 541				



**N89-22605****ACCESSION NUMBER INDEX**

N89-22605 \* # p 537  
N89-22606 \* # p 537  
N89-22607 \* # p 537  
N89-22608 # p 537  
N89-22609 # p 538  
N89-22610 # p 540  
N89-22611 # # p 541  
N89-22614 \* # # p 542  
N89-22615 # # p 543  
N89-22616 \* # # p 543  
N89-22617 \* # # p 543  
N89-22619 # # p 543  
N89-22620 # p 543  
N89-22621 # p 543  
N89-22654 # # p 548  
N89-22655 # # p 548  
N89-22656 # # p 549  
N89-22657 # # p 549  
N89-22658 # # p 549  
N89-22659 # # p 538  
N89-22660 # # p 549  
N89-22661 # # p 549  
N89-22662 # # p 549  
N89-22663 # # p 549  
N89-22665 # # p 550  
N89-22688 # # p 550  
N89-22702 # # p 550  
N89-22703 # # p 550  
N89-22707 # # p 550  
N89-22718 # # p 550  
N89-22768 # # p 550  
N89-22807 # # p 557  
N89-22830 \* # # p 522  
N89-22835 # # p 558  
N89-22838 \* # # p 558  
N89-22845 # # p 558  
N89-22866 # # p 558  
N89-22868 \* # # p 558  
N89-22879 # # p 558  
N89-22891 \* # # p 558  
N89-22892 \* # # p 559  
N89-22894 \* # # p 559  
N89-22895 \* # # p 559  
N89-22897 \* # # p 559  
N89-22898 \* # # p 559  
N89-22899 \* # # p 559  
N89-22900 \* # # p 560  
N89-22901 \* # # p 560  
N89-22905 \* # # p 560  
N89-22906 \* # # p 560  
N89-22909 \* # # p 560  
N89-22910 \* # # p 560  
N89-22911 \* # # p 561  
N89-22912 \* # # p 561  
N89-22913 \* # # p 561  
N89-22914 \* # # p 561  
N89-22915 \* # # p 561  
N89-22916 \* # # p 561  
N89-22917 \* # # p 561  
N89-22925 \* # # p 562  
N89-22939 \* # # p 562  
N89-23048 \* # # p 562  
N89-23213 # # p 563  
N89-23361 # # p 566  
N89-23403 # # p 566

# 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<sup>(1)</sup> 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. NASA SP-7037 (243)		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Aeronautical Engineering A Continuing Bibliography (Supplement 243)				5. Report Date September 1989	
				6. Performing Organization Code	
7. Author(s)				8. Performing Organization Report No.	
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, DC 20546				10. Work Unit No.	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address				13. Type of Report and Period Covered	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract This bibliography lists 423 reports, articles and other documents introduced into the NASA scientific and technical information system in August 1989.					
17. Key Words (Suggested by Authors(s)) Aeronautical Engineering Aeronautics Bibliographies				18. Distribution Statement Unclassified - Unlimited	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 124	
				22. Price * A06/HC	

\*For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-Langley, 1989