NASA

Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037(221)
January 1988

National Aeronautics and Space Administration

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NASA SP-7037(221)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 221)

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 December 1987 in

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

Scientific and Technical Information Division 1988
National Aeronautics and Space Administration
Washington, DC

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 409 reports, journal articles and other documents originally announced in December 1987 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

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

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

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

An annual cummulative index will be published.

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

		Page
Category 01	**Aeronautics (General)**	**801**
Category 02	**Aerodynamics** Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.	**803**
Category 03	**Air Transportation and Safety** Includes passenger and cargo air transport operations; and aircraft accidents.	**818**
Category 04	**Aircraft Communications and Navigation** Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.	**820**
Category 05	**Aircraft Design, Testing and Performance** Includes aircraft simulation technology.	**823**
Category 06	**Aircraft Instrumentation** Includes cockpit and cabin display devices; and flight instruments.	**828**
Category 07	**Aircraft Propulsion and Power** Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.	**830**
Category 08	**Aircraft Stability and Control** Includes aircraft handling qualities; piloting; flight controls; and autopilots.	**835**
Category 09	**Research and Support Facilities (Air)** Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.	**837**
Category 10	**Astronautics** Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.	**840**
Category 11	**Chemistry and Materials** Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.	**840**

PAGE IV BLANK

Category 12 Engineering 847

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

Category 13 Geosciences 853

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

Category 14 Life Sciences 855

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.

Category 15 Mathematical and Computer Sciences 856

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

Category 16 Physics 859

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

Category 17 Social Sciences 861

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

Category 18 Space Sciences N.A.

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

Category 19 General N.A.

Subject Index A-1
Personal Author Index B-1
Corporate Source Index C-1
Foreign Technology Index D-1
Contract Number Index E-1
Report Number Index F-1
Accession Number Index G-1

TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED

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ACCESSION NUMBER → **N87-10039*#** National Aeronautics and Space Administration. ← CORPORATE SOURCE
Langley Research Center, Hampton, Va.

TITLE → **WIND-TUNNEL INVESTIGATION OF THE FLIGHT CHARACTERISTICS OF A CANARD GENERAL-AVIATION AIRPLANE CONFIGURATION**

PUBLICATION DATE

AUTHOR → D. R. SATRAN Oct. 1986 60 p

AVAILABILITY SOURCE

REPORT NUMBERS → (NASA-TP-2623; L-15929; NAS 1.60:2623) Avail: NTIS HC

PRICE CODE → A04/MF A01 CSCL 01A ← COSATI CODE

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

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

ACCESSION NUMBER → **A87-11487*** National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.

COMPUTATION OF TURBULENT SUPERSONIC FLOWS AROUND POINTED BODIES HAVING CROSSFLOW SEPARATION ← TITLE

AUTHORS → D. DEGANI and L. B. SCHIFF (NASA, Ames Research Center, Moffett Field, CA) ← AUTHOR'S AFFILIATION

JOURNAL TITLE → Journal of Computational Physics (ISSN 0021-9991), vol. 66, Sept. 1986, p. 173-196. refs

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

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 221)

JANUARY 1988

01

AERONAUTICS (GENERAL)

A87-53413
SPECIALISTS' MEETING ON ROTARY WING PROPULSION SYSTEMS, WILLIAMSBURG, VA, NOV. 12-14, 1986, TECHNICAL PAPERS
Meeting sponsored by AHS. Alexandria, VA, American Helicopter Society, 1987, 212 p. For individual items see A87-53414 to A87-53431.

The conference presents papers on the 214ST drive system Lead-the-Fleet program, a supportability model which quantifies the reliability and maintainability influence on cost, the future impact of manufacturing technology and automation at Pratt & Whitney Canada, reducing the total cost of ownership, and the design and development of a high-contact-ratio helicopter transmission utilizing a self-aligning bearingless planetary. Other topics include advances and applications of Pyrowear 53 in helicopter transmission systems, T406-AD-400 full-scale development, and improved reliability and maintainability in advanced-technology engines. Consideration is also given to compressors for advanced turboshaft engines and a design system for erosion-tolerant helicopter engines. K.K.

A87-53414
THE 214ST DRIVE SYSTEM LEAD-THE-FLEET PROGRAM
JAMES D. ROCKWOOD (Bell Helicopter Textron, Inc., Fort Worth, TX) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 21 p.

The 214ST Lead-the-Fleet program was one of a series of similar analytical inspection programs designed to evaluate the durability of an aircraft in diverse operating conditions and to initiate timely changes which would improve the durability and reduce operating costs. In the case of components with specified overhaul intervals, the program was also used to confirm that the times between overhauls (TBOs) initially established were realistic, and to gather baseline information for possible TBO extensions. It is estimated that the optimim TBO for improved combining gearboxes and transmissions will be between 3500 and 4000 hours; the improved intermediate and tail rotor gearboxes are estimated to be capable of achieving TBOs of 4000 to 5000 hours. K.K.

A87-53415
SUPPORTABILITY MODEL - QUANTIFIES RELIABILITY AND MAINTAINABILITY INFLUENCE ON COST
B. E. ROBERTON (Pratt and Whitney, Engineering Div., West Palm Beach, FL) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 6 p.

A support cost model initially created to support the USAF F100-PW-100 fighter engine is described. Its most recent application has been in the design of the T800 to power the US Army LHX helicopter. Model methodology is discussed as well as typical input assumptions, prediction methods, model features, applications, and typical output. K.K.

A87-53425
LHTEC - MEETING THE LHX COST CHALLENCE
PAUL J. HURLEY and LYNN E. SNYDER (Light Helicopter Turbine Engine Co., St. Louis, MO) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986; Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 7 p.

The Light Helicopter Turbine Engine Company (LHTEC) has seen significant and innovative steps to ensure that aggressive cost guarantees in the T800-LHT-800 Full-Scale Development (FSD) contract will be satisfied. The management approach being used applies to design-to-cost (DTC), procure-to-cost, and manufacture-to-cost activities as well as operating and support cost activities. Examples of how this management approach is being implemented are given throughout the paper. Author

A87-53552
VOYAGER CREW FACES TURBULENCE, FATIGUE ON WORLD FLIGHT ATTEMPT
KEITH F. MORDOFF Aviation Week and Space Technology (ISSN 0005-2175), vol. 125, Dec. 22, 1986, p. 18-21.

A progress report is presented for the Voyager aircraft's 25,000-mile nonstop, unrefueled flight, with attention to the aerodynamic consequences of the loss of wingtip winglet structures during takeoff and the adverse weather subsequently encountered. Storm conditions in the South Pacific became a major concern early in the flight. As of the present report, the Voyager had traversed Sri Lanka and the southern tip of India, and was approaching the coast of Africa. Storm encounters had required greater use of both engines, thereby endangering the effort's fuel consumption schedule. O.C.

A87-53553
AROUND-THE-WORLD FLIGHT
Aviation Week and Space Technology (ISSN 0005-2175), vol. 126, Jan. 5, 1987, p. 22-27.

A brief account and evaluation is presented for the Rutan/Yeager Voyager aircraft round-the-world unrefueled flight, which was completed with only 15-20 gal of fuel remaining in the aircraft. The flight was aided for much of its duration by unseasonably favorable tail winds that allowed Voyager to arrive back at its starting point a full day early. The tail winds compensated for increased drag due to wingtip damage during takeoff and unscheduled climbs to avoid bad weather. The Voyager airframe was entirely constructed of advanced graphite fiber-reinforced polymer composite materials yielding outstanding strength/weight performance. O.C.

A87-54252#
ONCE AROUND THE EARTH WITHOUT REFUELING [EINMAL UM DIE ERDE, OHNE NACHZUTANKEN]
Luft- und Raumfahrt (ISSN 0173-6264), vol. 8, 2nd Quarter, 1987, p. 45, 46, 48, 49. In German.

The nonstop circumnavigation of the globe by the Voyager aircraft with pilots Rutan and Yeager is discussed. The constructional aspects of the aircraft that enabled it to achieve its objective are reviewed. The main problems that occurred during the flight are described, and the ways they were overcome are shown. C.D.

N87-28500# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ACTA AERONAUTICA ET ASTRONAUTICA SINICA (SELECTED ARTICLES)
17 Jun. 1987 73 p Transl. into ENGLISH from Hangkong Xuebao (China), v. 7, no. 4, Aug. 1986 p 325-353
(AD-A182447; FTD-ID(RS)T-0134-87) Avail: NTIS HC A04/MF A01 CSCL 01B

Articles are translated from a Chinese journal of aeronautics and astronautics. Some selected article titles are: A Study of the Rotor Wake in Nap-Of-The-Earth; Study of the Separation Criterion for Steady 3-Dimensional Viscous Flows; Determination of Optimal Position of Actuators for Flexible Flight Vehicles; and Numerical Simulation of a Flexible Aircraft Taking Off and Landing on Uneven Runway. GRA

N87-28501*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
VORTEX-SCALAR ELEMENT CALCULATIONS OF A DIFFUSION FLAME STABILIZED ON A PLANE MIXING LAYER
AHMED F. GHONIEM (Massachusetts Inst. of Tech., Cambridge.) and PEYMAN GIVI Aug. 1987 26 p Previously announced in IAA as A87-22499
(Contract AF-AFOSR-0356-84; NSF CPE-84-0481)
(NASA-TM-100133; E-3683; NAS 1.15:100133; ICOMP-87-4)
Avail: NTIS HC A03/MF A01 CSCL 01A

The vortex-scalar element method, a scheme which utilizes vortex elements to discretize the region of high vorticity and scalar elements to represent species or temperature fields, is utilized in the numerical simulations of a two-dimensional reacting mixing layer. Computations are performed for a diffusion flame at high Reynolds and Peclet numbers without resorting to turbulence models. In the nonreacting flow, the mean and fluctuation profiles of a conserved scalar show good agreement with experimental measurements. Results for the reacting flow indicate that for temperature independent kinetics, the chemical reaction begins immediately downstream of the splitter plate where mixing starts. Results for the reacting flow with Arrhenius kinetics show an ignition delay, which depends on reactant temperature, before significant chemical reaction occurs. Harmonic forcing changes the structure of the layer, and concomitantly the rates of mixing and reaction, in accordance with experimental results. Strong stretch within the braids in the nonequilibrium kinetics case causes local flame quenching due to the temperature drop associated with the large convective fluxes. Author

N87-28502*# McDonnell-Douglas Corp., Long Beach, Calif.
DEVELOPMENT OF LAMINAR FLOW CONTROL WING SURFACE POROUS STRUCTURE Final Report
M. KLOTZSCHE, W. PEARCE, C. ANDERSON, J. THELANDER, W. BORONOW, F. GALLIMORE, W. BROWN, T. MATSUO, J. CHRISTENSEN, and G. PRIMAVERA Jul. 1984 104 p
(Contract NAS1-17506)
(NASA-CR-172424; NAS 1.26:172424) Avail: NTIS HC A06/MF A01 CSCL 01B

It was concluded that the chordwise air collection method, which actually combines chordwise and spanwise air collection, is the best of the designs conceived up to this time for full chord laminar flow control (LFC). Its shallower ducting improved structural efficiency of the main wing box resulting in a reduction in wing weight, and it provided continuous support of the chordwise panel joints, better matching of suction and clearing airflow requirements, and simplified duct to suction source minifolding. Laminar flow control on both the upper and lower surfaces was previously reduced to LFC suction on the upper surface only, back to 85 percent chord. The study concludes that, in addition to reduced wing area and other practical advantages, this system would be lighter because of the increase in effective structural wing thickness. Author

N87-29404# Washington Univ., Seattle. Dept. of Civil Engineering.
GENERAL AVIATION AIRCRAFT UTILIZATION IN THE CONSTRUCTION INDUSTRY M.S. Thesis
GARY W. FEMLING 1987 144 p
(AD-A183155) Avail: NTIS HC A07/MF A01 CSCL 05C

This research revealed that general aviation (GA) aircraft are a useful tool in the construction industry. Many construction companies employ aircraft in the performance of their daily operations and business. The following uses, in order of frequency of reported use, were: executive mobility, site investigation, personnel transport, parts and equipment expediting, photo and observation platform, and heavy lift operations. Of these, the first five fall generally in the construction support function while the last is the only direct construction operational use identified for GA aircraft. The type of projects for which aircraft are most often reported being used includes highway, dam and heavy earthwork projects. The predominant type of aircraft being used was the multi-engine airplane followed in frequency by the single-engine airplane and then the helicopter. GRA

N87-29405# Logistics Management Inst., Bethesda, Md.
PROTOTYPE AIRCRAFT SUSTAINABILITY MODEL
F. M. SLAY and RANDALL M. KING Mar. 1987 44 p
(Contract MDA903-85-C-0139)
(AD-A183183; LMI-AF601R2) Avail: NTIS HC A03/MF A01 CSCL 01C

This report describes the mathematical algorithms of a prototype version of the Aircraft Sustainability Model (ASM), a model designed to relate U.S. Air Force funding for reparable spares to aircraft sustainability measures. The ASM is a multi-echelon, multi-indenture inventory model that is unique in its portrayal of the transient effects resulting from a dynamic demand environment. Furthermore, the ASM is unique in its ability to simultaneously optimize spare requirements for multiple days of a conflict scenario. GRA

N87-29406# Federal Aviation Administration, Washington, D.C. Office of Management Systems.
CENSUS OF US CIVIL AIRCRAFT, CALENDAR YEAR 1986 Annual Report
31 Dec. 1986 316 p
(AD-A183423) Avail: NTIS HC A14/MF A01 CSCL 01C

This annual publication includes statistical data on the registered civil fleet, air carrier aircraft, and general aviation aircraft (both registered and active), detailed reports for general aviation aircraft by owner's state and county, and registered aircraft by make and model. GRA

N87-29407# Federal Aviation Administration, Washington, D.C. Office of Management Systems.
FAA (FEDERAL AVIATION ADMINISTRATION) AIR TRAFFIC ACTIVITY FY 1986 Statistical Report, 1 Oct. 1985 - 30 Sep. 1986
NANCY TREMBLEY 30 Sep. 1986 230 p
(AD-A183624) Avail: NTIS HC A11/MF A01 CSCL 01E

This report furnishes terminal and enroute air traffic activity information of the National Airspace System. The data have been reported by the FAA-operated Airport Traffic Control Towers (ATCTs), Air Route Traffic Control Centers (ARTCCs), Flight Service Stations (FSSs), International Flight Service Stations (IFSSs), Approach Control Facilities, and FAA contract-operated control towers. GRA

02

AERODYNAMICS

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

A87-50876
CALCULATION OF THE AERODYNAMIC COEFFICIENTS OF AIRCRAFT ON A COMPUTER WITH ALLOWANCE FOR PHYSICOCHEMICAL REACTIONS [RASCHET NA EVM AERODINAMICHESKIKH KOEFFITSIENTOV LETATEL'NYKH APPARATOV S UCHETOM FIZIKOKHIMICHESKIKH REAKTSII]
A. M. ANTONOV, G. G. SKIBA (Kievskii Gosudarstvennyi Universitet, Kiev, Ukrainian SSR), and A. N. TSAR'KOV Vychislitel'naia i Prikladnaia Matematika (ISSN 0321-4117), no. 59, 1986, p. 43-51. In Russian. refs

The method of aerodynamic equivalency is extended to aircraft of arbitrary cross section, with allowance made for physicochemical transformations. Calculation results are presented for traditional aerodynamic shapes of the blunted cone type for various Mach numbers, angles of attack, and flight altitudes. Different methods are compared in terms of accuracy, algorithm simplicity, and computation efficiency. The efficiency of the method presented here is demonstrated by using it to calculate the aerodynamic characteristics of a body with a square cross section. V.L.

A87-50880
FLOW OF A MONOATOMIC RAREFIED GAS AROUND A ROTATING CIRCULAR CYLINDER [OBTEKANIE KRUGOVOGO VRASHCHAIUSHCHEGOSIA TSILINDRA POTOKOM ODNOATOMNOGO RAZREZHENNOGO GAZA]
M. I. GRADOBOEV and V. A. RYKOV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669), vol. 27, June 1987, p. 898-904. In Russian.

A numerical scheme for solving kinetic equations in polar coordinates with a variable step along the radius is proposed. The numerical approach is then used to analyze flow of a monoatomic rarefied gas around a rotating circular cylinder; the characteristic structure of the flow lines for the case of supersonic flow around the cylinder is determined. Calculations of the Magnus force, which decreases with decreasing Knudsen number, are presented. V.L.

A87-50890
FORCED OSCILLATIONS IN A BOUNDARY LAYER AT FREQUENCIES CLOSE TO THE UPPER BRANCH OF THE NEUTRAL CURVE [O VYNUZHDENNYKH KOLEBANIIAKH V POGRANICHNOM SLOE NA CHASTOTAKH, BLIZKIKH K VERKHNEI VETVI NEITRAL'NOI KRIVOI]
V. I. ZHUK Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 51, May-June 1987, p. 417-424. In Russian. refs

The paper is concerned with perturbations introduced into a boundary layer of an incompressible fluid by a harmonic oscillator in the form of a moving section of the surface area. The Reynolds number is assumed to be high, and the oscillation frequency is assumed to be of the order of the asymptotic form of the upper branch of the neutral stability curve. For small oscillator amplitudes, the system of equations for the perturbations is linearized and solved by the Fourier method; the amplitude of the Tollmien-Schlichting wave is determined. In the case where the oscillator frequency exceeds the neutral value on the upper branch of the neutral stability curve for a given Reynolds number, the amplitude of the Tollmien-Schlichting wave is attenuated. For frequencies below the neutral value, the wave amplidute increases exponentially downstream. V.L.

A87-50972
CONTROL OF THE INTENSITY OF CONVECTIVE HEAT TRANSFER IN A LAVAL NOZZLE UNDER CONDITIONS OF TURBULENT FLOW AND IN THE PRESENCE OF LOCAL SEPARATION ZONES [UPRAVLENIE VELICHINOI KONVEKTIVNOGO TEPLOOBMENA V SOPLE LAVALIA PRI TURBULENTNOM TECHENII I NALICHII LOKAL'NYKH ZON OTRYVA]
E. G. ZAULICHNYI and V. M. TROFIMOV PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), May-June 1987, p. 110-115. In Russian. refs

The pressure and heat transfer coefficients on the walls of a cavern with a step in the direction opposite to the flow direction in the supersonic section of a Laval nozzle are investigated experimentally. The effect of changes in the shape of the cavern on the flow and heat transfer characteristics is examined. Details of the experimental procedure and results are presented. V.L.

A87-51007
A THREE-DIMENSIONAL BOUNDARY LAYER ON BLUNT BODIES WITH A POROUS SURFACE AT ANGLES OF ATTACK AND SIDESLIP [PROSTRANSTVENNYI POGRANICHNYI SLOI NA ZATUPLENNYKH TELAKH S PRONITSAEMOI POVERKHNOST'IU, OBTEKAEMYKH POD UGLAMI ATAKI I SKOL'ZHENIIA]
A. I. BORODIN and S. V. PEIGIN (Tomskii Gosudarstvennyi Universitet, Tomsk, USSR) Teplofizika Vysokikh Temperatur (ISSN 0040-3644), vol. 25, May-June 1987, p. 509-516. In Russian. refs

The paper is concerned with hypersonic flow of a homogeneous compressible gas in a three-dimensional laminar boundary layer on blunt bodies with a porous surface at angles of attack and sideslip. An efficient numerical method with a high order of approximation with respect to the transverse coordinate is used to calculate the equations of the three-dimensional boundary layer for the case where there are no planes of symmetry in the flow. The effects of the body surface temperature, injection parameter, and angles of attack and sideslip on the principal flow characteristics are determined. V.L.

A87-51221
NEAR WAKE OF AN UNSTEADY SYMMETRIC AIRFOIL
S.-H. CHEN and C.-M. HO (Southern California, University, Los Angeles, CA) Journal of Fluids and Structures (ISSN 0889-9746), vol. 1, April 1987, p. 151-164. refs
(Contract F49620-85-C-0080)

The near wake properties and the Kutta condition of an airfoil in plunging motion are examined in this paper. The plunging airfoil had many operating parameters, e.g. reduced frequency, oscillating amplitude and angle of attack. The velocity field near the trailing edge was found to be strongly affected by the operating condition of the airfoil. In inviscid analytical or numerical approaches, it is necessary to require that the rear stagnation streamline leaves the airfoil from the sharp trailing edge, so that the solution is unique. This is the well known Kutta condition. For an airfoil in unsteady motion, the Kutta condition is not as obvious as in the steady case and thus becomes a complicated and interesting problem. In this paper, the unsteady Kutta condition was studied experimentally, in terms of both the trailing edge loading and the rear stagnation streamline. Author

A87-51454
DYNAMIC STALL AROUND AN AIRFOIL AT HIGH REYNOLDS NUMBERS - A COMPARISON BETWEEN NUMERICAL RESULTS AND EXPERIMENTAL VISUALIZATION [SUR LE DECOLLEMENT INSTATIONNAIRE AUTOUR D'UN PROFIL A GRANDS NOMBRES DE REYNOLDS - UNE COMPARAISON CALCUL EXPERIENCE]
LAURE MANE, HENRI WERLE (ONERA, Chatillon-sous-Bagneux, France), and TA PHUOC LOC (CNRS, Laboratoire d'Informatique pour la Mecanique et les Sciences de l'Ingenieur, Orsay, France) Academie des Sciences (Paris), Comptes Rendus, Serie II - Mecanique, Physique, Chimie, Sciences de l'Univers, Sciences de la Terre (ISSN 0249-6305), vol. 305, no. 4, June 28, 1987, p. 229-232. In French. refs

Details of unsteady separated viscous incompressible flow around the NACA 0012 airfoil are presented for different Reynolds numbers and incidences. Numerical results are obtained by solving unsteady Navier Stokes equations. A parallel algorithm has been performed. It is based on a subdomain decomposition method coupled with the alternating direction implicit technique. Experimental visualizations are realized in the ONERA hydrodynamic tunnel. The comparison between numerical results and experimental visualization is found satisfactory before the appearance of the three-dimensional effects. Author

A87-51473
MODIFIED CHARACTERISTIC METHOD FOR CALCULATION OF SUPERSONIC S2 FLOW FIELD IN COMPRESSOR
TAO BO and PING-CHENG SHEN (Shanghai Institute of Mechanical Engineering, People's Republic of China) International Journal of Turbo and Jet-Engines (ISSN 0334-0082), vol. 3, no. 2-3, 1986, p. 223-229. refs

Due to the irregular grids and complex boundary conditions in turbomachines, difficulties remain in flow field calculations for the case of a highly loaded supersonic or transonic compressor. Attention is presently given to a simpler and more practical method of characteristics which adopts reverse directional differentials for solving the supersonic S(2) flow field in compressors of this type. Advantage is taken of the predetermined, regular grids in the differential method, in order to overcome difficulties caused by irregular grids in the more conventional method of characteristics. O.C.

A87-51651
NUMERICAL MODELING IN AEROHYDRODYNAMICS [CHISLENNOE MODELIROVANIE V AEROGIDRODINAMIKE]
G. G. CHERNYI, ED. Moscow, Izdatel'stvo Nauka, 1986, 264 p. In Russian. For individual items see A87-51652 to A87-51672.

Papers are presented on such topics as the numerical modeling of high-velocity impact by the method of large particles in the Vega project involving the exploration of Comet Halley; efficient numerical methods for solving the Navier-Stokes equations; closed models of turbulent jets; numerical modeling of supersonic multiphase flows; the numerical calculation of solar-wind flow past the magnetopause; and the calculation of the aerodynamic characteristics of bodies of complex shape in transition flow. Consideration is also given to the internal-wave field around a body moving in an inhomogeneous medium; computational errors of difference schemes for calculating discontinuous solutions; the characteristics of separated flow past a delta wing; three-dimensional supersonic flow past cone-like bodies with a separated shock wave; and the profiling of a lifting convex wing by a hodograph method. B.J.

A87-51653
THREE-DIMENSIONAL FLOW AROUND AND RADIATIVE HEATING OF BLUNT BODIES [TREKHMERNOE OBTEKANIE I RADIATSIONNYI NAGREV ZATUPLENNYKH TEL]
N. A. ANFIMOV, A. N. RUMYNSKII, and V. N. FOMIN IN: Numerical modeling in aerohydrodynamics . Moscow, Izdatel'stvo Nauka, 1986, p. 18-27. In Russian. refs

Radiative heat transfer in a shock layer in the case of three-dimensional hypersonic flow past blunt bodies is studied theoretically with reference to the flight of hypersonic vehicles in planetary atmospheres. The gas is assumed to be non-heat-conducting and selectively emitting and absorbing. A nonstationary grid method and the method of large particles are used to calculate the flow field. The radiative transfer is examined in a three-dimensional formulation and in the framework of a model of a locally one-dimensional plane layer. Calculation results are presented on the distribution of radiative-heat-flux components on the surfaces of various blunt bodies. B.J.

A87-51654
THE APPLICATION OF THE METHOD OF STREAMS TO THE NUMERICAL MODELING OF UNSTEADY AEROHYDRODYNAMICS PROBLEMS [PRIMENENIE METODA POTOKOV DLIA CHISLENNOGO MODELIROVANIIA NESTATSIONARNYKH ZADACH AEROGIDRODINAMIKE]
A. V. BABAKOV IN: Numerical modeling in aerohydrodynamics . Moscow, Izdatel'stvo Nauka, 1986, p. 28-36. In Russian. refs

The use of the method of streams (Belotserkovskii and Severinov, 1973) for the numerical analysis of unsteady dynamic problems of a compressible gas and an incompressible fluid is examined with reference to the determination of the aerodynamic characteristics of flight bodies. The vortex street behind a circular cylinder is calculated using Euler's model of a compressible gas; and a modified method is developed for the analysis of unsteady dynamic problems of a viscous stratified fluid. The method is extended to account for turbulence by means of a semiempirical k-epsilon model. Numerical results are compared with available experimental data. B.J.

A87-51659
NUMERICAL MODELING OF SUPERSONIC MULIPHASE FLOWS [CHISLENNOE MODELIROVANIE SVERKHZVUKOVYKH MNOGOFAZNYKH TECHENII]
IU. P. GOLOVACHEV and IU. P. LUN'KIN IN: Numerical modeling in aerohydrodynamics . Moscow, Izdatel'stvo Nauka, 1986, p. 72-80. In Russian. refs

The paper examines a number of dynamic problems of two-phase media using various models of gas/solid particle interaction. A complex approach is used which combines phenomenological and kinetic models, and makes it possible to perform analyses in a wide range of state parameters of the suspension (from frozen to equilibrium). The specific problems addressed are: (1) supersonic flow past a gas with solid particles and (2) the interaction between a shock wave and a cloud of solid particles. B.J.

A87-51663
INTERACTION OF BODIES WITH A NONUNIFORM SUPERSONIC FLOW [VZAIMODEISTVIE TEL S NEODNORODNYM SVERKHZVUKOVYM POTOKOM]
V. F. KAMENETSKII and L. I. TURCHAK IN: Numerical modeling in aerohydrodynamics . Moscow, Izdatel'stvo Nauka, 1986, p. 104-115. In Russian. refs

The grid-characteristic scheme (a difference scheme based on characteristic relationships) is applied to the numerical solution of problems of supersonic aerodynamics. Attention is given to flow past bodies of variable shape as well as to the effect of body-velocity or flow-velocity changes on the flow pattern. Wake flows past bodies and two-dimensional separated flows past steps are modeled by introducing a nonuniformity into the oncoming flow. The motion of a body at supersonic velocity in an ideal gas in the presence of various types of discontinuities is examined. Particular consideration is given to transition flows during the interaction between a body and a plane shock wave and during the motion of a body in a point-explosion region. B.J.

A87-51664
CALCULATION OF THE AERODYNAMIC CHARACTERISTICS OF BODIES OF COMPLEX SHAPE IN TRANSITION FLOW [RASCHET AERODINAMICHESKIKH KHARAKTERISTIK TEL SLOZHNOI FORMY V PROMEZHUTOCHNOI OBLASTI]
V. M. KOTOV, E. N. LYCHKIN, A. G. RESHETIN, and A. N. SHCHELKONOGOV IN: Numerical modeling in aerohydrodynamics . Moscow, Izdatel'stvo Nauka, 1986, p. 115-124. In Russian. refs

An approximate method is proposed for calculating the aerodynamic characteristics of bodies (e.g., supersonic flight vehicles) in transition flow between continuum and free-molecular regimes. Supersonic flows past diferent kinds of bodies (a sphere, a blunt cone, a cylinder, and a plate) are calculated numerically on the basis of the complete Navier-Stokes equations. Dependences of the surface pressure and friction coefficients on the similarity parameters used in the approximate method are obtained. A comparison is made with experimental data and other calculations. B.J.

A87-51669
CHARACTERISTICS OF SEPARATED FLOW PAST A DELTA WING [O NEKOTORYKH OSOBENNOSTIAKH OTRYVNOGO OBTEKANIIA TREUGOL'NOGO KRYLA]
G. M. RIABINKOV, A. D. KHON'KIN, A. F. KISELEV, and P. P. VOROTNIKOV IN: Numerical modeling in aerohydrodynamics . Moscow, Izdatel'stvo Nauka, 1986, p. 202-211. In Russian. refs

Experimental results are presented on distributions of pressure, friction drag, and direction of limiting streamlines on the leeward side of a delta half-wing of small aspect ratio at low subsonic flow velocities and relatively large angles of attack. The study is based on an improved Stanton-nozzle technique. B.J.

A87-51671
CALCULATION OF THREE-DIMENSIONAL SUPERSONIC FLOW PAST CONE-LIKE BODIES WITH A SEPARATED SHOCK WAVE [O RASCHETE PROSTRANSTVENNOGO SVERKHZVUKOVOGO OBTEKANIIA O KONUSOVIDNYKH TEL S OTOSHEDSHEI UDARNOI VOLNOI]
P. I. CHUSHKIN IN: Numerical modeling in aerohydrodynamics . Moscow, Izdatel'stvo Nauka, 1986, p. 219-230. In Russian. refs

A numerical solution is presented to the problem of three-dimensional supersonic flow past cone-shaped bodies with an elliptical cross section and a small bluntness at the apex. Mixed flow behind a separated bow shock is calculated by the method of integral relations in special variables, taking into account the flow behavior at the apex of the body. Calculation examples are presented for cone-like bodies with different relative thickness for different angles of attack. B.J.

A87-51672
PROFILING OF A LIFTING CONVEX WING BY A HODOGRAPH METHOD [PROFILIROVANIE NESUSHCHEGO VYPUKLOGO KRYLA METODOM GODOGRAFA]
E. G. SHIFRIN IN: Numerical modeling in aerohydrodynamics . Moscow, Izdatel'stvo Nauka, 1986, p. 246-255. In Russian. refs

Consideration is given to the problem of profiling a lifting convex wing with a sharp trailing edge in incompressible-fluid flow at a given velocity. A two-sheet definition domain in the hodograph plane is limited by a prescribed curve with specific geometric properties. The existence, uniqueness, and physical attainability of solutions close to the prescribed ones are demonstrated on the basis of a theorem concerning an implicit operator function and a variational analysis of the problem. B.J.

A87-51809#
THREE-DIMENSIONAL CALCULATION IN A HIGH SUBSONIC AXIAL COMPRESSOR ROTOR AND ITS COMPARED WITH L2F VELOCITY MEASUREMENT
QINGHUAN WANG, JIANAN WANG, ZONGYI FANG, and CHUNG-HUA WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 8, May 1987, p. 119-124. In Chinese, with abstract in English. refs

As a part of a basic research program to increase the understanding of the internal flow in high subsonic and transonic flow compressors and to improve the design and analysis calculation methods, a two-focus laser velocimeter has been employed in measuring the velocity and the flow angles in a compressor rotor running at peak-efficiency points of several partial design speeds. Three-dimensional flow calculation has also been undertaken for these off-design conditions. The outlet velocity measured by the velocimeter, outlet stagnation pressure measured by pitot tubes, and isentropic rotor efficiency measured by phase-difference torquemeter are used as input values to the theoretical calculation. The variation of flow on the S(2m) surface and on the S1 surfaces, as measured by the velocimeter, agrees reasonably well with the calculated variation. This indicates that the three-dimensional calculation method used can give a good picture of the internal flow in the compressor rotor. Author

A87-51811#
NUMERICAL SOLUTION OF TRANSONIC STREAM FUNCTION EQUATION ON S1 STREAM SURFACE
YAONAN HUA and WENQUAN WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 8, May 1987, p. 130-132. In Chinese, with abstract in English. refs

With respect to nonorthogonal curvilinear coordinates, the stream-function equation governing transonic flow on an S1 surface was established. Using the artificial-compressibility method, the discretization of the partial differential equation was carried out by use of the standard central-difference formula. The set of linear algebraic equations obtained is solved by means of the direct matrix method. In order to overcome the nonuniqueness of density in transonic flow in the stream-function method, the velocities are first obtained by integrating the momentum equation, and then the densities are determined. Application of this method to some transonic cascade flows with supersonic or subsonic inlet velocity shows that the solution obtained is in fair agreement with experimental data. Author

A87-51813#
AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF INLET FLOW DISTORTION ON COMPRESSOR PERFORMANCE
CHUNCAI LAI, PEIYING SHEN, and LIHUA ZHOU (Gas Turbine Establishment, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 8, May 1987, p. 136-139. In Chinese, with abstract in English.

In this paper, an experimental investigation of the effect of inlet pressure distortion on compressor performance is described, and the main test results are analyzed and compared. The experiment is conducted on a three-stage supersonic axial compressor, using a rotatory distortion generator with which fewer probes are required for measuring the conditions at the compressor inlet and outlet accurately. The rotatory distortion generator has been found to be a desirable device. Author

A87-52056
MANIPULATED TURBULENCE STRUCTURE IN FLIGHT
A. BERTELRUD (Kungliga Tekniska Hogskolan, Stockholm; Flygtekniska Forsokanstalten, Bromma, Sweden) IN: Advances in turbulence; Proceedings of the First European Turbulence Conference, Ecully, France, July 1-4, 1986 . Berlin and New York, Springer-Verlag, 1987, p. 524-532. refs

An experimental investigation of drag reduction on airplanes in flight by the use of thin transverse ribbons (or Large Eddy Breakup, LEBU, devices) to manipulate turbulent boundary layers is reported. Time-average as well as turbulence information was gathered which indicates a drastic reduction in vertical convective velocity. The results are in strong agreement with laboratory tests at lower Reynolds numbers under idealized conditions. LEBU device optimization in the light of these results is discussed. C.D.

A87-52251*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
WIND TUNNEL PERFORMANCE RESULTS OF AN AEROELASTICALLY SCALED 2/9 MODEL OF THE PTA FLIGHT TEST PROP-FAN
GEORGE L. STEFKO, GARY G. PODBOY (NASA, Lewis Research Center, Cleveland, OH), and GAYLE E. ROSE (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 23rd, San Diego, CA, June 29-July 2, 1987. 49 p. Previously announced in STAR as N87-25294. refs
(AIAA PAPER 87-1893)

High speed wind tunnel aerodynamic performance tests of the SR-7A advanced prop-fan have been completed in support of the Prop-Fan Test Assessment (PTA) flight test program. The test showed that the SR-7A model performed aerodynamically very well. At the cruise design condition, the SR-7A prop fan had a high measured net efficiency of 79.3 percent. R.J.F.

A87-52291*# Vigyan Research Associates, Inc., Hampton, Va.
VISCOUS SHOCK-LAYER ANALYSIS OF HYPERSONIC FLOWS OVER LONG SLENDER BODIES
R. N. GUPTA, K. P. LEE (Vigyan Research Associates, Inc., Hampton, VA), J. N. MOSS, E. V. ZOBY (NASA, Langley Research Center, Hampton, VA), and S. N. TIWARI (Old Dominion University, Norfolk, VA) AIAA, Atmospheric Flight Mechanics Conference, Monterey, CA, Aug. 17-19, 1987. 16 p. refs
(AIAA PAPER 87-2487)

Numerical solutions from the time-steady viscous shock-layer equations are presented for the hypersonic laminar and turbulent flow of a perfect gas over long slender bodies. These results are obtained from a spatial-marching implicit finite-difference technique. Detailed comparisons have been made with other predictions and experimental data to assess the accuracy of the present numerical technique, especially for slender-body flows. Results from the present method show that coupling the normal momentum and continuity equations and the use of the Vigneron pressure condition in the subsonic nose region give quite accurate and stable results. These results compare (with some exceptions) favorably with those obtained using PNS and other VSL methods. Author

A87-52304
MOVING SHOCK WAVES IN TRANSONIC FLOWS
W. FRANK (Karlsruhe, Universitaet, West Germany) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 25-35. refs

Two types of unsteady shock motions in a transonic flow field are studied: the detachment and the upstream motion of a bow shock from the tip of a wedge profile which is pitched suddenly or periodically, and the unsteady shock motion in different supersonic nozzles due to an energy addition. The realization of the transonic flow fields in a wind-tunnel is described, in addition to the visualization and the registration of the unsteady flow phenomena. The experimental results are compared with theoretical considerations. Author

A87-52306
A TECHNIQUE OF HOLOGRAPHIC VISUALIZATION TO FLOW FIELDS OF A MODEL WITH VARIABLE ANGLES OF ATTACK
XINGYUAN WU (China Aerodynamic Research and Development Center, Mianyang, People's Republic of China) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 57-60.

A technique involving improvement of the holder is proposed to make possible holographic visualization of the flow field of a model with several angles of attack in a hypersonic wind tunnel. The technique employs a unique drum-holographic-holder and dual hologram interferometry. It is suggested that the present method can reduce the blow-down operation time and expense, while increasing the working efficiency by a factor of five. The method is validated by testing in a hypersonic wind tunnel for various angles of attack. R.R.

A87-52322
VISUALIZATION OF SHOCK WAVE AND STREAMLINE AROUND HYPERSONIC VEHICLE BY USING ELECTRICAL DISCHARGE
MASATOMI NISHIO and TAKEYOSHI KIMURA (Kobe University, Japan) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 185-190.

The electrical discharge method is used to visualize both cross sectional shock shapes around semicone bodies with a delta wing, and streamlines over a wedge and a circular cylinder, shapes that are typical of hypervelocity vehicles. In the present method, the intersection of the shock wave and the electrical discharge is visualized by the difference of the radiation intensities from the two parts of the discharge, one in the freestream and the other in the shock layer. Results show that, when the semiapex angle of the delta wing is small enough, a single shock pattern appears; when its angle becomes sufficiently large, a double shock pattern including the body shock and wing shock occurs. Good agreement is found between visualized and theoretical streamlines around a wedge. R.R.

A87-52324
APPLICATIONS OF THE TITANIUM TETRACHLORIDE METHOD FOR FLOW VISUALIZATION IN AERODYNAMIC TESTING
F. FINAISH, P. FREYMUTH, and W. BANK (Colorado, University, Boulder) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 197-202.
(Contract AF-AFOSR-81-0037)

The technique of direct injection of liquid titanium tetrachloride used by Freymuth (1985) for airflow visualization is extended to the visualization of steady and unsteady flow histories over a wide range of geometries. The steady flow example is the visualization of the two-dimensional vortex street behind a circular cylinder. The accelerating flow examples include a smoke-wire visualization, three-dimensional vortex patterns in accelerating flow, and the accelerating flow near the tip of swept backward and swept forward wings. Impulsive flow starting from rest over an airfoil is also considered. R.R.

A87-52348* Notre Dame Univ., Ind.
VISUALIZATION OF THE LAMINAR SEPARATION BUBBLE ON AIRFOILS AT LOW REYNOLDS NUMBERS
T. J. MUELLER, M. BRENDEL, and G. S. SCHMIDT (Notre Dame, University, IN) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 359-364.
(Contract NSG-1419; N00014-83-K-0239)

The use of the smoke tube and titanium tetrachloride techniques in the study of low Reynolds number flow about two different airfoils is presented. Emphasis is placed on the problems of determining the characteristics of laminar separation bubbles occurring on the Wortmann FX63-137 airfoil and the NACA

66(3)-018 airfoil. Comparisons are made with the hot-wire technique and the use of kerosene vapor. C.D.

A87-52355
PARAMETRIC EXPLORATION OF UNSTEADY WING TIP VORTICES
P. FREYMUTH, F. FINAISH, and W. BANK (Colorado, University, Boulder) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 419-424.

The titanium tetrachloride flow visualization technique is presently used in conjunction with motion picture filming to examine the unsteady wing tip vortex characteristics of wind tunnel wing models having different tip geometries. The wingtip geometries in question were rectangular, semicircular oblique, and semicircular oblique in reverse; the angle-of-attack in all cases was 40 deg. It is found that while the vortex patterns initially follow the shape of the tip, the global vortex patterns of this variety of tips subsequently resemble each other. The influence of Re number is similar to that for airfoil starting vortices. O.C.

A87-52357* Notre Dame Univ., Ind.
VISUALIZATION OF VORTEX BREAKDOWN ON A DELTA WING
R. C. NELSON, F. M. PAYNE, and T. T. NG (Notre Dame, University, IN) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 431-436. refs
(Contract NAG2-258)

An account is given of the results obtained by a flow visualization study of the roll-up, breakdown position, and spiral- or bubble-type breakdown characteristics of an 85-deg sweep, flat-plate delta wing at large angles-of-attack. The two different breakdown modes were noted to metamorphose into each other, with the bubble-type phenomenon appearing to prefer a more upstream location relative to the spiral mode. In those instances when the breakdown location was changing, the breakdown took the form of a bubble when moving forward, and spiral when moving aft. O.C.

A87-52359
STUDY OF THE FLOW VISUALIZATION ON THE ROTARY WING WITH LOW ASPECT RATIO
SHIGERU SAITO (National Aerospace Laboratory, Chofu, Japan), TADAHARU WATANUKI, YOSHIAKI TAMURA, KOJIRO SUZUKI, KOHICHI SAGAWA (Tokyo, University, Japan) et al. IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 443-448. refs

Flow pattern on a rotary wing with low aspect ratio is investigated in the wind tunnel experimentally. The Goettingen-type low speed wind tunnel with 1.5-m diameter is used to simulate the takeoff and landing operating regimes. Four means (oil flow, china-clay, tuft, minituft) of flow pattern visualization on the rotary wing are applied and compared to each other. Photographs are taken to record the phenomena. To analyze the flow pattern on the blade, boundary layer calculations are carried out by the integral method. External flow around a blade is calculated by means of the vortex lattice method. To judge the separation line on the rotary blade, the limiting streamline is used. Comparison between calculations and experiments shows good coincidence. Author

A87-52360
SUPERSONIC VORTEX RINGS - VISUALIZATION TECHNIQUES
JOHN P. BAIRD, DUNCAN CAMPBELL-WILSON, and SUDHIR GAI (New South Wales, University; Australian Defence Force Academy, Campbell, Australia) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 451-453.

Differential interferometry is used to investigate the complex flow phenomenon, considered by Baird (1968). The interferometer measures the vertical integrated density gradients, and the fringes are insensitive to the shock waves normal to the flow. The effect of certain flow features was suppressed in order to enhance the clarity in other areas.The main features of the flow, the toroidal shock vortex ring and the embedded shock structure, could be clearly visualized simultaneously with the present technique. R.R.

A87-52371
FLOW BEHIND A REARWARD FACING STEP IN HYPERSONIC HIGH ENTHALPY FLOW - SOME INTERFEROMETRIC STUDIES
J. P. BAIRD, S. L. GAI, and N. T. REYNOLDS (New South Wales, University; Australian Defence Force Academy, Campbell, Australia) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 549-553.

Two-dimensional hypersonic flow behind a rearward-facing step is characterized by strong expansion around the corner of the step; this influences the downstream separated region, causing a considerable growth of the shear layer that in turn affects heat transfer rates. Attention is presently given to the simple case of two-dimensional flow past a backstep under hypersonic, high enthalpy conditions. Emphasis is placed on Mach-Zehnder interferometry-based flow visualization, which can be facilitated through a digitization of the interferograms and the use of Fourier analysis to determine fringe positions. O.C.

A87-52386* Virginia Univ., Charlottesville.
FLOW VISUALIZATION STUDIES OF TRANSVERSE FUEL INJECTION PATTERNS IN A NONREACTING MACH 2 COMBUSTOR
J. C. MCDANIEL (Virginia, University, Charlottesville) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 747-752. refs
(Contract NAG1-373)

Planar visualization images are recorded of transverse jet mixing in a supersonic combustor flowfield, without chemical reaction, using laser-induced fluorescence from iodine molecules. Digital image processing and three-dimensional display enable complete representations of fuel penetration boundary and shock surfaces corresponding to several injection geometries and pressures. Author

A87-52878*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AEROTHERMODYNAMICS OF TRANSATMOSPHERIC VEHICLES
MICHAEL E. TAUBER, GENE P. MENEES (NASA, Ames Research Center, Moffett Field, CA), and HENRY G. ADELMAN (Eloret Institute, Sunnyvale, CA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 594-602. Previously cited in issue 18, p. 2607, Accession no. A86-39880. refs

A87-52882#
WAVE DRAG ANALYSIS OF REALISTIC FIGHTER AIRCRAFT USING A FULL-POTENTIAL METHOD
KENNETH B. WALKLEY and GREGORY E. SMITH (Dynamic Enginering, Inc., Newport News, VA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 623-628. Previously cited in issue 05, p. 586, Accession no. A87-17886. refs
(Contract AF TASK 0130-26)

A87-52883#
INVESTIGATION OF UNSTEADY SUBSONIC SPOILER AND FLAP AERODYNAMICS
M. COSTES, A. GRAVELLE, J. J. PHILIPPE (ONERA, Chatillon-sous-Bagneux, France), S. VOGEL (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany), and H. TRIEBSTEIN (DFVLR, Goettingen, West Germany) (ICAS, Congress, 15th, London, England, Sept. 7-12, 1986, Proceedings. Volume 2, p. 1243-1253) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 629-637. Previously cited in issue 24, p. 3533, Accession no. A86-49106.

A87-52884#
RAIN EFFECTS AT LOW REYNOLDS NUMBER
J. F. MARCHMAN, III (Virginia Polytechnic Institute and State University, Blacksburg), EDWARD A. ROBERTSON, and HOWARD T. EMSLEY Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 638-644. Previously cited in issue 08, p. 1035, Accession no. A87-22517. refs

A87-52885*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
INFLUENCE OF FOREBODY CROSS-SECTIONAL SHAPE ON WING VORTEX-BURST LOCATION
ROBERT M. HALL (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 645-652. Previously cited in issue 17, p. 2463, Accession no. A86-37845. refs

A87-52886#
LEADING- AND TRAILING-EDGE FLAPS ON A LOW REYNOLDS NUMBER AIRFOIL
M. L. PERRY and T. J. MUELLER (Notre Dame, University, IN) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 653-659. Previously cited in issue 17, p. 2461, Accession no. A86-37817. refs
(Contract N00014-83-K-0239)

A87-52888#
LIFT AND PITCHING MOMENT COEFFICIENT CHANGES FROM LOW-LEVEL FREESTREAM TURBULENCE
GEORGE D. CATALANO and CHARLES M. FREMAUX (Louisiana State University, Baton Rouge) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 666-668. refs

Experiments are carried out to investigate changes in the behavior of the lift and pitching moment coefficients for two different airfoils as a function of the freestream turbulent intensity. It is found that an increase in the freestream turbulent intensity from 0.6 to 1.8 percent results in a 15 percent decrease in the lift coefficient for the NACA-0012 and for the NASA LS (1)-0417 airfoils. The results of a prediction model for the lift coefficient variation are in agreement with experimental data. K.K.

A87-52889#
SOLUTION OF AERODYNAMIC INTEGRAL EQUATIONS WITHOUT MATRIX INVERSION
OMAR AMRANI AHMED (Stanford University, LA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 668, 669.

A new efficient method for the solution of aerodynamic integral equations is presented which utilizes scalar products. It was used to compute the pressure distribution around a nonsymmetric Joukowsky airfoil at a 5-deg angle of attack. It is noted that the present method can be implemented on a microcomputer or a programmable pocket calculator and applied to problems involving lifting line and surface theory. K.K.

A87-52890*# North Carolina State Univ., Raleigh.
UNSTEADY TRANSONIC FLOWS PAST AIRFOILS USING THE EULER EQUATIONS
GREGORY E. SMITH, H. A. HASSAN (North Carolina State University, Raleigh), and WOODROW WHITLOW, JR. (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 670-672. Previously cited in issue 17, p. 2460, Accession no. A86-37802. refs
(Contract NGT-34-002-800)

A87-53412#
PROCESSES IN TURBOMACHINERY: APPLICATIONS AND EXERCISES [PROCESE IN MASINI TERMICE CU PALETE: APLICATII SI PROBLEME]
VICTOR PIMSNER, CORNELIU BERBENTE, VIRGIL STANCIU, VALENTIN LUCA, DIMITRIE NEGULESCU et al. Bucuresti, Editura Tehnica, 1986, 384 p. In Romanian. refs

This book covers computational methods for one-, two-, and three-dimensional flows in turbomachines, with emphasis on their degree of precision and basic physical motions. Topics discussed include the supersonic isentropic two-dimensional expansion of perfect gases, shock waves in perfect gases, boundary layer problems, the characteristics of axial and radial multistage compressors, three-dimensional cascade flows, and cascade losses. Each chapter includes examples and a series of exercises for engineers and undergraduates. N.D.

A87-53520
A SUPERSONIC JET IN A CHAMBER WITH A DIAPHRAGM [SVERKHZVUKOVAIA STRUIA V KAMERE S DIAFRAGMOI]
B. A. BALANIN and O. S. ZELENKOV Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), April 1987, p. 43-46. In Russian.

The problem considered here concerns a supersonic jet issuing into a chamber with an abrupt cross-sectional expansion and with a diaphragm in its end wall. A transcendent equation is obtained which makes it possible to determine the dependence of the bottom pressure in the chamber on the full jet pressure. The results obtained are compared with experimental data. V.L.

A87-53522
SOLUTION OF THE VOLTERRA INTEGRAL EQUATION IN THE PROBLEM OF THE UNSTEADY MOTION OF A THIN WING [O RESHENII INTEGRAL'NOGO URAVNENIIA VOL'TERRA V ZADACHE NEUSTANOVIVSHEGOSIA DVIZHENIIA TONKOGO KRYLA]
B. A. ERSHOV Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), April 1987, p. 59-62. In Russian.

The unsteady motion of a thin wing in an incompressible flow (M less than 0.4) is investigated analytically. The problem is reduced to that of solving the Volterra integral equation of the first kind. A solution to the equation is obtained in the form of a series. The main vector and the main moment of the forces acting on the wing on the side of the flow are determined. V.L.

A87-53526
AN ANALYSIS OF THE APPROXIMATION OF THE AERODYNAMIC COEFFICIENTS OF THIN BODIES IN A RAREFIED GAS [ANALIZ APPROKSIMATSII AERODINAMICHESKIKH KOEFFITSIENTOV TONKIKH TEL V RAZREZHENNOM GAZE]
V. S. NARITSA Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), April 1987, p. 114-116. In Russian. refs

The approximation of the dependences of exchange coefficients on the local incidence angle is investigated using regression analysis. The analysis uses the results of a numerical study of the aerodynamic characteristics of a plate. The selected approximation contains three parameters to be determined experimentally. An analytical approximation of the dependence of these parameters on the Knudsen (Reynolds) number is proposed. V.L.

A87-53544
AEROGASDYNAMICS AND ITS DEVELOPMENT AT THE INSTITUTE OF THEORETICAL AND APPLIED MECHANICS OF THE SIBERIAN SECTION OF THE ACADEMY OF SCIENCES OF THE USSR [AEROGAZODINAMIKA I EE RAZVITIE V ITPM SO AN SSSR]
V. G. DULOV and V. M. FOMIN (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskie Nauki (ISSN 0002-3434), June 1987, p. 3-13. In Russian. refs

Developments in the field of aerogasdynamics for the past 30 years are reviewed with reference to the research carried out at the Institute of Theoretical and Applied Mechanics. The wind tunnel facilities of the Institute are briefly described, and results of some aerodynamic studies conducted by the Institute are discussed. These results cover the structure of three-dimensional supersonic gas flows in the interference region of intersecting surfaces; configurations of gasdynamic discontinuities; the structure of a three-dimensional boundary layer and its interaction with shock waves; and problems related to the properties of supersonic gas jets. Particular attention is given to mathematical modeling and the use of computers in aerogasdynamic research. V.L.

A87-53562
NUMERICAL AERODYNAMICS USING LARGE COMPUTERS [NUMERISCHE AERODYNAMIK MIT GROSSRECHENANLAGEN]
WILHELM KORDULLA, HERBERT OERTEL, and HELMUT SOBIECZKY (DFVLR, Institut fuer theoretische Stroemungsmechanik, Goettingen, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), June 1987, p. 1-6. In German.

Selected examples from aerodynamics and flow physics are used to demonstrate the use of the DFVLR Cray 1/S vector computer in these areas. The application areas considered include transition, transonic flow around blunt bodies, supersonic flow, and numerical optimization of a transonic airfoil wing. The relevant numerical processes used by the computer are reviewed, and future applications of the computer are considered. C.D.

A87-53563
CALCULATION OF FRICTIONLESS FLOW ABOUT AIRFOIL WINGS AND PROPELLERS BY NUMERICAL SOLUTION OF THE EULER EQUATIONS [BERECHNUNG DER REIBUNGSLOSEN STROEMUNG UM TRAGFLUEGEL UND PROPELLER DURCH DIE NUMERISCHE LOESUNG DER EULER-GLEICHUNGEN]
NORBERT KROLL (DFVLR, Institut fuer Entwurfsaerodynamik, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), June 1987, p. 6-10. In German. refs

The solution of the Euler equations on the Cray 1/S vector computer is addressed. The method of solution is briefly described, and some applications of the solution in the calculation of frictionless flow about airfoil wings and propellers are demonstrated. The prospects for this approach are briefly addressed. C.D.

A87-53574
THE FLOW FIELD IN THE SECOND THROAT REGION OF A WIND TUNNEL, COMPUTED BY AN EULER METHOD
H. W. STOCK and W. HAASE (Dornier GmbH, Friedrichshafen, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 11, Mar.-Apr. 1987, p. 106-116. Research sponsored by the Europaeischer Transsonischer Windkanal. refs

The effects of geometry parameters (center body length, shape, and high-speed diffusion sidewall divergence angle) and inlet flow conditions on the performance of a completely choked second throat are investigated. The flow in the second throat region of the European Transonic Wind Tunnel is studied using the Euler method. Two inlet velocity profiles are studied: a uniform inlet velocity and one that simulates the defect in velocity in the tunnel wall region due to reentry. Pressure and Mach number distributions on the tunnel wall, the center body, and the tunnel center line are presented and analyzed. It is determined that the optimum features for a second throat configuration are: (1) minimum total pressure losses, (2) minimum exit velocity nonuniformity, and (3) maximum static pressure ratio. Based on these requirements, a second high center body is proposed for a second throat configuration. I.F.

A87-53777#
VORTEX INFLUENCE ON OSCILLATING AIRFOILS AT HIGH ANGLE OF ATTACK
D. FAVIER, C. MARESCA, C. BARBI (Aix-Marseille II, Universite, Marseille, France), and A. CASTEX Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 424-432. Sponsorship: Service Technique des Programmes Aeronautiques. Previously cited in issue 24, p. 3535, Accession no. A86-49592. refs
(Contract STPA-84-95-005)

A87-53778*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PROSPECTS FOR DESTRUCTIVE SELF-INDUCED INTERACTIONS IN A VORTEX PAIR
VERNON J. ROSSOW (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 433-440. Previously cited in issue 17, p. 2462, Accession no. A86-37821. refs

A87-53784*# Kansas Univ., Lawrence.
EFFECT OF A ROUND AIRFOIL NOSE ON LEADING-EDGE SUCTION
C. EDWARD LAN and INGCHUNG SU (Kansas, University, Lawrence) Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 472-474. refs
(Contract NSG-1629)

Kulfan (1979) assumed that the angle of attack for initial vortex separation on a slender wing with rounded leading edges could be obtained by equating the leading-edge suction (LES) and nose drag coefficients. In the present study, this assumption is examined and is shown to predict reasonably well the initial angle of attack at which laminar separation occurs near the airfoil nose. However, the assumption is shown to be slightly less accurate for thick or cambered airfoils. Attainable LES estimated by Kulfan's method seemed to agree well with that obtained from an airfoil aerodynamics code and experimental data on a NACA 64A009 airfoil at M = 0.4 and Re = 0.86 x 10 to the 6th. B.J.

A87-54361
ON THE COMPUTATION OF TRANSONIC LEADING-EDGE VORTICES USING THE EULER EQUATIONS
ARTHUR RIZZI (Flygtekniska Forsoksanstalten, Bromma; Kungliga Tekniska Hogskolan, Stockholm, Sweden) and CHARLES J. PURCELL (ETA Systems, Inc., Saint Paul, MN) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 181, Aug. 1987, p. 163-195. refs

Two cases of transonic leading-edge vortex flow, flow at M 0.7 around a pure delta wing and flow at M 0.9 past a twisted cranked-and-cropped delta wing, are simulated numerically, and the results are compared under mesh refinement. In the case of the pure delta wing, the sequence converges to the classical steady vortex flow. In the case of the cranked delta wing, however, only a quasi-steady solution is reached, and the sequence of refined solutions does not converge to a laminar flow. The lack of mesh converges and the quasi-steady nature of the solution are attribued to the crank in the leading edge. V.L.

A87-54363
NUMERICAL SIMULATION OF COMPRESSIBLE HOMOGENEOUS FLOWS IN THE TURBULENT REGIME
T. PASSOT and A. POUQUET (Nice, Observatoire, France) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 181, Aug. 1987, p. 441-466. refs
(Contract CNRS-RCP-080702; CNRS-ATP-1227)

Two-dimensional homogeneous flows are investigated in the subsonic and supersonic regimes using direct numerical simulations. In the subsonic case and for the density fluctuations

of the order of the squared Mach number, the flow is shown to retain its incompressible character at all scales, with the acoustic level remaining low. In the supersonic case, the opposite occurs, with a strong domination of longitudinal modes, in particular in the small scales of the flow. The transition between the two flows occurs at an rms Mach number of 0.3. One of the important results of the study is the conclusion that shear turbulence may be produced from shocks. V.L.

A87-54364
A RECONSIDERATION OF THE THREE-SHOCK THEORY FOR A PSEUDO-STEADY MACH REFLECTION
G. BEN-DOR (Negev, University, Beersheba, Israel) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 181, Aug. 1987, p. 467-484. refs

The analytical solution of a pseudosteady Mach reflection was considered. It was found that the solution of the well-known perfect-gas conservation equations of a pseudosteady Mach reflection - the three-shock theory - failed to accurately predict the angles between the incident, reflected and Mach stem shock waves. The disagreement between theory and experiments was not settled even when real-gas effects were accounted for. However, the inclusion of real-gas effects did improve the analytical predictions. In order to improve the analytical model, the boundary layers developing on both sides of the slipstream were integrated into the analysis. Using these boundary layers, the displacement thickness as a function of distance along the slipstream from the triple point was calculated. The displacement thickness was then related to the angular displacement of the slipstream, as a function of that distance. Finally it was shown that the displacement, taken at a distance equivalent to the incident-shock-wave thickness, could be used to obtain computed results which agree with experimentally measured data. Author

N87-28503# Advanced Technologies and Testing Labs., Greensboro, N.C.
RADIATIVE AND CONVECTIVE HEAT TRANSFER OVER ABLATING COMPOSITE FLAT SURFACE IN HYPERSONIC FLOW REGIME Final Report, 1 Sep. 1986 - 1 Mar. 1987
D. Y. GOSWAMI 22 Apr. 1987 103 p
(Contract F49620-86-C-0118)
(AD-A182119; AFOSR-87-0818TR) Avail: NTIS HC A06/MF A01 CSCL 20M

A computer program was developed for predicting the convective and radiative heat transfer to the surface of a flat plate with hypersonic boundary layer flow and with injection of absorbing, emitting and scattering particles due to ablation. The program was used to study the heat transfer rate as a function of wall and freestream temperatures and Mach number of the flow. The results were also obtained to study the effect of injection of absorbing and scattering particles in the boundary layer on the heat flux as a function of wall and free-stream temperatures, Mach numbers and particle radiative properties. It is seen that, if there is a strong external incident radiation, the injection of scattering particles reduces the radiative flux by as much as 75% depending on the scattering coefficient of the particles and the particle density in the flow. A review of the published literature shows that the data of the radiative properties of particles is lacking. Also the data of the radiative properties of modern composite materials surfaces is not available. Heat transfer; Absorption; Scattering; Hypersonic flow; Ablation; Radiative properties. GRA

N87-28504# Technische Univ., Brunswick (West Germany). Fakultaet fuer Maschinenbau und Elektrotechnik.
A CONTRIBUTION TO THE AERODYNAMICS OF UNSYMMETRICAL AIRCRAFT CONFIGURATIONS Ph.D. Thesis [EIN BEITRAG ZUR AERODYNAMIK UNSYMMETRISCHER FLUGZEUG-KONFIGURATIONEN]
HARTMUT BAUMEISTER 1986 287 p In GERMAN
(ETN-87-90030) Avail: NTIS HC A13/MF A01

The basic aerodynamic special features of unsymmetrical wing contours and wing-fuselage arrangements were investigated. The theoretical reduction of the aerodynamic drag due to the asymmetries was determined on the basis of geometrically simple arrangements. Theoretical and experimental investigations of incompressible flow on unsymmetrical configurations demonstrated the possibilities and difficulties of the use of unsymmetrical aircraft for drag reduction. It is shown that a significant reduction can be obtained, even for nonoptimized configurations. The unsymmetrical wing arrangement produces a coupling between the lateral and the longitudinal notion, resulting in forces and moments which are small as long as it concerns configurations with a low asymmetry and for moderate angles of attack. ESA

N87-28505# Stuttgart Univ. (West Germany). Inst. fuer Aerodynamik und Gasdynamik.
A CONTRIBUTION TO THE COMPUTATION OF UNSTEADY, TRANSONIC, INVISCID FLOW ABOUT A WING PROFILE Ph.D. Thesis [EIN BEITRAG ZUR BERECHNUNG DER INSTATIONAEREN, TRANSSONISCHEN, REIBUNGSFREIEN STROEMUNG UM EIN TRAGFLUEGELPROFIL]
FENGWEI LI 1986 157 p In GERMAN
(ETN-87-90038) Avail: NTIS HC A08/MF A01

A computation method for the stationary and unsteady compressible flow about a wing profile was developed. The physical data, especially the global infinitely extended space, were as far as possible taken into account. The method is characterized by a series of conformal mappings which are optimized in critical points. This results, with 600 calculation points, in accuracies comparable to other computations with 6000 calculation points. The method allows the computation of the transonic flow about a vibrating profile, without the usual limitations (small perturbations, low reduced frequency, rotation freedom). ESA

N87-28506# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Hochgeschwindigkeitsstroemungen.
INVESTIGATIONS ON A TRANSONIC AIRFOIL WITH A 30 MM WIDE PERFORATION/CAVITY ARRANGEMENT
PAUL KROGMANN Nov. 1986 52 p In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-1072)
(DFVLR-FB-86-59; ISSN-0171-1342; ETN-87-90047) Avail: NTIS HC A04/MF A01; DFVLR, Cologne , West Germany DM 16

Pressure distribution and wake measurements were carried out in a 1mx1m transonic wind tunnel on a two-dimensional supercritical airfoil equipped with a perforated strip and a cavity underneath. Compared with reference measurements on the same model with a solid surface, the results of the model with the perforation/cavity arrangement at supercritical flow conditions show a substantial increase of the maximum lift and especially strong reductions. These aerodynamic improvements are related to the very favorable effect of the passive secondary flow through the perforation and cavity, induced by strong adverse pressure gradients in this region. The detrimental effects of the passive device on the aerodynamic characteristics of the airfoil at subcritical flow are negligible. ESA

N87-28507# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique de l'Aerodynamique.
THEORETICAL EVALUATION OF THE AERODYNAMIC PERFORMANCE OF A TRANSONIC WING [EVALUATION THEORIQUE DES PERFORMANCES AERODYNAMIQUES DUNE VOITURE EN TRANSSONIQUE]
J. L. GODARD Oct. 1986 48 p In FRENCH
(Contract STPA-85-95-009)
(ONERA-20/3423-AY; ETN-87-90287) Avail: NTIS HC A03/MF A01

Computer programs to estimate the viscous flow around finite or infinite wings were used to evaluate the aerodynamic coefficients, and the drag coefficient in particular, of wings in transonic regime. Results show that while the lift coefficient and the pitching moment are correctly estimated, the evaluation of the drag coefficient presents problems. The pressure contribution is over estimated, while the induced drag is under evaluated. ESA

N87-28508# Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
SUPERSONIC AND TRANSONIC SUPERSONIC FLOW
F. OBERMEIER Dec. 1986 27 p
(MPIS-16/1986; ISSN-0436-1199; ETN-87-90323) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 14

An analytical solution of nonlinear wave equations describing a supersonic flow around slender bodies, where the Mach number of the oncoming flow gets close to one, is derived. It is valid for two dimensional, supersonic transonic flow around thin airfoils. A relationship between the ordinary supersonic flow and the supersonic transonic one is obtained by the method of matched asymptotic expansions. The drag pressure of thin bodies in supersonic transonic flow is determined and compared with the corresponding results from the reverse flow theorem of Schnerr and Zierep (1985). ESA

N87-28509 Kansas Univ., Lawrence.
ANALYSIS AND DESIGN OF AIRFOILS AND AXISYMMETRIC BODIES IN TRANSONIC NONUNIFORM FLOW Ph.D. Thesis
JEN-FU CHANG 1986 153 p
Avail: Univ. Microfilms Order No. DA8711206

Computer codes capable of design and analysis of airfoils and axisymmetric bodies in nonuniform transonic flow are developed by introducing a rotation function in the velocity formulation. The main applications considered involve airfoils and axisymmetric bodies immersed in a propfan slipstream. A parametric investigation indicates that the airfoil lift drag ratio can be increased by decreasing the thickness ratio. A better performance can be achieved if the airfoil is located below the slipstream center. In a axisymmetric flow, results show that nonuniformity causes pressure coefficient to be more negative and shocks to be stronger and more rearward. A sting attached to a body reduces the pressure peak and moves the rear shock forward. The spread and Mach profile shape of the nonuniform flow region appear to have little effect on the pressure distribution. A design study was conducted for one subsonic and one supersonic uniform freestream and a transonic nonuniform freestream. The general trend shows that to reduce the pressure drag, the front portion should be flatter than an ellipsoid. Drag reduction achieved in all cases exceeds 10 percent except in subsonic uniform flow. Dissert. Abstr.

N87-28510 Cornell Univ., Ithaca, N.Y.
NUMERICAL CALCULATION OF UNSTEADY INVISCID ROTATIONAL TRANSONIC FLOW PAST AIRFOILS USING EULER EQUATIONS Ph.D. Thesis
MURALI DAMODARAN 1987 284 p
Avail: Univ. Microfilms Order No. DA8708864

Unsteady, inviscid rotational transonic flow past airfoils is computed numerically by solving the unsteady two dimensional Euler equations in integral form using the finite volume scheme. The numerical scheme is explicit, conservative and non-iterative. The region surrounding the airfoil is subdivided into small quadrilateral cells and in each of these cells the Euler equations are integrated in time using a fourth-order Runge-Kutta scheme. Spatial discretization is based on simple central differences supplemented with dissipated terms. The no normal flow condition is imposed on the airfoil surface and appropriate non-reflective boundary conditions are imposed on the far field boundaries. Unsteady transonic flow is studied first by creating approximate initial conditions, which are formed by superposing perturbations in the flow field variables, by way of time dependent mappings and by flow field decomposition techniques. The equations of motion are then integrated numerically in a time-accurate manner to obtain and resolve the evolving unsteady transonic flow field. Several unsteady transonic flows past airfoils are investigated including the computation of the responses of airfoils to step changes in angle of attack, transonic flow past airfoils in arbitrary rigid body motion and transonic airfoil-vortex interaction. These prolems emulate the typical rotational transonic flow environment of helicopter rotor blades and the solutions could serve as benchmark solutions to check out more appropriate engineering predictions of transonic flow past rotors. Dissert. Abstr.

N87-28511 Virginia Polytechnic Inst. and State Univ., Blacksburg.
TWO-DEGREE-OF-FREEDOM SUBSONIC WING ROCK AND NONLINEAR AERODYNAMIC INTERFERENCE Ph.D. Thesis
JAMAL M. ELZEBDA 1986 179 p
Avail: Univ. Microfilms Order No. DA8710991

In many situations the motion of the fluid must be determined simultaneously and interactively. One example is the phenomenon of subsonic wing rock. A method was developed that accurately simulates the pitching and rolling motions and accompanying unsteady flow field for a slender delta wing. The method uses a predictor-corrector technique in conjunction with the general unsteady vortex-lattice method to compute simultaneously the motion of the wing and the flow field, fully accounting for the dynamic/aerodynamic interaction. For a single degree of freedom in roll, the method predicts the angle of attack at which the symmetric configuration of the leading edge vortex system becomes unstable, the amplitude, and the period of the resulting self-sustained limit cycle, in close agreement with two wind tunnel experiments. In addition, a versatile method for the simulation of unsteady aerodynamic interference, based on the general unsteady vortex-lattice technique was developed. The method yields the time histories of the pressure distribution on the lifting surfaces, the distribution of vorticity in the wakes, and the position of the wakes simultaneously. As an illustration of the method, the unsteady flow field for a configuration closely resembling the X-29 is presented. The results show the strong influence of the canards on the main wing, including the time lag between the motions of the canards and the subsequent changes in the vorticity and hence the pressure distributions and loads on the main wing. Dissert. Abstr.

N87-28513 Arizona Univ., Tucson.
EFFECT OF AIRFOIL MEAN LOADING ON HIGH-FREQUENCY GUST INTERACTION NOISE Ph.D. Thesis
MATTHEW RONALD MYERS 1987 246 p
Avail: Univ. Microfilms Order No. DA8711642

The effect of airfoil steady loading on the sound generated by the interaction of an isolated, zero-thickness airfoil with a high frequency convected disturbance is investigated. The analysis is based on the inviscid equations of motion about a nonuniform mean flow. The mean flow is assumed to be two-dimensional and subsonic. The analysis shows that essentially all of the sound is generated at the leading and trailing edges. The solution in the local leading edge region reveals several sound generating mechanisms that do not exist for an airfoil with no mean loading. The propagation of sound away from the airfoil edges is described by geometric acoustics, with the amplitude varying on the scale of the airfoil chord and the phase varying on a much smaller scale of the disturbance wavelength. In addition, a diffraction type transition region exists downstream of the airfoil. The sound field depends strongly on Mach number, gust characteristics, and airfoil steady loading. The amount of power radiated correlates very well with the strength of the mean flow around the leading edge. Dissert. Abstr.

N87-28514*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
IMPLEMENTATION AND VALIDATION OF A WAKE MODEL FOR LOW-SPEED FORWARD FLIGHT Final Technical Report, 1 Oct. 1986 - 30 Sep. 1987
NARAYANAN M. KOMERATH and OLIVIER A. SCHREIBER Sep. 1987 97 p
(Contract NAG1-693)
(NASA-CR-181341; NAS 1.26:181341) Avail: NTIS HC A05/MF A01 CSCL 01A

The computer implementation and calculations of the induced velocities produced by a wake model consisting of a trailing vortex system defined from a prescribed time averaged downwash distribution are detailed. Induced velocities are computed by

approximating each spiral turn by a pair of large straight vortex segments positioned at critical points relative to where the induced velocity is required. A remainder term for the rest of the spiral is added. This approach results in decreased computation time compared to classical models where each spiral turn is broken down in small straight vortex segments. The model includes features such a harmonic variation of circulation, downwash outside of the blade and/or outside the tip path plane, blade bound vorticity induced velocity with harmonic variation of circulation and time averaging. The influence of various options and parameters on the results are investigated and results are compared to experimental field measurements with which, a resonable agreement is obtained. The capabilities of the model as well as its extension possibilities are studied. The performance of the model in predicting the recently-acquired NASA Langley Inflow data base for a four-bladed rotor is compared to that of the Scully Free Wake code, a well-established program which requires much greater computational resources. It is found that the two codes predict the experimental data with essentially the same accuracy, and show the same trends. Author

N87-28518# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
FUTURE RESEARCH ON TRANSONIC UNSTEADY AERODYNAMICS AND ITS AEROELASTIC APPLICATIONS
Aug. 1987 45 p Meeting held in Athens, Greece, 28 Sep. - 3 Oct. 1986
(AGARD-R-749; ISBN-92-835-0425-9) Avail: NTIS HC A03/MF A01

The workshop focused on strategies for promoting and developing engineering level transonic flutter prediction techniques. The technology of transonic aerodynamics is currently undergoing rapid development. Significant progress is being made to solve the inherently nonlinear equations describing unsteady motions of wings in transonic flow, while the availability of reliable and efficient computational methods will greatly enhance the ability to predict the aeroelastic behavior of modern aircraft operating under transonic flow conditions.

N87-28520# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (West Germany).
COMPARISON BETWEEN 2D TRANSONIC FLUTTER CALCULATIONS IN THE TIME AND FREQUENCY DOMAIN
HELMUT ZIMMERMANN and BERND SCHULZE *In* Advisory Group for Aerospace Research and Development, Future Research on Transonic Unsteady Aerodynamics and Its Aeroelastic Applications 16 p Aug. 1987
Avail: NTIS HC A03/MF A01

Unsteady airloads in the transonic speed range for the application in flutter calculations can only be predicted by using nonlinear flow equation codes. The MBB-A3 profile is used as theoretical model for the flutter investigations. Flutter calculations are presented using the classical method in the frequency domain as well as a structural aerodynamic coupling procedure in the time domain. The unsteady aerodynamic coefficients which are used for these flutter investigations are calculated for several M-numbers and incidences with the transonic small perturbation (TSP) equation without and with quasiunsteady boundary layer and with the time linearized TSP equation without and with steady boundary layer and for comparison reasons with the Doublet Lattice method. The boundary layer influences essentially the unsteady aerodynamic pressure distributions and coefficients. The flutter results obtained in the frequency and time domain differ less from each other. Nevertheless the time marching flutter simulation takes the nonlinearity effects of the airloads dependent on the vibration amplitude essentially better into account than the classical flutter solution. Author

N87-28521*# McDonnell Aircraft Co., St. Louis, Mo.
PROPULSION AND AIRFRAME AERODYNAMIC INTERACTIONS OF SUPERSONIC V/STOL CONFIGURATIONS, PHASE 1 Final Report
M. R. MRAZ and P. E. HILEY Sep. 1985 145 p
(Contract NAS2-10791)
(NASA-CR-177369; NAS 1.26:177369) Avail: NTIS HC A07/MF A01 CSCL 01A

A wind tunnel model of a supersonic V/STOL fighter configuration has been tested to measure the aerodynamic interaction effects which can result from geometrically close-coupled propulsion system/airframe components. The approach was to configure the model to present two different test techniques. One was a coventional test technique composed of two test modes. In the Flow-Through mode, absolute configuration aerodynamics are measured, including inlet/airframe interactions. In the Jet-Effects mode, incremental nozzle/airframe interactions are measured. The other test technique is a propulsion simulator approach, where a subscale, externally powered engine is mounted in the model. This allows proper measurement of inlet/airframe and nozzle/airframe interactions simultaneously. Author

N87-28522*# Kentron International, Inc., Hampton, Va.
THE DESIGN AND ANALYSIS OF SIMPLE LOW SPEED FLAP SYSTEMS WITH THE AID OF LINEARIZED THEORY COMPUTER PROGRAMS
HARRY W. CARLSON Aug. 1985 52 p
(Contract NAS1-16000)
(NASA-CR-3913; NAS 1.26:3913) Avail: NTIS HC A04/MF A01 CSCL 01A

The purpose here is to show how two linearized theory computer programs in combination may be used for the design of low speed wing flap systems capable of high levels of aerodynamic efficiency. A fundamental premise of the study is that high levels of aerodynamic performance for flap systems can be achieved only if the flow about the wing remains predominantly attached. Based on this premise, a wing design program is used to provide idealized attached flow camber surfaces from which candidate flap systems may be derived, and, in a following step, a wing evaluation program is used to provide estimates of the aerodynamic performance of the candidate systems. Design strategies and techniques that may be employed are illustrated through a series of examples. Applicability of the numerical methods to the analysis of a representative flap system (although not a system designed by the process described here) is demonstrated in a comparison with experimental data. Author

N87-28523*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
FLOW ENERGIZERS. TASK A Progress Report
D. WARD, R. BINFORD, E. VONLAVANTE, and B. PAUL 1985 53 p
(Contract NAG1-344)
(NASA-CR-176202; NAS 1.26:176202) Avail: NTIS HC A04/MF A01 CSCL 01A

The effects of a propeller slipstream on the wing laminar boundary are being investigated. Hot-wire velocity sensor measurements have been performed in flight and in a wind tunnel. It is shown that the boundary layer cycles between a laminar state and a turbulent state at the propeller blade passage rate. The cyclic length of the turbulent state increases with decreasing laminar stability. Analyses of the time-varying velocity profiles show the turbulent state to lie in a transition region between fully laminar and fully turbulent. The observed cyclic boundary layer has characteristics similar to relaminarizing flow and laminar flow with external turbulence. Author

N87-28524# Texas Technological Univ., Lubbock. Dept. of Mechanical Engineering.
USER'S MANUAL FOR ADAM (ADVANCED DYNAMIC AIRFOIL MODEL)
J. W. OLER, J. H. STRICKLAND, and B. J. IM Jun. 1987 97 p Prepared in cooperation with Sandia National Labs., Albuquerque, N. Mex.
(Contract DE-AC04-76DP-00789)
(DE87-012342; SAND-86-7182) Avail: NTIS HC A05/MF A01

The computer code for an advanced dynamic airfoil model (ADAM) is described. The code is capable of calculating steady or unsteady flow over two-dimensional airfoils with allowances for boundary layer separation. Specific types of airfoil motions currently installed are steady rectilinear motion, impulsively started rectilinear motion, constant rate pitching, sinusoidal pitch oscillations, sinusoidal lateral plunging, and simulated Darrieus turbine motion. Other types of airfoil motion may be analyzed through simple modifications of a single subroutine. The code has a built-in capability to generate the geometric parameters for a cylinder, the NACA four-digit series of airfoils, and a NASA NLF-0416 laminar airfoil. Other types of airfoils are easily incorporated. The code ADAM is currently in a state of development. It is theoretically consistent and complete. However, further work is needed on the numerical implementation of the method. DOE

N87-28525*# Nielsen Engineering and Research, Inc., Mountain View, Calif.
PROGRAM LRCDM2: IMPROVED AERODYNAMIC PREDICTION PROGRAM FOR SUPERSONIC CANARD-TAIL MISSILES WITH AXISYMMETRIC BODIES Final Report, 31 Aug. 1981 - 15 Feb. 1983
MARNIX F. E. DILLENIUS Washington NASA Apr. 1985 401 p
(Contract NAS1-16770)
(NASA-CR-3883; NAS 1.26:3883; NEAR-TR-287) Avail: NTIS HC A18/MF A01 CSCL 01A

Program LRCDM2 was developed for supersonic missiles with axisymmetric bodies and up to two finned sections. Predicted are pressure distributions and loads acting on a complete configuration including effects of body separated flow vorticity and fin-edge vortices. The computer program is based on supersonic panelling and line singularity methods coupled with vortex tracking theory. Effects of afterbody shed vorticity on the afterbody and tail-fin pressure distributions can be optionally treated by companion program BDYSHD. Preliminary versions of combined shock expansion/linear theory and Newtonian/linear theory have been implemented as optional pressure calculation methods to extend the Mach number and angle-of-attack ranges of applicability into the nonlinear supersonic flow regime. Comparisons between program results and experimental data are given for a triform tail-finned configuration and for a canard controlled configuration with a long afterbody for Mach numbers up to 2.5. Initial tests of the nonlinear/linear theory approaches show good agreement for pressures acting on a rectangular wing and a delta wing with attached shocks for Mach numbers up to 4.6 and angles of attack up to 20 degrees. Author

N87-28526*# National Aeronautics and Space Administration, Washington, D.C.
DEVELOPMENT OF SUPERSONIC COMPUTATIONAL AERODYNAMIC PROGRAM USING PANEL METHOD
Y. MARUYAMA, S. AKISHITA, and A. NAKAMURA Sep. 1987 13 p Transl. into ENGLISH of Paneruho ni yoru Choonsoku Keisan Kuryoku Proguramu no Kaihatsu Presented at the 3rd NAL Symposium on Aircraft Computational Aerodynamics, p 113-119 Symposium held in Japan Original language document was announced as N87-14261 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-4005)
(NASA-TT-20113; NAS 1.77:20113) Avail: NTIS HC A02/MF A01 CSCL 01A

An aerodynamic program for steady supersonic linearized potential flow using a higher order panel method was developed. Boundary surface is divided into planar triangular panels on each of which a linearly varying doublet and a constant or linearly varying source are distributed. Distributions of source and doublet on the panel assemblies of the panels can be determined by their strengths at nodal points, which are placed at the vertices of the panels for linear distribution or on each panel for constant distribution. Author

N87-28527*# National Aeronautics and Space Administration, Washington, D.C.
SOME NUMERICAL CALCULATIONS BY USING LINEAR CLASSICAL SONIC THEORIES APPROACHED FROM SUB- OR SUPERSONIC SPEEDS
Y. YAMAMOTO and S. ANDO Sep. 1987 19 p Transl. into ENGLISH of Cho/A Ryogawakarano Kotenteki Onsokuriron (Senkei) no Jakkanno Suchikeisan Presented at the 3rd NAL Symposium on Aircraft Computational Aerodynamics p 121-129 Symposium held in Japan Original language document was announced as N87-14262 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-4005)
(NASA-TT-20112; NAS 1.77:20112) Avail: NTIS HC A02/MF A01 CSCL 01A

The unsteady aerodynamics of a two-dimensional wing at sonic speed are studied by using so-called classical sonic theories (linear), approached from supersonic flow ($M=1+0$) or subsonic flow ($M=1-0$). In the former approach, the exact expressions of lift and lift distribution are obtained in terms of Fresnel integrals, while in the latter approach an integral equation must be solved, the kernel function of which is obtained from the subsonic Possio's equation and has a root singularity. The discrete analysis is adopted on the basis of the semicircle method (SCM) and the weighting function for subsonic-flow-Gauss-quadrature, as well as modified characteristics obtained from both approaches agree quite well with each other. The results obtained by the present computations are compared with those of DLM-C (subsonic 2D code) developed by ANDO et al, and are found to give a reasonable outer boundary for subsonic unsteady aerodynamics. Author

N87-29409 ESDU International Ltd., London (England).
CONTRIBUTION OF WING DIHEDRAL TO SIDEFORCE, YAWING MOMENT AND ROLLING MOMENT DERIVATIVES DUE TO RATE OF ROLL AT SUBSONIC SPEEDS, (Y SUB P)SUB GAMMA, (N SUB P)SUB GAMMA AND (L SUB P)SUB GAMMA
Mar. 1985 8 p
(ESDU-85006; ISBN-0-85679-512-7; ISSN-0141-397X) Avail: ESDU

This Data Item #85006, an addition to the Aerodynamics Sub-series, provides a method that relates the values of the dihedral contributions to the rolling moment due to the rate of roll, which can be estimated from ESDU A.06.01.01. The method is based on simple lifting-line and strip theory assumptions and applies to subcritical Mach numbers in attached flow on straight tapered wings with taper ratio greater than 0.25, aspect ratio greater than 1.5, and quarter-chord sweep less than 60 degrees. Comparison between predicted and experimental results for one wing shows good agreement, and a practical worked example illustrates the use of the method. ESDU

N87-29410 ESDU International Ltd., London (England).
PITOT AND STATIC ERRORS DUE TO NON-STEADY FLIGHT
May 1985 23 p
(ESDU-85011; ISBN-0-85679-517-8; ISSN-0141-4054) Avail: ESDU

The additional corrections to the pitot and static pressures, registered by their sensors in unsteady flight conditions, required to allow the use of the steady flight calibration are treated. The corrections arise because there is a lag in the transmission of a pressure change at the sensor ports to the instrumentation. That lag is caused by acoustic and friction effects in the airflow in the system when the pressures are changing but, for high performance aircraft, includes contributions from the inertia of the air mass in the pressure system in accelerated flight and, when the static

ports are relatively small, a lag additional to that found in ground calibrations that is thought to be due to the flow through the ports themselves. Estimation methods are provided for each contribution to lag for use when measured values are not available, and allows corrections derived from ground (or flight) calibrations to be adjusted to apply to different conditions from those under which they were obtained. A practical worked example demonstrates how the methods are applied. ESDU

N87-29411*# United Technologies Research Center, East Hartford, Conn.
AN ANALYSIS OF THE CROSSOVER BETWEEN LOCAL AND MASSIVE SEPARATION ON AIRFOILS Final Report
M. BARNETT and J. E. CARTER Washington NASA Sep. 1987 107 p
(Contract NAS1-16585)
(NASA-CR-4096; NAS 1.26:4096) Avail: NTIS HC A06/MF A01 CSCL 01A

Massive separation on airfoils operating at high Reynolds number is an important problem to the aerodynamicist, since its onset generally determines the limiting performance of an airfoil, and it can lead to serious problems related to aircraft control as well as turbomachinery operation. The phenomenon of crossover between local separation and massive separation on realistic airfoil geometries induced by airfoil thickness is investigated for low speed (incompressible) flow. The problem is studied both for the asymptotic limit of infinite Reynolds number using triple-deck theory, and for finite Reynolds number using interacting boundary-layer theory. Numerical results are presented which follow the evolution of the flow as it develops from a mildly separated state to one dominated by the massively separated flow structure as the thickness of the airfoil geometry is systematically increased. The effect of turbulence upon the evolution of the flow is considered, and the impact is significant, with the principal effect being the suppression of the onset of separation. Finally, the effect of surface suction and injection for boundary-layer control is considered. The approach which was developed provides a valuable tool for the analysis of boundary-layer separation up to and beyond stall. Another important conclusion is that interacting boundary-layer theory provides an efficient tool for the analysis of the effect of turbulence and boundary-layer control upon separated vicsous flow. Author

N87-29412*# City Coll. of the City Univ. of New York. School of Engineering.
AN INVESTIGATION OF THE FLOW CHARACTERISTICS IN THE BLADE ENDWALL CORNER REGION Final Contractor Report
BIRINCHI K. HAZARIKA and RISHI S. RAJ Washington NASA Jul. 1987 291 p
(Contract NAG3-122)
(NASA-CR-4076; E-3500; NAS 1.26:4076) Avail: NTIS HC A13/MF A01 CSCL 01A

Studies were undertaken to determine the structure of the flow in the blade end wall corner region simulated by attaching two uncambered airfoils on either side of a flat plate with a semicircular leading edge. Detailed measurements of the corner flow were obtained with conventional pressure probes, hot wire anemometry, and flow visualization. The mean velocity profiles and six components of the Reynolds stress tensor were obtained with an inclined single sensor hot wire probe whereas power spectra were obtained with a single sensor oriented normal to the flow. Three streamwise vortices were identified based on the surface streamlines, distortion of total pressure profiles, and variation of mean velocity components in the corner. A horseshoe vortex formed near the leading edge of the airfoil. Within a short distance downstream, a corner vortex was detected between the horseshoe vortex and the surfaces forming the corner. A third vortex was formed at the rear portion of the corner between the corner vortex and the surface of the flat plate. Turbulent shear stress and production of turbulence are negligibly small. A region of negative turbulent shear stress was also observed near the region of low turbulence intensity from the vicinity of the flat plate. Author

N87-29413*# Lockheed-Georgia Co., Marietta.
PROPFAN TEST ASSESSMENT TESTBED AIRCRAFT FLUTTER MODEL TEST REPORT
C. M. J. JENNESS 20 Oct. 1987 102 p
(Contract NAS3-24339)
(NASA-CR-179458; NAS 1.26:179458; LG85ER0187; L86R1350) Avail: NTIS HC A06/MF A01 CSCL 01A

The PropFan Test Assessment (PTA) program includes flight tests of a propfan power plant mounted on the left wind of a modified Gulfstream II testbed aircraft. A static balance boom is mounted on the right wing tip for lateral balance. Flutter analyses indicate that these installations reduce the wing flutter stabilizing speed and that torsional stiffening and the installation of a flutter stabilizing tip boom are required on the left wing for adequate flutter safety margins. Wind tunnel tests of a 1/9th scale high speed flutter model of the testbed aircraft were conducted. The test program included the design, fabrication, and testing of the flutter model and the correlation of the flutter test data with analysis results. Excellent correlations with the test data were achieved in posttest flutter analysis using actual model properties. It was concluded that the flutter analysis method used was capable of accurate flutter predictions for both the (symmetric) twin propfan configuration and the (unsymmetric) single propfan configuration. The flutter analysis also revealed that the differences between the tested model configurations and the current aircraft design caused the (scaled) model flutter speed to be significantly higher than that of the aircraft, at least for the single propfan configuration without a flutter boom. Verification of the aircraft final design should, therefore, be based on flutter predictions made with the test validated analysis methods. Author

N87-29414# Sandia National Labs., Albuquerque, N. Mex.
THE AEROTHERMODYNAMIC ENVIRONMENT FOR HOLES IN HYPERSONIC CONFIGURATIONS
JOHN J. BERTIN, WILLIAM J. TEDESCHI, ALBINO C. BUSTAMANTE, and ERIC W. REECE 1987 10 p Presented at the AIAA Aerodynamics Flight Mechanics Conference, Monterey, Calif., 17 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-003790; SAND-86-2875C; CONF-870830-2) Avail: NTIS HC A02/MF A01

Results that are presented in this paper were generated in a study that focused on determining the aerothermodynamic environment that results when the external flow over a configuration in a hypersonic stream encounters a hole in its surface. A numerical code has been developed to compute a two-dimensional, expanding shear layer and the inviscid/viscid interaction that occurs at the recompression face at the downstream end of the hole. Surface pressures and heating rates were measured in a wind tunnel test and compared to the computed values using this new technique. The results of these comparisons are satisfactory. DOE

N87-29415# Sandia National Labs., Albuquerque, N. Mex.
PARACHUTE SYSTEMS TECHNOLOGY: FUNDAMENTALS, CONCEPTS, AND APPLICATIONS. ADVANCED PARACHUTE DESIGN
C. W. PETERSON and D. W. JOHNSON 1987 23 p Presented at the Parachute Systems Technology: Fundamentals, Concepts, and Applications, Munich, West Germany, 22 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011634; SAND-87-1648C; CONF-8706165-1) Avail: NTIS HC A02

Advances in high-performance parachute systems and the technologies needed to design them are presented in this paper. New parachute design and performance prediction codes are being developed to assist the designer in meeting parachute system performance requirements after a minimum number of flight tests. The status of advanced design codes under development at Sandia National Laboratories is summarized. An integral part of parachute performance prediction is the rational use of existing test data. The development of a data base for parachute design has been initiated to illustrate the effects of inflated diameter, geometric

porosity, reefing line length, suspension line length, number of gores, and number of ribbons on parachute drag. Examples of advancements in parachute materials are presented, and recent problems with Mil-Spec broadgoods are reviewed. Finally, recent parachute systems tested at Sandia are summarized to illustrate new uses of old parachutes, new parachute configurations, and underwater recovery of payloads. DOE

N87-29416# Sandia National Labs., Albuquerque, N. Mex.
PARACHUTE SYSTEMS TECHNOLOGY: FUNDAMENTALS, CONCEPTS, AND APPLICATIONS
D. W. JOHNSON 1987 10 p Presented at the Parachute Systems Technology: Fundamentals, Concepts, and Applications, Munich, West Germany, 22 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011722; SAND-87-1649C; CONF-8706165-2) Avail: NTIS HC A02/MF A01

In this paper, many different types of tests, vehicles, and data acquisition systems will be discussed. The types of tests used by parachute designers are only limited by the designers' imaginations. Since the paper is of finite length, some designers' favorite methods of accomplishing a certain objective will not be discussed. Any omissions are unintentional and are left to future discussions either formally or informally. DOE

N87-29417# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
CALCULATION OF PRESSURE DISTRIBUTIONS ON SUPERSONIC DELTA WINGS USING STAGNATION SOLUTIONS [BEREKENING DRUKVERDELINGEN OP SUPERSONE DELTA-VLEUGELS M.B.V. STUWPUNTS-OPLOSSINGEN]
A. J. N. VREENEGOOR and P. G. BAKKER Nov. 1986 60 p In DUTCH; ENGLISH summary
(VTH-LR-484; B8707457; ETN-87-90223) Avail: NTIS HC A04/MF A01

The supersonic inviscid three-dimensional (3D) potential flow about a plane delta wing was investigated; a method which calculates pressure distributions on the wing surface was derived. The flow was considered as conical, and could be completely analyzed in one cross flow plane in which the conical potential F was defined. Power series expansions for F were derived; they are called conical stagnation solutions and they still contain parameters which can be chosen freely. By embedding the expansions in the conical flow pattern about the delta wing, the free parameters can be determined systematically. This matching precedure was applied to both sides of the delta wing, determing expansions for F on the compression and expansion side. Using this result, pressure distributions on the wing surface were calculated. The method is shown to be quite accurate. ESA

N87-29418*# Cleveland State Univ., Ohio. Dept. of Civil Engineering.
ENHANCED MIXING OF AN AXISYMMETRIC JET BY AERODYNAMIC EXCITATION Final Report M.S. Thesis
GANESH RAMAN Mar. 1986 177 p
(Contract NCC3-49)
(NASA-CR-175059; NAS 1.26:175059) Avail: NTIS HC A09/MF A01 CSCL 01A

The main objective of acoustic excitation studies is to gain a high level of control over processes governing free shear flow characteristics. The basic premise is that inherent instability waves in free shear flows are excitable by external perturbations with frequencies close to the natural instability frequency of the flow. An 8.89 cm diameter axisymmetric jet was acoustically excited by four loudspeakers placed upstream of the nozzle exit. Measurements were made at Mach numbers of 0.435 and 0.2. A single hot-wire probe was used to obtain turbulence levels at the nozzle exit and along the centerline, and a microphone at the nozzle exit was used to study the resonance characteristics of the rig. A Pitot probe was stationed at X/D = 9 downstream along the nozzle axis to study the Strouhal number dependence and to look at threshold levels for excitation. The test results were obtained after a preliminary evaluation and facility improvement. Excitation at the correct Strouhal number enhanced mixing significantly. The effects were most prominent in the Strouhal number range between 0.4 and 1.0. The effects of acoustic excitation also depend considerably on the sound pressure level at the nozzle exit and were more pronounced at higher sound levels. Other factors which influenced the excitability were valve noise, exit turbulence levels, extraneous noise, and a flanged nozzle. Analysis of the hot-wire signal, in conditions of optimum jet mixing, showed vortex pairing to occur between 2 and 3 diameters downstream. Author

N87-29419*# Ohio State Univ., Columbus. Aeronautical and Astronautical Research Lab.
TRANSONIC INTERFERENCE REDUCTION BY LIMITED VENTILATION WALL PANELS Final Report
JOHN D. LEE Jan. 1986 15 p
(Contract NAG3-109)
(NASA-CR-175039; NAS 1.26:175039) Avail: NTIS HC A02/MF A01 CSCL 01A

In two wind tunnels used for the two-dimensional airfoil tests, each wall above and below the model was modified by replacing small segments of the solid boundaries with perforated plates vented into sealed chambers. Perforated segments having approximately 40 percent open area were found to reduce the transonic wall interference to a negligible level, for a model chord-to-tunnel height ratio of 0.5. This report describes the physical arrangement and presents typical model pressure distributions to illustrate the effectiveness of the technique. Author

N87-29420*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CONTROL OF SHEAR FLOWS BY ARTIFICIAL EXCITATION
E. J. RICE and K. B. M. Q. ZAMAN Oct. 1987 12 p Prepared for presentation at the 11th Aeroacoustics Conference, Sunnyvale, Calif., 19-21 Oct. 1987; sponsored by the AIAA
(NASA-TM-100201; E-3794; NAS 1.15:100201; AIAA-87-2722)
Avail: NTIS HC A02/MF A01 CSCL 01A

Investigations involving artificial excitation of various shear flows are reviewed. Potential applications of excitation in flow control, e.g., in enhancing mixing, and in delaying transition and separation are discussed. An account is given of the current activities at NASA Lewis Research Center in this regard. Author

N87-29421*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ESTIMATION OF BLADE AIRLOADS FROM ROTOR BLADE BENDING MOMENTS
WILLIAM G. BOUSMAN (Army Aviation Research and Development Command, Moffett Field, Calif.) Aug. 1987 23 p Presented at the 13th European Rotorcraft Forum, Arles, France, Sep. 1987
(NASA-TM-100020; A-87311; NAS 1.15:100020;
USAAVSCOM-TR-87-A-8) Avail: NTIS HC A02/MF A01 CSCL 01A

A method is developed to estimate the blade normal airloads by using measured flap bending moments; that is, the rotor blade is used as a force balance. The blade's rotation is calculated in vacuum modes and the airloads are then expressed as an algebraic sum of the mode shapes, modal amplitudes, mass distribution, and frequency properties. The modal amplitudes are identified from the blade bending moments using the Strain Pattern Analysis Method. The application of the method is examined using simulated flap bending moment data that have been calculated for measured airloads for a full-scale rotor in a wind tunnel. The estimated airloads are compared with the wind tunnel measurements. The effects of the number of measurements, the number of modes, and errors in the measurements and the blade properties are examined, and the method is shown to be robust. Author

N87-29422*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
INVESTIGATION OF GENERIC HUB FAIRING AND PYLON SHAPES TO REDUCE HUB DRAG
ROBERT H. STROUB, LARRY A. YOUNG, DAVID R. GRAHAM, and ALEXANDER W. LOUIE (Sterling Software, Moffett field, Calif.) Sep. 1987 19 p Presented at the 13th European Rotorcraft Forum, Arles, France, 8-11 Sep. 1987
(NASA-TM-100008; A-87287; NAS 1.15:100008) Avail: NTIS HC A02/MF A01 CSCL 01A

Reported are investigations of fairing configurations pointed toward substantially reducing hub drag. Experimental investigations have shown the importance of hub-fairing camber, lower-surface curvature, and relative size of the drag. The significance of pylon and hub fairings in combination have also been shown. Model test data presented here documented these findings, and also showed the effect of gaps and hub-fairing inclination angle on drag. From a drag standpoint, the best hub fairing had a circular arc, upper-surface curvature, a flat bottom surface, and 8.75% camber. Author

N87-29425# Vigyan Research Associates, Inc., Hampton, Va.
LOW-SPEED INVESTIGATIONS OF APEX FENCE AND CAVITY FLAP CONCEPTS ON A 60 DEGREES DELTA CONFIGURATION Final Report, 15 Mar. 1985 - 15 Oct. 1986
DHANVADA M. RAO, KEITH D. HOFFLER, and CHARLES T. MILLS Mar. 1987 74 p
(Contract F33615-85-C-3008)
(AD-A183138; AFWAL-TR-86-3114) Avail: NTIS HC A04/MF A01 CSCL 20D

This report describes low-speed wind tunnel investigations of apex fence and cavity flap concepts applied to a 60-deg. uncambered delta wing/body configuration. The upper-surface apex fences, hinged near the leading edges, are deployed vertically at low to moderate angles of attack (appropriate to approach and landing) to force a powerful vortex pair which augments suction over the forward regions of the wing planform. The resulting nose-up moment is balanced by means of trailing edge flaps, resulting in increased trimmed lift as well as drag for improved short-field landing capability of the tailless delta. The cavity flap is a lower-surface hinged vortex flap whose deflection creates a frontal cavity underneath the leading edge. Above a certain angle of attack the flap vortex fills the mouth of the cavity, which helps the external flow to turn around the leading edge thus reducing the vortex lift at high angles of attack, and creates suction over the cavity frontal area which generates a side-force component. The potential of asymmetrically deployed cavity flaps for lateral/directional control at high angles of attack was of interest. These concepts were subjected to low-speed tunnel studies. GRA

N87-29426# Naval Weapons Center, China Lake, Calif.
PARACHUTE RECOVERY SYSTEMS DESIGN MANUAL, CHAPTER 5 Partial Report, Jan. - May 1987
THEO W. KNACKE Jun. 1987 182 p
(AD-A183191; AD-E900716; NWC-TP-6575-CH-5-OFFPRINT)
Avail: NTIS HC A09/MF A01 CSCL 01C

This manual provides the recovery system engineer in Government and industry with tools to evaluate, select, design, test, manufacture, and operate parachute recovery systems. These systems range from simple, one-parachute assemblies to multiple-parachute systems, and may include equipment for impact attenuation, flotation, location, retrieval, and disposition. All system aspects are discussed, including the need for parachute recovery, the selection of the most suitable recovery system concept, a computerized approach to parachute performance, force and stress analysis, geometric gore design, component layout, material selection, system design, manufacturing, and in-service maintenance. GRA

N87-29427# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
NUMERICAL SIMULATION OF X24C-10D Final Report, Jun. 1984 - Jul. 1985
JOSEPH J. SHANG and STEPHEN J. SCHERR Jun. 1987 59 p
(AD-A183287; AFWAL-TR-86-3072) Avail: NTIS HC A04/MF A01 CSCL 01A

The present effort represents a first attempt of numerical simulation of the flow field around a complete aircraft configuration utilizing the Reynolds average Navier-Stokes equations. The numerical solution generated for the experimental aircraft concept X24C-10D at a Mach number of 5.95 not only exhibited accurate prediction of detailed flow properties but also of the integrated aerodynamic coefficients. In addition, the present analysis demonstrated that a page structure of data collected in cyclic blocks is an efficient and viable means for processing the Navier-Stokes equations on the Cray XMP-22 computer with external memory device. Author (GRA)

N87-29428# Physical Research, Inc., Torrance, Calif.
HIGH REYNOLDS NUMBER FLOWS AROUND SMOOTH AND ROUGH CYLINDERS. VOLUME 1. MEAN SURFACE PRESSURE DISTRIBUTION Final Report, 21 Aug. 1985 - 20 Aug. 1986
CHIUN WANG and W. C. SHIH 2 Mar. 1987 309 p
(Contract N00014-85-C-0764)
(AD-A183531; PRI-PV-87-R001-VOL-1) Avail: NTIS HC A14/MF A01 CSCL 20D

Nonsteady phenomena associated with flows around smooth and rough cylinders at high Reynolds numbers (300,000 to 8 million) were investigated. Boundary-layer profiles were surveyed. Mean and fluctuating surface pressures were measured in both the circumferential and the spanwise directions. The mean surface pressure data are compiled and presented in the Volume 1 report using both graphical and tabular format. Mean sectional drag and lift coefficients were calculated. The drag coefficients, the base pressures, and the boundary-layer separation angles were also compared to data existing in the literature. GRA

N87-29429*# Vanderbilt Univ., Nashville, Tenn. Dept. of Mechanical and Materials Engineering.
AERODYNAMICS OF 3-DIMENSIONAL BODIES IN TRANSITIONAL FLOW
J. LEITH POTTER 11 Oct. 1987 14 p
(Contract NAG1-549)
(NASA-CR-181395; NAS 1.26:181395) Avail: NTIS HC A02/MF A01 CSCL 01A

Based on considerations of fluid dynamic simulation appropriate to hypersonic, viscous flow over blunt-nosed lifting bodies, a method was presented earlier for estimating drag coefficients in the transitional-flow regime. The extension of the same method to prediction of lift coefficients is presented. Correlation of available experimental data by a simulation parameter appropriate for this purpose is the basis for the procedure described. The ease of application of the method makes it useful for preliminary studies which involve a wide variety of three-dimensional vehicle configurations or a range of angles of attack of a given vehicle. Author

N87-29431*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRANSONIC ROTOR TIP DESIGN USING NUMERICAL OPTIMIZATION
MICHAEL E. TAUBER and RONALD G. LANGHI Oct. 1985 41 p
(NASA-TM-86771; REPT-85333; NAS 1.15:86771) Avail: NTIS HC A03/MF A01 CSCL 01A

The aerodynamic design procedure for a new blade tip suitable for operation at transonic speeds is illustrated. For the first time, 3 dimensional numerical optimization was applied to rotor tip design, using the recent derivative of the ROT22 code, program R22OPT. Program R22OPT utilized an efficient quasi-Newton optimization algorithm. Multiple design objectives were specified. The

delocalization of the shock wave was to be eliminated in forward flight for an advance ratio of 0.41 and a tip Mach number of 0.92 at psi = 90 deg. Simultaneously, it was sought to reduce torque requirements while maintaining effective restoring pitching moments. Only the outer 10 percent of the blade span was modified; the blade area was not to be reduced by more than 3 percent. The goal was to combine the advantages of both sweptback and sweptforward blade tips. A planform that featured inboard sweepback was combined with a sweptforward tip and a taper ratio of 0.5. Initially, the ROT22 code was used to find by trial and error a planform geometry which met the design goals. This configuration had an inboard section with a leading edge sweep of 20 deg and a tip section swept forward at 25 deg; in addition, the airfoils were modified. Author

N87-29445*# Army Research and Technology Labs., Moffett Field, Calif.
RECONSTRUCTION OF A THREE-DIMENSIONAL, TRANSONIC ROTOR FLOW FIELD FROM HOLOGRAPHIC INTERFEROGRAM DATA
JOHN K. KITTLESON and YUNG H. YU *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms p 149-170 May 1987
Avail: NTIS HC A99/MF A01 CSCL 01A

Holographic interferometry and computerized aided tomography (CAT) are used to determine the transonic velocity field of a model rotor blade in hover. A pulsed ruby laser recorded 40 interferograms with a 2 ft dia view field near the model rotor blade tip operating at a tip Mach number of 0.90. After digitizing the interferograms and extracting the fringe order functions, the data are transferred to a CAT code. The CAT code then calculates the perturbation velocity in several planes above the blade surface. The values from the holography-CAT method compare favorably with previously obtained numerical computations in most locations near the blade tip. The results demonstrate the technique's potential for three dimensional transonic rotor flow studies. Author

N87-29461*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
APPLICATION OF A PANEL METHOD TO WAKE-VORTEX/WING INTERACTION AND COMPARISON WITH EXPERIMENTAL DATA
BRIAN E. SMITH and JAMES C. ROSS Sep. 1987 74 p
(NASA-TM-88337; A-86330; NAS 1.15:88337) Avail: NTIS HC A04/MF A01 CSCL 01A

The ability of the Vortex Separation AEROdynamics (VSAERO) program to calculate aerodynamic loads on wings due to interaction with free vortices was studied. The loads were calculated for various positions of a downstream following wing relative to an upstream vortex-generating wing. Calculated vortex-induced span loads, rolling-moment coefficients, and lift coefficients on the following wing were compared with experimental results of McMillan et al. and El-Ramly et al. Comparisons of calculated and experimental vortex tangential velocities were also made. Author

N87-29462*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A TWIN-ENGINE GENERAL AVIATION CONFIGURATION WITH AFT-FUSELAGE-MOUNTED PUSHER PROPELLERS
DANA MORRIS DUNHAM, GARL L. GENTRY, JR., GREGORY S. MANUEL, ZACHARY T. APPLIN, and P. FRANK QUINTO Oct. 1987 116 p
(NASA-TP-2763; L-16331; NAS 1.60:2763) Avail: NTIS HC A06/MF A01 CSCL 01A

An investigation was conducted to determine the aerodynamic characteristics of an advanced turboprop aircraft model with aft-pylon-mounted pusher propellers. Tests were conducted through an angle-of-attack range of -8 to 28 degrees, and an angle-of-sideslip range of -20 to 20 degrees at free-stream conditions corresponding to Reynolds numbers of 0.55 to 2.14 x 10 to the 6th power based on mean aerodynamic chord. Test results show that for the unpowered configurations the maximum lift coefficients for the cruise, takeoff, and landing configurations are 1.45, 1.90, and 2.10, respectively. Nacelle installation results in a drag coefficient increase of 0.01. Increasing propeller thrust results in a significant increase in lift for angles of attack above stall and improves the longitudinal stability. The cruise configuration remains longitudinally stable to an angle of attack 5 degrees beyond the stall angle, the takeoff configuration is stable 4 degrees beyond stall angle, and the landing configuration is stable 3 degrees beyond stall angle. The predominant effect of symmetric thrust on the lateral-directional aerodynamic characteristics is in the post-stall region, where additional rudder control is available with power on. Author

N87-29464 Arizona State Univ., Tempe.
SUPERSONIC FLOW OVER ELASTIC BODIES IN OSCILLATION Ph.D. Thesis
PABLO NUNEZ GARCIA-FOGEDA 1987 167 p
Avail: Univ. Microfilms Order No. DA8713657

Supersonic flow over flexible bodies of arbitrary cross section performing bending oscillations was investigated. For bodies of revolution three different systems, namely the wind-fixed, the body-fixed, and the pseudowind-fixed, are first investigated. It is shown that, when the wind-fixed system is used in a straightforward manner, a spurious singularity at the body apex appears. Further investigation of this singularity shows that it also appears in the other two coordinate systems when the linearized equation is solved. Also, it is shown that when the problem is properly formulated in a conical coordinate system the pressure coefficient remains regular at the body apex. The formulation is a generalization of the harmonic gradient method for oscillating wings. The influence of the mean flow nonlinearity on the unsteady pressure and forces was investigated for bodies of revolution according to Van Dyke's nonlinear iterative scheme. In all computed cases, improvements are found for the present nonlinear results over the linear ones. Flutter and divergence boundaries and aerodynamic damping coefficients for various configurations including that of a Saturn SA-1 launch vehicle in free-free bending modes of oscillation are presented. Overall close trends are established with measured data throughout the supersonic Mach number range. A spline panel method is introduced to generalize the present method to include the effect of body asymmetry. Dissert. Abstr.

N87-29465 George Washington Univ., Washington, D.C.
FULL-POTENTIAL MODELING OF BLADE-VORTEX INTERACTIONS Ph.D. Thesis
HENRY EDWARD JONES 1987 193 p
Avail: Univ. Microfilms Order No. DA8708054

The primary goal was to investigate the effectiveness of the various methods of modeling a blade-vortex interaction (BVI). The problem was studied within the context of a 2-dimensional model problem, which represents one of the limiting types of BVIs. The model problem restricts the interaction to that of an infinite wing with an infinite line vortex moving parallel to its leading edge. A full-potential algorithm specifically tailored to solve the BVI was developed to solve this problem. The algorithm makes use of the unsteady mass conservation and Bernoulli equations to form a full-potential model of the flow field. The basic algorithm was modified to include the effect of a vortex passing near the airfoil. Four different methods of modeling the vortex were used: the angle-of-attack, the lifting-surface, the branch-cut, and the split-potential. A side by side comparison of the four models was conducted. These comparisons include: comparing generated velocity fields, a subcritical interaction, and a critical interaction. The split-potential model was used to make a survey of some of the more critical parameters which effect BVI. For the vortex parameters, the freestream Mach number was chosen to be just subcritical in order to study the effect of the vortex on the formulation of critical flow on the airfoil. Dissert. Abstr.

N87-29466 California Univ., Los Angeles.
AN EXPERIMENTAL INVESTIGATION OF WING-TIP TURBULENCE AND SOUND RADIATED FROM THE TIP REGION OF A BLUNT-TIPPED AIRFOIL Ph.D. Thesis
SALLY ANNE MCINERNY 1987 311 p
Avail: Univ. Microfilms Order No. DA8713713

The characteristics of turbulence generated in the tip region of a blunt-tipped airfoil were studied using surface pressure measurements and limited hot-wire, velocity measurements. Tests were performed in the NASA Ames 7 x 10 foot wind tunnel at flow speeds of 75, 55, and 35 m/s (Reynolds numbers based on wing chord were 1.9, 3.0, and 4.1 x 10 to the 6th power) and angles of attack of 16, 12, and 6 degrees. The maximum, rms, pressure fluctuations measured in the tip region were on the order of the induced drag, or roughly proportional to the angle of attack squared. Dimensionless, pressure spectra measured at a fixed location and angle of attack collapsed well on the variables, t (the wing thickness) and U sub 0 (the freestream velocity). Upper surface pressure fluctuations were poorly correlated with those on the blunt tip. Fluctuations on the high pressure side of the wing were strongly correlated with, but 10 to 20 dB less intense than, those on the flat tip. A model was proposed that may explain the complex patterns of the measured surface pressure spectra and surface pressure cross-correlations. Two distinct sources of blunt tip noise were found at an angle of attack of 16 degrees.
Dissert. Abstr.

N87-29467 Notre Dame Univ., Ind.
THE STRUCTURE OF LEADING EDGE VORTEX FLOWS INCLUDING VORTEX BREAKDOWN Ph.D. Thesis
FRANCIS MICHAEL PAYNE 1987 351 p
Avail: Univ. Microfilms Order No. DA8712952

The structure of leading edge vortex flows on thin sharp edged delta wings was investigated at low Reynolds numbers. Flow visualization techniques were used to study the topology of the vortex and the phenomenon of vortex breakdown. Seven hole probe wake surveys and laser Doppler anemometer measurements were obtained and compared. Smoke flow visualization revealed the presence of small Kelvin-Helmholtz type vortical structures in the shear layer of a leading edge vortex. These shear layer vortices follow a helical path and grow in the streamwise direction as they wind into the vortex core where the individual shear layers merge. The phenomenon of vortex breakdown was studied using high speed cinema photography. The bubble and spiral type of breakdown were observed and appear to represent the extremes in a continuum of breakdown forms. Good agreement was obtained between the pressure probe and laser anemometer measurements. The influence of the probe on the vortex at critical conditions was found to depend on the size of the probe, the wing sweep, and the location of the breakdown relative to the wing.
Dissert. Abstr.

03

AIR TRANSPORTATION AND SAFETY

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

A87-53780*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STRUCTURAL DYNAMICS RESEARCH IN A FULL-SCALE TRANSPORT AIRCRAFT CRASH TEST
HARVEY G. MCCOMB, JR., ROBERT J. HAYDUK (NASA, Langley Research Center, Hampton, VA), and ROBERT G. THOMSON (ICAS, Congress, 15th, London, England, Sept. 7-12, 1986, Proceedings. Volume 1, p. 703-713) Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 447-453. Previously cited in issue 24, p. 3537, Accession no. A86-49053. refs

A87-53783*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
POOL FIRES IN A SIMULATED AIRCRAFT CABIN INTERIOR WITH VENTILATION
C. P. BANKSTON, L. H. BACK, Y. I. CHO, and P. SHAKKOTTAI (California Institute of Technology, Jet Propulsion Laboratory, Pasadena) Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 470-472. NASA-supported research. refs

Results of experiments conducted at the JPL to evaluate aircraft postcrash fire hazards are presented. The experiments were carried out in a one-third scale simulated aircraft cabin geometry to study pool fire and ventilation flow interactions. It is shown that wind-induced ventilation may significantly affect fire plume orientation, smoke transport, and heat fluxes and thus will affect subsequent fire spread and the immediate survivability of the passengers. K.K.

A87-54191#
ICING AND DE-ICING ON A DOWNSCALE MODEL IN ONERA S1 MA WIND TUNNEL
D. GUFFOND, J. CASSAING, and J.-P. DREVET (ONERA, Chatillon-sous-Bagneux, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 2, 1987, p. 23-32. refs

Icing and de-icing tests have been conducted with a one quarter scale rotor in the S1MA wind tunnel in Modane, France. The main results are presented and compared with data from wind tunnel blade component tests and flight test. Influence of outside air temperature, droplet diameter, water flux density and local velocity on the shape of the deposit ice and the aerodynamic distortion are presented. Differences have been found between down scale and full scale de-icing. These tests have also provided the framework for a study of the refreezing phenomena and the role of the different de-icer heating elements. Author

A87-54315
AIRCRAFT FIRES - LIVING THROUGH THE SMOKE
HELEN GAVAGHAN New Scientist (ISSN 0028-6664), vol. 115, Aug. 6, 1987, p. 54-57.

An evaluation is made of the results of a UK Accident Investigation Branch study of the August 22, 1985 fire aboard a B 737 airliner, which was at that time located on a runway at Manchester Airport in Britain. These findings are then used as the primary evidence in consideration of whether passengers' chances of escape from an airliner fire of this type are increased by the use of smoke-hoods to protect each individual from the inhalation of smoke and toxic fumes. Survey figures on the support for such devices among aircraft manufacturers, operators, pilots and passengers, etc., are noted. O.C.

N87-28528# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS. BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 2, 1986 ACCIDENTS
18 Jun. 1987 414 p
(PB87-916904; NTSB/AAB-87/04) Avail: NTIS HC A18/MF A01; also available on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01C

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1986. The approximately 200 General Aviation and Air Carrier accidents contained in this publication represent a random selection. The publication is issued regularly, normally eighteen times each year. The Brief Format presents the facts, conditions, circumstances, and probable cause(s) for each accident. GRA

N87-28529# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS. BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 3, 1986 ACCIDENTS
8 Jun. 1987 410 p
(PB87-916905; NTSB/AAB-87/05) Avail: NTIS HC A18/MF A01; also available on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01C

The publication contains selected aircraft accident reports in brief format occurring in U.S. civil and foreign aviations operations during Calendar Year 1986. The approximately 200 General Aviation and Air Carrier accidents contained in this publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format presents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

N87-29468# General Accounting Office, Washington, D. C. Resources, Community and Economic Development Div.
AVIATION SAFETY: PROCEDURES FOR REGISTERING AND CERTIFYING AIR CARRIERS
May 1987 36 p
(PB87-193249; GAO/RCED-87-115FS; B-226786) Avail: NTIS HC A03/MF A01 CSCL 01C

The fact sheet describes the procedures two Dept. of Transportation (DOT) organizations, the Office of the Secretary of Transportation (OST) and the Federal Aviation Administration (FAA), use to register and certify air carriers of the type chartered by the Department of Defense (DOD). To document the procedures OST and FAA use to determine whether an air carrier should be granted these documents, officials were interviewed at OST and FAA headquarters and at FAA's flight standards district office in Seattle, Wash. At these locations, applicable FARS and various DOT, OST, and FAA records were reviewed. Although the registration and certification processes were documented, how well they were actually being carried out was not evaluated nor was how well OST monitors registration and certifications once they were granted. The report on the FAA's air carrier inspection program addresses how well FAA's inspection program monitors air carriers after they receive FAA operating certificates. GRA

N87-29469*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
JET TRANSPORT FLIGHT OPERATIONS USING COCKPIT DISPLAY OF TRAFFIC INFORMATION DURING INSTRUMENT METEOROLOGICAL CONDITIONS: SIMULATION EVALUATION
DAVID H. WILLIAMS and DOUGLAS C. WELLS May 1986 50 p
(NASA-TP-2567; L-16091; NAS 1.60:2567) Avail: NTIS HC A03/MF A01 CSCL 01C

A simulation study was undertaken to evaluate flight operations using cockpit display of traffic information (CDTI) in a conventional jet transport aircraft. Eight two-person airline flight crews participated as test subjects flying simulated terminal area approach and departure operations under instrument meteorological conditions (IMC). A fixed-base cockpit simulator configured with a full complement of conventional electromechanical instrumentation to permit full workload operations was utilized. Traffic information was displayed on a color cathode-ray tube (CRT) mounted above the throttle quadrant in the typical weather radar location. A transparent touchpanel overlay was utilized for pilot interface with the display. Air traffic control (ATC) simulation included an experienced controller and full partyline radio environment for evaluation of pilot-controlled self-separation and traffic situation monitoring tasks. Results of the study revealed the CDTI to be well received by the test subjects as a useful system which could be incorporated into an existing jet transport cockpit. Crew coordination and consistent operating procedures were identified as important considerations in operational implementation of traffic displays. Cockpit workload was increased with active CDTI tasks. However, all test subjects rated the increase to be acceptable. Author

N87-29470*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NEW METHODS AND MATERIALS FOR MOLDING AND CASTING ICE FORMATIONS
ANDREW L. REEHORST and G. PAUL RICHTER Sep. 1987 16 p
(NASA-TM-100126; E-3673; NAS 1.15:100126) Avail: NTIS HC A02/MF A01 CSCL 01C

This study was designed to find improved materials and techniques for molding and casting natural or simulated ice shapes that could replace the wax and plaster method. By utilizing modern molding and casting materials and techniques, a new methodology was developed that provides excellent reproduction, low-temperature capability, and reasonable turnaround time. The resulting casts are accurate and tough. Author

N87-29471*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYSIS OF CONVAIR 990 REJECTED-TAKEOFF ACCIDENT WITH EMPHASIS ON DECISION MAKING, TRAINING AND PROCEDURES
BYRON E. BATTHAUER 1987 23 p Presented at the 40th International Air Safety Seminar, Tokyo, Japan, 26-29 Oct. 1987; sponsored by the Flight Safety Foundation, Inc.
(NASA-TM-100189; E-3771; NAS 1.15:100189) Avail: NTIS HC A02/MF A01 CSCL 01C

This paper analyzes a NASA Convair 990 (CV-990) accident with emphasis on rejected-takeoff (RTO) decision making, training, procedures, and accident statistics. The NASA Aircraft Accident Investigation Board was somewhat perplexed that an aircraft could be destroyed as a result of blown tires during the takeoff roll. To provide a better understanding of tire failure RTO's, The Board obtained accident reports, Federal Aviation Administration (FAA) studies, and other pertinent information related to the elements of this accident. This material enhanced the analysis process and convinced the Accident Board that high-speed RTO's in transport aircraft should be given more emphasis during pilot training. Pilots should be made aware of various RTO situations and statistics with emphasis on failed-tire RTO's. This background information could enhance the split-second decision-making process that is required prior to initiating an RTO. Author

N87-29472# Air Force Occupational and Environmental Health Lab., Brooks AFB, Tex.
COMBUSTION BY-PRODUCTS ON F-4 DROGUE PARACHUTES Final Report
BRUCE J. POITRAST, WILLIAM C. KELLER, and ROBERT G. ELVES Jun. 1987 8 p
(AD-A182929; USAFOEHL-87-073C00253FOC) Avail: NTIS HC A02/MF A01 CSCL 01C

Concerns of F-4 drogue parachute packers concerning cracking and peeling dry skin led to analysis of the parachutes for polynuclear aromatic hydrocarbons (PAH). F-4 drogue parachutes with varying numbers of deployments were analyzed for PAH. Results show a linear increase of PAH concentration with increasing deployments. Protective measures are suggested. GRA

N87-29473# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
LOW ALTITUDE LIGHTNING ATTACHMENT TO AN AIRCRAFT Interim Report, Oct. 1983 - Feb. 1985
PEDRO L. RUSTAN, JR., BRIAN P. KUHLMAN, HAROLD D. BURKET, JEAN S. REAZER, and ARTURO SERRANO May 1987 183 p
(AD-A183290; AFWAL-TR-86-3009) Avail: NTIS HC A09/MF A01 CSCL 04A

A CV-580 aircraft was instrumented with external displacement current density sensors, surface current density sensors, current shunts, and static electric field mill sensors and was flown in the neighborhood of active thunderstorms in central Florida during Summer 1984. Electromagnetic data were collected for 21 direct lighting strikes to the aircraft at altitudes between 2,000 and 18,000 ft. The data consisted of DC to 2 MHz analog records and 10.24

microsecond windows of digital samples taken at five nanosecond intervals. The data show the physical mechanism of lightning attachment to the aircraft. GRA

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A87-51231
THE MLS ANGLE RECEIVER [LE RECEPTEUR ANGULAIRE MLS]
M. SCHILLIGER (LMT Radio Profesionnelle, Boulogne-Billancourt, France) Navigation (Paris) (ISSN 0028-1530), vol. 34, Oct. 1986, p. 415-440. In French.

The MLS angle receiver and its performance specifications are discussed, and the various angle functions and data transmission functions processed by the receiver are described. MLS functions are transmitted on a single channel using time division multiplexing, and they are processed in real time. Characteristics of the analog and digital interfaces of the receiver are considered. Technical specifications, based on the EUROCAE ED 36 specifications, are discussed, including receiver sensitivity, the rejection of parasitic signals, and angle measurement precision. The received MLS signal is described, and the functions of RF processing, preamble and DPSK data decoding, and digital processing of the angle data are discussed. Results of flight tests performed aboard a Nord 260 aircraft are presented. R.R.

A87-51322
AVIATION SATCOMS
CHRIS BULLOCH Space Markets (ISSN 0258-4212), Summer 1987, p. 60-66.

The ARINC and Inmarsat approaches to the development of aeronautical satellite communications are described. The ARINC approach involves obtaining the support of users prior to developing the service, and Inmarsat's goal is to launch its communications system and obtain users by proving the system's technical and economic viability. The use of an aeronautical satellite communication system for passenger communications is discussed. The designs and capabilities of the ARINC and Inmarsat aeronautical satellite communications systems are examined. I.F.

A87-51325
SPACE-AGE NAVIGATION
CHRIS BULLOCH Space Markets (ISSN 0258-4212), Summer 1987, p. 100-105.

Various satellite-based navigation systems are analyzed. The features and availability of the Navstar GPS are described. Methods for improving the performance of the system, in particular in the coarse/acquisition mode, are proposed. The use of the ESA Navsat concept for civil navigation use, and the advantages and disadvantages of user active versus passive systems are examined. The benefits satellites can provide to navigation and the need for new satellite-based navigation systems are discussed. I.F.

A87-52765
DYNAMIC POSITIONING USING GPS CARRIER PHASE MEASUREMENTS
GERALD L. MADER (NOAA, Geodetic Research and Development Laboratory, Rockville, MD) Manuscripta Geodaetica (ISSN 0340-8825), vol. 11, Dec. 1986, p. 272-277.

The technique by which GPS carrier phase measurements may be used for precise dynamic positioning are developed. This technique requires at least one fixed receiver and continuous tracking of at least four GPS satellites. Some techniques for correcting cycle slips in the phase data on moving platforms are also discussed. Test data obtained aboard a P-3 aircraft demonstrate the feasibility of dynamic carrier phase measurements and the achievement of decimeter accuracy. Author

A87-53578
INERTIAL-GPS - A MARRIAGE OF CONVENIENCE UNDER TEST
P. LLORET and B. CAPIT (SAGEM - Societe d'Applications Generales d'Electricite et de Mecanique, Departement Aeronautique, Paris, France) Navigation (Paris) (ISSN 0028-1530), vol. 35, July 1987, p. 295-325. In French.

This paper provides synthetic results of a 'loose coupling' between a GPS receiver and a gimballed inertial system (a ULISS 1 Nm/hr class navigator of SAGEM) which was test flown in 1986 at the official flight test center of Bretigny (France). The net result of this 'loose coupling' is that the inertial system is flight aligned by the GPS in such a way that 'post coupling inertial navigation' shows an accuracy comparable with that of a freshly ground aligned inertial system, i.e. typical velocity errors in the order of 0.2 to 0.3 m/s for one to two hours of navigation. The paper also describes typical errors observed with the stand alone GPS, and gives an overview of past experience with comparable inertial/radio-navigation couplings (Inertial/DME, Transit, Omega, ILS, Terrain Contour Matching), as well as considerations about the various possible and recommended combinations of inertial systems (depending on their accuracy and mechanization, i.e. conventional or 'strap down') and GPS receivers (C/A or P code, 2 or 5 channel, etc.). Author

A87-53580
SATELLITES FOR AIR NAVIGATION - AN AIRLINE VIEW [LES SATELLITES AERONAUTIQUES - L'OPINION D'UNE COMPAGNIE]
C. CASTELBOU (Air France, Paris, France) Navigation (Paris) (ISSN 0028-1530), vol. 35, July 1987, p. 338-348. In French.

The possibility of a satellite-based integrated system of communications and navigation for commercial aircraft is discussed, and obstacles are addressed. Recent emphasis has been on navigation, and with the exception of the ACARS system of data transmission using VHF, little recent progress in satellite-based communications has been made. Objectives of the global approach include immediate goals such as reduced maintenance costs and improved automatic pilot and flight management system guidance, and future goals such as reduction in the horizontal separation between aircraft in airspaces with heavy traffic. The aircraft and ground-based equipment for a global system are discussed. The present satellite-based system is projected to make use of the 1545-1559 and 1646.5-1660.5 MHz frequency bands. R.R.

A87-53582
THE ROLE OF NAVSTAR/GPS IN CIVIL AVIATION [LA PLACE DE NAVSTAR/GPS DANS L'AVIATION CIVILE]
OLIVIER CAREL (Direction Generale de l'Aviation Civile, Service Technique de la Navigation Aerienne, Paris, France) Navigation (Paris) (ISSN 0028-1530), vol. 35, July 1987, p. 358-368. In French. refs

An ICAO Future Air Navigation Systems (FANS) perspective on the role of the Navstar/GPS system in future civil aviation is presented. The general notions of performance parameters (including precision and coverage) and reliability parameters (including service continuity, integrity, and the time of reaction to out-of-tolerance operation) for communication, navigation, and surveillance systems are first considered. The role of FANS in the ICAO is then reviewed. The projected importance of GPS and MLS in future navigation, and the application of GPS to various civil aeronautical programs are discussed. It is suggested that the operational safety which will be required for future navigation systems can be achieved by a geostationary complement to the GPS. R.R.

A87-53800
AIRBORNE NAVIGATION PLOTS ITS FUTURE
PIERRE CONDOM Interavia (ISSN 0020-5168), vol. 42, Aug. 1987, p. 850-852, 854, 856.

The association between inertial navigation and GPS in the future of airborne navigation is discussed. The development of all-inertial navigation systems over the past 30 years is reviewed, and various hybrids of inertial systems with complementary navigation systems that have been tried are summarized. Inertial/GPS hybrids of the future are addressed, and the choices in this area that the military and industry will be making are considered. C.D.

A87-54367* National Aeronautics and Space Administration. Wallops Flight Center, Wallops Island, Va.
AIRCRAFT POSITIONING USING GLOBAL POSITIONING SYSTEM CARRIER PHASE DATA
WILLIAM B. KRABILL (NASA, Wallops Flight Center, Wallops Island, VA) and CHRESTON F. MARTIN (EG&G Washington Analytical Service Center, Inc., Lanham, MD) Navigation (ISSN 0028-1522), vol. 34, Spring 1987, p. 1-21. refs

Results from a flight test of a GPS carrier phase tracking receiver operated on a NASA Orion P-3 aircraft are presented. The trajectory of the aircraft relative to a second, fixed receiver has been determined. The test was made over water, and the GPS vertical trajectory is compared to airborne lidar measured altitude data from the NASA Airborne Oceanographic Lidar. The two data sets compare with a relative accuracy of 12 centimeters rms, under poor GPS satellite geometry for vertical positioning. Analysis indicates that 1 to 2 centimeters relative vertical positioning is achievable with carrier phase tracking receivers and good GPS geometry. Author

N87-28530# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugfuehrung.
MODELING OF SYSTEMS FOR AIRCRAFT GUIDANCE AND AIR TRAFFIC CONTROL FOR RESEARCH, DEVELOPMENT, AND EVALUATION
Nov. 1986 215 p In GERMAN; ENGLISH summary Colloquium held in Brunswick, West Germany, 30 Jun. - 1 Jul. 1986 Report will also be announced as translation (ESA-TT-1071)
(DFVLR-MITT-86-24; ISSN-0176-7739; ETN-87-90046) Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

The role of models as tools for research and development is presented. The modeling of the dynamic anticipatory control as a decisive element of predetermined helicopter control systems; the modeling of radio navigation systems near airports; and the modeling of the fault situation in navigation systems are treated. The simulation of strapdown systems for error analysis and for the support of the integration of novel systems; and models for the description of air traffic holding procedures and air traffic control scenarios are examined. A model approach for the man machine system pilot-aircraft is described. Models and evaluation procedure for the ground based approach planning system COMPAS are given. ESA

N87-28531# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
ROLE AND TASK OF MODELS AS TOOLS FOR RESEARCH AND DEVELOPMENT [ROLLE UND AUFGABE VON MODELLEN ALS WERKZEUGE FUER FORSCHUNG UND ENTWICKLUNG]
HEINZ WINTER *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 7-18 Nov. 1986 In GERMAN
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

Simulation models are classified and their application domains are outlined. It is shown that modeling is not an isolated field of activity, but that the research results in artificial intelligence make classes of models such as symbolic models highly important. ESA

N87-28533# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
MODELING OF RADIO NAVIGATION SYSTEMS IN THE NEIGHBORHOOD OF AIRPORTS [MODELLIERUNG VON FUNKNAVIGATIONSSYSTEMEN IM FLUGHAFENNAHBEREICH]
ALFRED BECKER and WOLF-DIETER KABIERSCH *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 39-66 Nov. 1986 In GERMAN
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

Landing system models which allow a complete computer simulation of landing in a selected airport scenario were investigated. The environment (scenario, trajectory) model, the microwave landing system, and the precision distance measuring equipment model were considered. The purpose and simulation limitations of the different models are presented, and the models are applied to the example of Braunschweig airport (West Germany). ESA

N87-28534# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
MODELING OF THE FAULT SITUATION IN NAVIGATION SYSTEMS [MODELLIERUNG DER FEHLER-SITUATION BEI NAVIGATIONSSYSTEMEN]
KARLHEINZ HURRASS *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 67-80 Nov. 1986 In GERMAN
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

Functional models for the description of the fault behavior of navigation systems are treated. Radio navigation systems and airborne autonomous systems (Doppler navigation, air data navigation, and inertial navigation) are considered. Examples show that the description of the fault behavior in the form of functional models is required for integrated navigation systems, simulations, and routing design. ESA

N87-28535# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
SIMULATION OF STRAPDOWN SYSTEMS FOR ERROR ANALYSIS, AND MODELING FOR NAVIGATION WITH OTHER SENSOR SYSTEMS [SIMULATION VON STRAPDOWN-SYSTEMEN FUER DIE FEHLER-ANALYSE UND MODELLIERUNG ZUR INTEGRATION MIT ANDEREN SENSOR-SYSTEMEN]
BERNHARD STIELER *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 81-104 Nov. 1986 In GERMAN
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

The simulation of strapdown systems for the investigation of systems errors in conventional and novel systems concepts, and for the support of the integration of novel systems, was examined. The covariance and Monte Carlo simulation for the determination of the error behavior of strapdown systems are presented. It is shown that the required navigation accuracy in conventional systems can only be obtained with laser gyroscope strapdown systems. Error modeling of a laser gyroscope strapdown system for application in a Kalman filter is explained. The navigation accuracy does not only depend on the sensor accuracy, but also on the system configuration. Strapdown system configurations which allow a better accuracy and a broader application domain are presented. ESA

N87-28536# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
MODELS FOR THE DESCRIPTION OF HOLDING PROCEDURES IN AIR TRAFFIC AS AN AID FOR OPTIMIZATION WITH RESPECT TO SAFETY AND EFFICIENCY [MODELLE ZUR BESCHREIBUNG VON WARTEVERFAHREN IM LUFTVERKEHR ALS HILFSMITTEL EINER OPTIMIERUNG HINSICHTLICH SICHERHEIT UND WIRTSCHAFTLICHKEIT]
ULRICH BROKOF *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 105-131 Nov. 1986 In GERMAN
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

Models for the determination of flight contours for holding procedures were investigated. Problems and methods in the production of holding patterns are discussed. Statistical estimation methods and Monte Carlo simulation of a holding procedure for safety holding are outlined. The statistical methods are complicated and require simplification. The Monte Carlo simulation of holding contours is very flexible and shows satisfactory results. ESA

N87-28537# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
A MULTICHANNEL MODEL FOR THE DESCRIPTION OF THE PILOT IN THE CLOSED CONTROL SYSTEM, FOR THE EVALUATION OF FUTURE AIRCRAFT GUIDANCE SYSTEMS [EIN MEHRKANALIGES MODELL ZUR BESCHREIBUNG DES PILOTEN IM GESCHLOSSENEN REGELKREIS FUER DIE BEWERTUNG ZUKUENFTIGER FLUGFUEHRUNGSSYSTEME]
UWE TEEGEN *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 133-149 Nov. 1986 In GERMAN
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

A model approach for the man machine system pilot-aircraft is described. It is a control engineering approach for manual aircraft control. The characteristic data which describe a man-machine system, and the construction of the model are presented. The modeling and evaluation of a system for wind shear reduction are discussed. Moving cockpit simulator tests show many positive results for the wind shear reduction system. The indications have to be improved. The limitations of the modeling are indicated. ESA

N87-28538# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
MODELS OF THE DESCRIPTION OF AIR TRAFFIC CONTROL SCENARIOS, FOR THE EVALUATION OF FUTURE AIR TRAFFIC CONTROL SYSTEMS [MODELLE FUER DIE BESCHREIBUNG VON SZENARIEN DER FLUGSICHERUNG FUER DIE BEWERTUNG ZUKUENFTIGER FLUGSICHERUNGSSYSTEME]
JOSEF THOMAS *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 151-173 Nov. 1986 Partly in GERMAN and ENGLISH
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

Model representations for the evaluation of candidate scenarios for air navigation systems are treated. The meteorological aspects of the scenario development are reviewed. Questions related to modeling, especially under the conditions of a real time simulation, are discussed. The required degree of detail accuracy in a model in order to reach a given research goal is discussed. The applicability of the methodology to future scenarios is outlined. A work plan for the development of scenarios is included. ESA

N87-28539# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
MODELS FOR THE GROUND BASED APPROACH PLANNING SYSTEM COMPUTER ORIENTED METERING PLANNING AND ADVISORY SYSTEM (COMPAS) [MODELLE FUER DIE BODENSEITIGE ANFLUGPLANUNG COMPAS]
MANFRED SCHUBERT and UWE VOELCKERS *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 175-198 Nov. 1986 In GERMAN
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

The Computer Oriented Metering Planning and Advisory System (COMPAS) is presented, and correlations and problems in approach planning are described. The COMPAS system definition, purpose, and arrangement; the data processing concept; the models and procedures; and the system construction and simulation are explained. ESA

N87-28540# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
SYSTEMS EVALUATION PROCEDURE USING SIMULATION ILLUSTRATED BY THE COMPUTER ORIENTED METERING PLANNING AND ADVISORY SYSTEM (COMPAS) PROJECT [VERFAHREN DER SYSTEMBEWERTUNG MIT HILFE DER SIMULATION AM BEISPIEL DES PROJEKTS COMPAS]
FRED-VOLKER SCHICK *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 199-212 Nov. 1986 In GERMAN
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

The ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) was evaluated using models for air traffic control scenarios and models for approach planning, united in a real time simulation. The simulation provides conditions close to reality. The constancy and reproducibility of the working conditions were used for a comparison between existing approach control and a computer assisted approach system. The concept of the system COMPAS, the applied measuring methods, and the evaluation procedure are presented. The effects of COMPAS on air traffic flow control and on the work of the controller (anthropotechnical evaluation) were evaluated. ESA

N87-29474# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.
ADVANCES IN GUIDANCE AND CONTROL SYSTEMS AND TECHNOLOGY
Jul. 1987 146 p Symposium held in London, England, 7-10 Oct. 1986 Original contains color illustrations
(AGARD-CP-411; ISBN-92-835-0421-6) Avail: NTIS HC A07/MF A01

Papers were presented under the following headings: target and terrain sensors; aircraft state sensors; force and moment generators; guidance and control algorithms; and integrated systems.

N87-29477# Army Avionics Research and Development Activity, Fort Monmouth, N. J.
VELOCITY ACCURACY MEASUREMENT OF GPS USER EQUIPMENT
JOSEPH MCGOWAN *In* AGARD, Advances in Guidance and Control Systems and Technology 17 p Jul. 1987
Avail: NTIS HC A07/MF A01

A test program conducted by the U.S. Army Avionics Research and Development Activity (AVRADA) to determine the level of velocity accuracy achievable with Global Positioning System (GPS) is described. The precision of the reference instrumentation and the availability of the GPS receiver measurement data were exploited to characterize the errors in GPS observables. An investigation into the performance benefits of GPS and inertial integration is described. Author

N87-29480# Honeywell Advanced Technology Centre, North York (Ontario).
CONFIGURATION DESIGN OF A HELICOPTER INTEGRATED NAVIGATION SYSTEM
S. I. FINGEROTE, D. B. REID, D. F. LIANG, L. VALLOT, C. GREENE, and J. MAHESH (Honeywell Systems and Research Center, Minneapolis, Minn.) *In* AGARD, Advances in Guidance and Control Systems and Technology 9 p Jul. 1987
Avail: NTIS HC A07/MF A01

Results are presented from the configuration performance study phase of the Helicopter Integrated Navigation System project. A configuration assessment is presented including processor selection, and a discussion of system architecture and configuration tradeoffs leading to a recommended configuration. Results of the system error analysis and the Kalman filter design are presented demonstrating integrated system performance. Author

N87-29481# Litton Technische Werke, Freiburg (West Germany).
NAVIGATION SYSTEMS FOR THE NEW GENERATION OF COMBAT AND TRANSPORT HELICOPTERS AND ASSOCIATED FLIGHT TESTS
W. HASSENPFLUG and M. BAEUMKER *In* AGARD, Advances in Guidance and Control Systems and Technology 22 p Jul. 1987
Avail: NTIS HC A07/MF A01

An integrated strapdown inertial helicopter navigator which is augmented by a Doppler velocity sensor and a magnetometer is described. A radar altimeter is used to obtain height above ground. Accurate weapon delivery requirements and flight safety aspects while operating the helicopter under adverse weather conditions and at night demand the accurate determination of TAS throughout the entire speed regime. Besides position, velocity, and attitude, the strapdown system provides angular rates for stability augmentation and linear accelerations in bodyframe coordinates, inertial altitude and vertical speed from the Doppler velocity sensor and the baro-inertial loop as well. The system communicates with the other avionics on board the helicopter through a duel MIL-STD 1553B bus and for redundancy purposes through an ARINC 429 interface with the AFCS. Flight tests were performed to demonstrate the navigation capability and performance of a Doppler and flux valve augmented strapdown navigator, a new analytical true air speed system for the low speed regime and the performance of a strapdown magnetometer. The navigation performance was verified in three different helicopters, a BO-105, a CH-53, and a Gazelle. Author

N87-29487# Federal Aviation Administration, Atlantic City, N.J.
HELIPORT CRITICAL AREA FLIGHT TEST RESULTS
BARRY R. BILLMANN, MICHAEL M. WEBB, JOHN G. MORROW, DONALD W. GALLAGHER, and CHRISTOPHER J. WOLF Feb. 1987 145 p
(AD-A183153; DOT/FAA/CT-TN86/64) Avail: NTIS HC A07/MF A01 CSCL 17G

The development of the microwave landing system (MLS) has resulted in the need for several different flight tests to optimize its utility. One such series of tests was designed to define criteria for siting MLS antennas at heliports. Due to the unique maneuver capabilities and the limited real estate available at heliports, flight tests were also conducted to determine the airspace and real estate surrounding the MLS antennas which must be protected when the MLS is sited at heliports. The need for this protected region is to guarantee signal coverage and quality. Based on the test flight results conducted at the Federal Aviation Administration (FAA) Technical Center, a minimum region (surrounding the MLS antennas and signal monitor poles) which must be protected is identified. GRA

N87-29488# Federal Aviation Administration, Atlantic City, N.J.
TEST PLAN FOR HELICOPTER GPS (GLOBAL POSITIONING SYSTEM) APPLICATIONS
MICHAEL MAGROGAN May 1987 18 p
(AD-A183299; DOT/FAA/CT-TN87/16) Avail: NTIS HC A02/MF A01 CSCL 17G

This test plan describes a project designed to collect data via flight testing from the Global Positioning System (GPS) when receivers are mounted on helicopters. GPS issues to be investigated include antenna location, satellite shielding, and multipath influences which might occur with rotorcraft applications in urban downtown areas. Minimum masking angle issues will also be addressed. GPS integrated with other navigation and guidance systems such as Microwave Landing System (MLS) and Loran C will also be investigated. Both precision (P) and coarse/acquisition (C/A) code receivers will be evaluated. In addition, studies will be carried out to determine how to install a GPS antenna on composite body aircraft. Further studies may be related to automatic dependent surveillance functions. Future work will include evaluation of a GPS P code receiver as a reference for flight inspection. GRA

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A87-51214
THE PREDICTION OF THE VIBRATORY AIRLOADS OF HELICOPTER ROTORS IN FORWARD FLIGHT
R. H. MILLER (MIT, Cambridge, MA) Journal of Fluids and Structures (ISSN 0889-9746), vol. 1, Jan. 1987, p. 107-119. refs

The determination of the vibratory airloads generated by helicopter rotors in forward flight presents a difficult problem in unsteady aerodynamics. However, their analytical prediction in the design phase is essential if the vibration level is to be controlled and rotor fatigue loads minimized. Recent advances in developing free-wake vortex theories for rotors in forward flight which are sufficiently compact for design purposes, yet agree well with the experimentally-determined blade loads, are discussed. The effects of modifications in blade geometry and of blade elasticity on the vibratory loads are shown. Author

A87-51347
PIAGGIO'S AVANTI COMBINES JET-LIKE HANDLING WITH TURBOPROP EFFICIENCY
BRENDAN M. GREELEY, JR. Aviation Week and Space Technology (ISSN 0005-2175), vol. 127, Aug. 10, 1987, p. 118-120, 123, 126, 129.

A design features and flight characteristics evaluation is presented for the Avanti twin-turboprop, canard-configuration business aircraft, of which two prototypes are currently flying. The primarily metallic airframe structural philosophy reduces costs and improves reliability, and the flight controls are cable-actuated. In the interest of the greatest aerodynamic smoothness, such classic design features as a very high aspect ratio wing, wing skin machining from a single stock, and outside-in fuselage manufacture have been employed. Dimensional and performance data are tabulated. O.C.

A87-52522
GROUND TESTING OF AN OPERATIONAL FIGHTER AIRCRAFT FOR P-STATIC DISCHARGE EFFECTS
E. B. JOFFE IN: 1986 IEEE International Symposium on Electromagnetic Compatibility, San Diego, CA, Sept. 16-18, 1986, Symposium Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1986, p. 288-292. refs

P-static noise on an operational RF-4C aircrat is studied and a method for the isolation of p-static noise sources is described. Sources of interference to the aircraft radio systems included sparks between unbonded surfaces, streamers from dielectric surfaces, and coronal discharges from the extremeties of the aircraft wings and stabilizers. An averall solution consists of the folowing: (1) coating all radomes and dielectric surfaces with an antistatic paint, (2) verification of the bonding of all metal surfaces to the aircraft structure, and (3) appropriate installation of static dischargers on the vertical and horizontal stabilizer trailing edges, and on the wing tips and trailing edges. K.K.

A87-52844#
UHB DEMONSTRATOR FLIGHT TEST PROGRAM
WILLIAM T. LEWERENZ (Douglas Aircraft Co., Long Beach, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 23rd, San Diego, CA, June 29-July 2, 1987. 10 p.
(AIAA PAPER 87-1732)

The design, development, and flight-test objectives of an ultrahigh-bypass (UHB) technology demonstrator using an MD-80 aircraft are presented. The technical challenges associated with UHB engine technology are reviewed. The aircraft modifications required to incorporate the UHB engine; protect the aircraft, crew, and passengers; and test potential solutions to the technical challenges are described. The aircraft modification sequence and flight-test program are also presented. Author

A87-52881#
REDUCING FUEL CONSUMPTION OF SUBSONIC AIRCRAFT BY OPTIMAL CYCLIC CRUISE
GOTTFRIED SACHS and THEODOROS CHRISTODOULOU (Muenchen, Technische Universitaet, Munich, West Germany) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 616-622. refs

Fuel consumption in range and endurance flight is considered as an optimal cyclic control problem. In regard to range cruise, the incompressible and compressible flight regimes are treated separately because each of them shows specific effects for optimal cyclic flight. The improvements achievable in the incompressible flight regime depend on the admissible altitude range. For the compressible flight regime, it is shown that drag rise effects represent a key factor limiting the improvements possible by optimal cyclic cruise. Furthermore, results are presented for endurance flight, which is more improved by optimal cyclic control than is range cruise. Author

A87-52887*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LABORATORY STUDY OF SIDEWALL NOISE TRANSMISSION AND TREATMENT FOR A LIGHT AIRCRAFT FUSELAGE
KAREN H. LYLE and JOHN S. MIXSON (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 660-665. Previously cited in issue 07, p. 844, Accession no. A86-19851. refs

A87-53564
SIMULATION AND CHARACTERISTIC VALUE DETERMINATION IN HELICOPTERS [SIMULATION UND KENNWERTERMITTLUNG VON HUBSCHRAUBERN]
WOLFGANG VON GRUENHAGEN and JUERGEN KALEKTA (DFVLR, Institut fuer Flugmechanik, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), June 1987, p. 11-15. In German.

The use of simulation and characteristic value determination to develop reliable analytical helicopter models is discussed. The different helicopter components are simulated by calculating the forces and moments on them, and the characteristic value determination proceeds by developing a mathematical model of the relationhip between the control and the helicopter movements. The use of vector computers in this area is discussed. C.D.

A87-53573
AN ACTIVE CONTROL LANDING GEAR FOR THE ALLEVIATION OF AIRCRAFT TAXI GROUND LOADS
R. FREYMANN (DFVLR, Institut fuer Aeroelastik, Goettingen, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 11, Mar.-Apr. 1987, p. 97-105. refs.

An active control undercarriage for the alleviation of aircraft landing gear and structural loads during operation on rough runway surfaces is described. For quantitative determination of the improvements obtained with an active control undercarriage (compared with conventional landing gear systems), aircraft taxiing is realistically simualted by means of a laboratory test set-up specially designed for this kind of testing. Author

A87-53744
CORSAIR WITH MORE - A-7 PLUS
MIKE GAINES Flight International (ISSN 0015-3710), vol. 132, Aug. 22, 1987, p. 21-24.

The A-7 Corsair is being reengined and updated to fulfill the US Air Force's close air support, battlefield air interdiction role. The changes being made in the aircraft's engine, fuselage, avionics, and weaponry are described. The planned performance parameters of the updated aircraft are listed. C.D.

A87-53776#
MULTIMISSION STOVL APPLICATION OF A HYBRID POWERED-LIFT SYSTEM
WILLIAM L. POSNETT, III (U.S. Navy, Naval Air Rework Facility, Pensacola, FL), YA-TUNG CHIN (Lockheed-California Co., Burbank), and MAX F. PLATZER (U.S. Naval Postgraduate School, Monterey, CA) Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 417-423. Previously cited in issue 05, p. 590, Accession no. A87-17916. refs

A87-53781#
EXPERIMENTAL AEROELASTIC BEHAVIOR OF FORWARD-SWEPT GRAPHITE/EPOXY WINGS WITH RIGID-BODY FREEDOM
GUN-SHING CHEN and JOHN DUGUNDJI (MIT, Cambridge, MA) (Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1, p. 462-471) Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 454-462. Previously cited in issue 18, p. 2610, Accession no. A86-38851. refs
(Contract F49620-85-C-0099)

A87-53782#
AEROELASTIC OSCILLATIONS CAUSED BY TRANSITIONAL BOUNDARY LAYERS AND THEIR ATTENUATION
D. G. MABEY, P. R. ASHILL, and B. L. WELSH (Royal Aircraft Establishment, Aerodynamics Dept., Bedford, England) Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 463-469. Previously cited in issue 10, p. 1329, Accession no. A86-24731. refs

A87-53798
CANADAIR'S CL-227 SENTINEL GAINS CREDIBILITY
MARK LAMBERT Interavia (ISSN 0020-5168), vol. 42, Aug. 1987, p. 839, 840.

Canadair's new military sensor, the CL-227 Sentinel, is discussed. The CL-227 modes of launch and recovery, which can be from and onto either ground or ship, are described. The configuration and functioning of the sensor are examined. Its use as a helicopter is also addressed. C.D.

A87-53901* SDRC, Inc., San Diego, Calif.
A STUDY OF SOME APPROXIMATIONS IN THE MODELING OF A COUPLED ROTOR/FUSELAGE AEROMECHANICAL SYSTEM
P. A. BLELLOCH (SDRC, Inc., San Diego, CA) and P. P. FRIEDMANN (California, University, Los Angeles) Vertica (ISSN 0360-5450), vol. 11, no. 3, 1987, p. 525-540. refs
(Contract NAG2-116; NAG2-209)

Equations of motion for a three-bladed hingeless rotor coupled to a gimbal-supported fuselage are developed. A brief derivation of the equations is presented, including the assumptions made, the ordering scheme, and a discussion of both the source of the aerodynamic axial load term and the reason for differences due to hinge sequence. The solution of the equations is discussed, including linearization, the use of multiblade coordinates to eliminate periodic coefficients, and specialization to a root-sprung model. The treatment of the blade root offset by using an ordering scheme to neglect higher-order terms is found to affect results in pitch and roll. A small aerodynamic loading term in the blade axial direction has a significant effect at large collective pitch settings, as does the choice of a flap-lag or a lag-flap transformation sequence for blade motion. The results for a hingeless rotor also differ significantly from those for the root-sprung model when the nonrotating natural frequencies are matched. C.D.

A87-54201
HELICOPTER CERTIFICATION - NEW TEST TECHNIQUES
B. PASQUET (Aerospatiale, Division Helicopteres, Marignane, France) Cockpit (ISSN 0742-1508), Apr.-June 1987, p. 5-9.

Safety tests for helicopter cetification have become increasingly stringent in such matters as the extension of altitude envelopes. Attention is presently given to improvements obtained in testing techniques covering the categories of helicopter hover, limiting height/speed envelope in multiengine helicopters, high and low points at zero speed, ability to withstand a wind from any direction in hover, distance to clear 50 feet after takeoff, and all-engines-out landings. The test methods in question do not use ground reference, and yield a large number of intermediate-value test points. O.C.

N87-28541# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
PRELIMINARY AIRWORTHINESS EVALUATION OF THE UH-1H HELICOPTER WITH THE T53-L-703 ENGINE INSTALLED Final Report, 12 Jun. - 18 Oct. 1985
CHARLES E. CASSIL and ROY A. LOCKWOOD Jun. 1986 97 p
(AD-A182369; AD-E951007; USAAEFA-84-25) Avail: NTIS HC A05/MF A01 CSCL 01C

Performance, handling qualities, and overall engine-airframe compatibility were evaluated to substantiate an airworthiness release and appropriate restrictions in the operator's manual. These tests were conducted at Bakersfield, Edwards AFB, Bishop, and Coyote Flats, California. Thirty-four flights were conducted for a total of 26.3 productive flight hours. The performance, handling qualities, and overall engine-airframe compatibility of the aircraft with the T53-L-13B engine are unchanged from those with the T53-L-13B engine when the aircraft is operated within the power-available capability of the -13B. Two shortcomings were identified: (1) poor torque gauge readability, and (2) ignition key location. Engine exhaust impingement on the tail boom produced skin temperatures high enough to cause loss of tail boom structural strength. No engine installation or maintenance problems were encountered during the evaluation. GRA

N87-28542# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
INVESTIGATION OF F-16 CONTROL SURFACE FAILURES AND OPTIMAL SETTING OF FUNCTIONAL CONTROLS M.S. Thesis
ERTUGRUL Y. TURHAL Dec. 1986 287 p
(AD-A182667; AFIT/GAE/AA/86D-19) Avail: NTIS HC A13/MF A01 CSCL 01A

Experimental investigation was conducted in the AFIT 5-Foot Wind Tunnel. 1/20 th scale F-16 model was used. Three different failure cases were investigated. These were fixed deflection of a control surface, floating left flaperson, and missing left flaperson. Angle of attack and sideslip angle varied for each control surface deflection. By using data reduction and least squares fits, the results of the investigation have been plotted. The curve fits were utilized to study control surface settings that produce minimum drag for given flight conditions when a control surface fails. Oil visualization were made for each failure case configuration. These were used to obtain an indication of the flow characteristics on the F-16 model. GRA

N87-28543# Massachusetts Inst. of Tech., Cambridge. Lab. for Advanced Composites.
DYNAMICS AND AEROELASTICITY OF COMPOSITE STRUCTURES Final Report, 1 Jul. 1985 - 30 Jun. 1986
GUN-SHING CHEN and JOHN DUGUNDJI 22 Apr. 1987 209 p
(Contract F49620-84-C-0099)
(AD-A182713; TELAC-86-14A; AFOSR-87-0845TR) Avail: NTIS HC A10/MF A01 CSCL 01C

An analytical and experimental investigation was made of the aeroelastic flutter and divergence behavior of a forward swept graphite epoxy wing aircraft with rigid body freedoms in free flight. Analytically, a transient aeroelastic analysis, using a Rayleigh Ritz formulation, modified strip theory and measured aircraft aerodynamic derivatives, was developed to predict and interpret the aeroelastic behavior and instability mechanisms. The transient aerodynamics approximated the Theodoresen function by Pade approximants and used augmented state variables to investigate stability by standard linear eigenvalue analysis. Some effects of aeroelastic tailoring, wing frequencies, rigid body modes, static stability margins, and inertial coupling effects were explored. Experimentally, a generic, full span, 30 degree forward swept wing aircraft model allowing both rigid body pitch and plunge was constructed and tested in MIT's low speed wind tunnel. The effects of aeroelastic tailoring were demonstrated by using wings with different ply layups, which covered a range of bending twisting coupling. GRA

N87-28544 Virginia Polytechnic Inst. and State Univ., Blacksburg.
SINGULAR TRAJECTORIES IN AIRPLANE CRUISE-DASH OPTIMIZATION Ph.D. Thesis
KARL D. BILIMORIA 1986 119 p
Avail: Univ. Microfilms Order No. DA8710988

The problem of determining cruise-dash trajectories is examined for the case of time-fuel optimization using a linear combination of time and fuel as the performance index. These trajectories consist of a transient arc followed by a steady state arc. For cases where the steady state arc is flown with full throttle the associated skeletal transient trajectories are also flown with full throttle, and approach the cruise-dash point monotonically in an asymptotic fashion. When the steady state arc is flown at an intermediate throttle setting, the transient trajectories follow a singular control law and exhibit a complex structure that is different from the full throttle transients. Singular transients in the vicinity of singular cruise-dash points are confined to a bounded singular surface. In state space these trajectories trace out asymptotic spirals on the singular surface as they approach the steady state arc. If the initial operating point lies outside the singular surface, then the transient trajectories are composites consisting of a full throttle or zero throttle segment flown until the singular surface is met, followed by a singular segment that fairs into the cruise-dash point. Dissert. Abstr.

N87-28545*# McDonnell-Douglas Corp., Long Beach, Calif.
PROPFAN EXPERIMENTAL DATA ANALYSIS
DAVID F. VERNON, GREGORY S. PAGE, and H. ROBERT WELGE Aug. 1984 117 p
(Contract NAS2-11672)
(NASA-CR-166582; NAS 1.26:166582; ACEE-28-FR) Avail: NTIS HC A06/MF A01 CSCL 01C

A data reduction method, which is consistent with the performance prediction methods used for analysis of new aircraft designs, is defined and compared to the method currently used by NASA using data obtained from an Ames Res. Center 11 foot transonic wind tunnel test. Pressure and flow visualization data from the Ames test for both the powered straight underwing nacelle, and an unpowered contoured overwing nacelle installation is used to determine the flow phenomena present for a wind mounted turboprop installation. The test data is compared to analytic methods, showing the analytic methods to be suitable for design and analysis of new configurations. The data analysis indicated that designs with zero interference drag levels are achieveable with proper wind and nacelle tailoring. A new overwing contoured nacelle design and a modification to the wing leading edge extension for the current wind tunnel model design are evaluated. Hardware constraints of the current model parts prevent obtaining any significant performance improvement due to a modified nacelle contouring. A new aspect ratio wing design for an up outboard rotation turboprop installation is defined, and an advanced contoured nacelle is provided. Author

N87-28546*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EXPERIMENTAL TECHNIQUES FOR THREE-AXES LOAD CELLS USED AT THE NATIONAL FULL-SCALE AERODYNAMICS COMPLEX
MICHAEL R. DUDLEY Sep. 1985 55 p
(NASA-TM-86693; REPT-85150; NAS 1.15:86693) Avail: NTIS HC A04/MF A01 CSCL 01C

The necessary information for an aerodynamic investigation requiring load cell force measurements at the National Full-Scale Aerodynamics Complex (NFAC) is provided. Included are details of the Ames 40x80 three component load cells; typical model/load cell installation geometries; transducer signal conditioning; a description of the Ames Standard Computations Wind Tunnel Data Reduction Program for Load Cells Forces and Moments (SCELLS), and the inputs required for SCELLS. The Outdoor Aerodynamic Facilities Complex (OARF), a facility within the NFAC where three axes load cells serve as the primary balance system, is used as an example for many of the techniques, but the information applies equally well to other static and wind tunnel facilities that make use of load cell balances. Author

N87-29297# Siecor Corp., Hickory, N.C.
LIGHTWEIGHT 2 FIBER AVIATION CABLE FEATURING LOW FIBER STRESS LEVELS
BERND D. ZIMMERMANN and JOHN C. CHAMBERLAIN *In* Army Communications-Electronics Command, Proceedings of the 35th International Wire and Cable Symposium, held in Reno, Nevada on 18-20 November 1986 p 526-532 Nov. 1986
(AD-P005282) Avail: NTIS HC A99/MF A01 CSCL 01C

An imminent need for fiber optics in aircraft applications has prompted the development of a lightweight, two-fiber, fanout cable. This cable consists of two fiber optic subunits, two glass reinforced polyester rods, aramid yarn strength members, a helically applied polyimide tape, and an outer fluoropolymer jacket. GRA

N87-29490 ESDU International Ltd., London (England).
ESTIMATION OF SIDEFORCE, YAWING MOMENT AND ROLLING MOMENT DERIVATIVES DUE TO RATE OF ROLL FOR COMPLETE AIRCRAFT AT SUBSONIC SPEEDS
Jun. 1985 34 p
(ESDU-85010; ISBN-0-85679-516-X; ISSN-0141-397X) Avail: ESDU

This Data Item #85010, an addition to the Aerodynamic Sub-series, discusses the application to the complete aeroplane of the prediction methods given for the contributions to the derivatives from wing planform and dihedral, and empennage. Illustrations show for diverse configurations at cruise the relative magnitudes of the contributions for each derivative, and comparisons with experimental data also show the effect of Mach number, incidence, wing sweep, and high lift devices. A detailed comparison of predictions with experimental data drawn from a wide range of sources including tunnel and flight results shows that the side force derivative is predicted to within 0.06, and the rolling moment derivative to within 10 percent. A comprehensive worked example shows the application of the methods. ESDU

N87-29491*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ANTICIPATION OF THE LANDING SHOCK PHENOMENON IN FLIGHT SIMULATION
RICHARD E. MCFARLAND Sep. 1987 17 p
(NASA-TM-89465; A-87237; NAS 1.15:89465) Avail: NTIS HC A02/MF A01 CSCL 01C

An aircraft landing may be described as a controlled crash because a runway surface is intercepted. In a simulation model the transition from aerodynamic flight to weight on wheels involves a single computational cycle during which stiff differential equations are activated; with a significant probability these initial conditions are unrealistic. This occurs because of the finite cycle time, during which large restorative forces will accompany unrealistic initial oleo compressions. This problem was recognized a few years ago at Ames Research Center during simulation studies of a supersonic transport. The mathematical model of this vehicle severely taxed computational resources, and required a large cycle time. The ground strike problem was solved by a described technique called anticipation equations. This extensively used technique has not been previously reported. The technique of anticipating a significant event is a useful tool in the general field of discrete flight simulation. For the differential equations representing a landing gear model stiffness, rate of interception and cycle time may combine to produce an unrealistic simulation of the continuum. Author

N87-29493# Boeing Military Airplane Development, Seattle, Wash.
FIGHTER AIRCRAFT OBIGGS (ON-BOARD INERT GAS GENERATOR SYSTEM) STUDY, VOLUME 1 Final Report, Jul. 1985 - Jan. 1987
W. L. VANNICE and A. F. GRENICH Jun. 1987 125 p
(Contract F33615-85-C-2545)
(AD-A183690; D180-29904-1; AFWAL-TR-87-2024-VOL-1) Avail: NTIS HC A06/MF A01 CSCL 01C

The objective of this study was to develop a prototype development plan for installing the best choice OBIGGS in an Advanced Tactical Fighter (ATF). The best choice OBIGGS was based on detailed studies of inert gas requirements for ATF missions and trade-off studies to arrive at the best system preliminary design. Detailed specifications were defined for the best choice OBIGGS and life cycle cost studies were conducted to compare this OBIGGS with other fuel tank fire protection techniques. Results of the mission analysis and preliminary design studies are presented. GRA

N87-29494# Boeing Military Airplane Development, Seattle, Wash.
FIGHTER AIRCRAFT OBIGGS (ON-BOARD INERT GAS GENERATOR SYSTEM) STUDY, VOLUME 2 Final Report, Jul. 1985 - Jan. 1987
T. J. HOWELL Jun. 1987 197 p
(Contract F33615-85-C-2545)
(AD-A183781; D180-29904-2; AFWAL-TR-87-2024-VOL-2) Avail: NTIS HC A09/MF A01 CSCL 01C

The objective of this study was to develop a prototype development plan for installing the best choice OBIGGS in an Advanced Tactical Fighter (ATF). The best choice OBIGGS was based on detailed studies of inert gas requirements for ATF missions and trade-off studies to arrive at the best system preliminary design. Detailed specifications were defined for the

best choice OBIGGS and life cycle cost studies were conducted to compare this OBIGGS with other fuel tank fire protection techniques. Results of the mission analysis and preliminary design studies are presented in Volume I; results of the other studies and the prototype development plan are in Volume II. GRA

N87-29495# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
FLIGHT EVALUATION OF THE UH-60A HELICOPTER WITH THE PITCH BIAS ACTUATOR CENTERED AND ELECTRICALLY DISCONNECTED Final Report, 4 Apr. 1985 - 2 Jul. 1986
REGINALD C. MURRELL, ROY A. LOCKWOOD, ROBERT A. WILLIAMS, MICHAEL K. HERBST, and GARY L. SKINNER Sep. 1986 279 p
(AD-A183954; USAAEFA-84-28) Avail: NTIS HC A13/MF A01 CSCL 01C

Testing was conducted to evaluate handling qualities of the UH-60A helicopter with the pitch bias actuator (PBA) centered and electrically disconnected and with various modes of automatic flight control system (AFCS) degradation. A total of 46.4 productive flight hours were flown between 4 April 1985 and 2 July 1986. Two shortcomings and two Prime Item Development Specification noncompliances were identified. The handling qualities of the UH-60A helicopter with the PBA centered and electrically disconnected are essentially unchanged from those with the PBA operational, except for: (1) slightly degraded static longitudinal stability, (2) slightly degraded dynamic stability, and (3) a shortcoming, the poor maneuvering stability characteristics. One additional shortcoming is the strong pitch-due-to-sideslip coupling. GRA

N87-29496*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE RESULTS OF A WIND TUNNEL INVESTIGATION OF A MODEL ROTOR WITH A FREE TIP
ROBERT H. STROUB and LARRY A. YOUNG Oct. 1985 176 p
(NASA-TM-86758; REPT-85266; NAS 1.15:86758) Avail: NTIS HC A09/MF A01 CSCL 01C

The results of a wind-tunnel test of the free tip rotor are presented. The free tip extended over the outer 10% of the rotor blade and included a simple, passive controller mechanism. Wind-tunnel test hardware is described. The free-tip assembly, which includes the controller, functioned flawlessly throughout the test. The tip pitched freely and responded to airflow perturbation in a sharp, quick, and stable manner. Tip pitch-angle responses are presented for an advance ratio range of 0.1 to 0.397 and for a thrust coefficient range of 0.038 to 0.092. The free tip reduced power requirements, loads going into the control system, and some flatwise blade-bending moments. Chordwise loads were not reduced by the free tip. Author

N87-29497*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
QUALITATIVE EVALUATION OF A FLUSH AIR DATA SYSTEM AT TRANSONIC SPEEDS AND HIGH ANGLES OF ATTACK
TERRY J. LARSON, STEPHEN A. WHITMORE, L. J. EHERNBERGER, J. BLAIR JOHNSON, and PAUL M. SIEMERS, III Washington NASA Apr. 1987 64 p
(NASA-TP-2716; H-1277; NAS 1.60:2716) Avail: NTIS HC A04/MF A01 CSCL 01C

Flight tests were performed on an F-14 aircraft to evaluate the use of flush pressure orifices on the nose section for obtaining air data at transonic speeds over a large range of flow angles. This program was part of a flight test and wind tunnel program to assess the accuracies of such systems for general use on aircraft. It also provided data to validate algorithms developed for the shuttle entry air data system designed at NASA Langley. Data were obtained for Mach numbers between 0.60 and 1.60, for angles of attack up to 26.0 deg, and for sideslip angles up to 11.0 deg. With careful calibration, a flush air data system with all flush orifices can provide accurate air data information over a large range of flow angles. Several orificies on the nose cap were found to be suitable for determination of stagnation pressure. Other orifices on the nose section aft of the nose cap were shown to be suitable for determination of static pressure. Pairs of orifices on the nose cap provided the most sensitive measurements for determining angles of attack and sideslip, although orifices located farther aft on the nose section could also be used. Author

N87-29498*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
BIBLIOGRAPHY FOR AIRCRAFT PARAMETER ESTIMATION
KENNETH W. ILIFF and RICHARD E. MAINE Oct. 1986 22 p
(NASA-TM-86804; H-1358; NAS 1.15:86804) Avail: NTIS HC A02/MF A01 CSCL 01C

An extensive bibliography in the field of aircraft parameter estimation has been compiled. This list contains definitive works related to most aircraft parameter estimation approaches. Theoretical studies as well as practical applications are included. Many of these publications are pertinent to subjects peripherally related to parameter estimation, such as aircraft maneuver design or instrumentation considerations. Author

N87-29499*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
APPLICATION OF PARAMETER ESTIMATION TO AIRCRAFT STABILITY AND CONTROL: THE OUTPUT-ERROR APPROACH
RICHARD E. MAINE and KENNETH W. ILIFF Jun. 1986 175 p Submitted for publication
(NASA-RP-1168; H-1299; NAS 1.61:1168) Avail: NTIS HC A08/MF A01 CSCL 01C

The practical application of parameter estimation methodology to the problem of estimating aircraft stability and control derivatives from flight test data is examined. The primary purpose of the document is to present a comprehensive and unified picture of the entire parameter estimation process and its integration into a flight test program. The document concentrates on the output-error method to provide a focus for detailed examination and to allow us to give specific examples of situations that have arisen. The document first derives the aircraft equations of motion in a form suitable for application to estimation of stability and control derivatives. It then discusses the issues that arise in adapting the equations to the limitations of analysis programs, using a specific program for an example. The roles and issues relating to mass distribution data, preflight predictions, maneuver design, flight scheduling, instrumentation sensors, data acquisition systems, and data processing are then addressed. Finally, the document discusses evaluation and the use of the analysis results. Author

N87-29500*# Pennsylvania Univ., Philadelphia. Dept. of Civil Engineering.
A STRATEGY FOR ADVANCING TILT-ROTOR TECHNOLOGY Final Report
EDWARD K. MORLOK and DAVID L. SCHOENDORFER Jun. 1985 82 p
(Contract NAG2-305)
(NASA-CR-181420; NAS 1.26:181420) Avail: NTIS HC A05/MF A01 CSCL 01C

Tilt-rotor technology has many features which make it a very promising development in aviation which might have application to a wide variety of transportation and logistics situations. However, aside from military applications and rather specialized industrial applications, little is known regarding the potential of tilt-rotor for commercial transportation and hence it is difficult to plan a development program which would gain support and be likely to produce a stream of significant benefits. The purpose is to attempt to provide some of this information in a manner that would be useful for preparing a strategy for development of tilt-rotor aircraft technology. Specifically, the objectives were: to identify promising paths of development and deployment of tilt-rotor aircraft technology in the air transportation system considering both benefits and disbenefits, and to identify any particular groups that are likely to benefit significantly and propose plans for gaining their support of research and development of this technology. Potential advantages of the tilt-rotor technology in the context of

air transportation as a door-to-door system were identified, and then promising paths of development of such tilt-rotor systems were analyzed. These then lead to recommendations for specific studies, information dissemination and development of awareness of the tilt-rotor among specific transport-related groups. Author

N87-29501*# Pennsylvania Univ., Philadelphia. Dept. of Civil Engineering.
COST CHARACTERISTICS OF TILT-ROTOR, CONVENTIONAL AIR AND HIGH SPEED RAIL SHORT-HAUL INTERCITY PASSENGER SERVICE Final Report
DAVID L. SCHOENDORFER and EDWARD K. MORLOK May 1985 113 p
(Contract NAG2-305)
(NASA-CR-181421; NAS 1.26:181421) Avail: NTIS HC A06/MF A01 CSCL 01C

The cost analysis done to support an assessment of the potential for a small tilt-rotor aircraft to operate in short-haul intercity passenger service is described in detail. Anticipated costs of tilt-rotor air service were compared to the costs of two alternatives: conventional air and high speed rail (HSR). Costs were developed for corridor service, varying key market characteristics including distance, passenger volumes, and minimum frequency standards. The resulting cost vs output information can then be used to compare modal costs for essentially identical service quality and passenger volume or for different service levels and volumes for each mode, as appropriate. Extensive sensitivity analyses are performed. The cost-output features of these technologies are compared. Tilt-rotor is very attractive compared to HSR in terms of costs over the entire range of volume. It also has costs not dramatically different from conventional air, but tilt-rotor costs are generally higher. Thus some of its other advantages, such as the VTOL capability, must offset the cost disadvantage for it to be a preferred or competitive mode in any given market. These issues are addressed in the companion report which considers strategies for tilt-rotor development in commercial air service. Author

N87-29502*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRIMMING AN AIRCRAFT MODEL FOR FLIGHT SIMULATION
RICHARD E. MCFARLAND Oct. 1987 32 p
(NASA-TM-89466; A-87238; NAS 1.15:89466) Avail: NTIS HC A03/MF A01 CSCL 01C

Real-time piloted aircraft simulations with digital computers have been performed at Ames Research Center (ARC) for over two decades. For the simulation of conventional aircraft models, the establishment of initial vehicle and control orientations at various operational flight regimes has been adequately handled by either analog techniques or simple inversion processes. However, exotic helicopter configurations have been introduced recently that require more sophisticated techniques because of their expanded degrees of freedom and environmental vibration levels. At ARC, these techniques are used for the backward solutions to real-time simulation models as required for the generation of trim points. These techniques are presented in this paper with examples from a blade-element helicopter simulation model. Author

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A87-51941#
A COMPARISON BETWEEN INTEGRATED AND SEPARATED NAVIGATION AND FLIGHT CONTROL MOTION SENSING EQUIPMENT AND A CONCEPT FOR AIRCRAFT MOTION SENSING AND ATTITUDE/HEADING DETERMINATION
H. BUITKAMP and W. HASSENPFLUG (Hellige GmbH, LITEF, Freiburg im Breisgau, West Germany) IN: Symposium Gyro Technology 1986; Proceedings of the Symposium, Stuttgart, West Germany, Sept. 23, 24, 1986 . Stuttgart/Duesseldorf, Universitaet Stuttgart/Deutsche Gesellschaft fuer Ortung und Navigation, 1986, p. 14.0-14.16. refs

The design requirements for high-precision strapdown inertial-navigation systems, attitude/heading reference systems, and robust wideband flight-control equipment, are discussed with a view to the integration of stability-augmentation and navigation functions in a single inertial system whose bandwidth satisfies the requirements for a control-configured vehicle. A concept for a strapdown aircraft motion sensor unit (AMSU) with suitable heading and attitude determination capabilities is presented. The AMSU employs such inertial instruments as a dynamically-tuned gyroscope and a dry-force-rebalanced accelerometer. O.C.

A87-52962*# Kansas Univ., Lawrence.
DEVELOPMENT OF A TAKEOFF PERFORMANCE MONITORING SYSTEM
R. SRIVATSAN, DAVID R. DOWNING (Kansas, University, Lawrence), and WAYNE H. BRYANT (NASA, Langley Research Center, Hampton, VA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Sept.-Oct. 1987, p. 433-440. Previously announced in STAR as N86-31591. refs
(AIAA PAPER 86-2145)

The development and testing of a real-time takeoff performance monitoring system is discussed. The algorithm is made up of two segments: a pretakeoff segment and a real-time segment. One-time inputs of ambient conditions and airplane configuration information are used in the pretakeoff segment to generate schedule performance data for that takeoff. The real-time segment uses the scheduled performance data generated in the pretakeoff segment, runway length data, and measured parameters to monitor the performance of the airplane throughout the takeoff roll. Airplane and engine performance deficiencies are detected and annunciated. An important feature of this algorithm is the one-time estimation of the runway rolling friction coefficient. The algorithm was tested using a six degree of freedom airplane model in a computer simulation. Results from a series of sensitivity analysis are also included. Author

A87-52963*# Minnesota Univ., Minneapolis.
ACCELEROMETER PLACEMENT IN ACTIVE FLUTTER SUPPRESSION SYSTEMS
BRADLEY S. LIEBST (Minnesota, University, Minneapolis) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Sept.-Oct. 1987, p. 441-446. refs
(Contract NAG1-217)

An elementary study of the placement of accelerometers when used as sensors in active flutter suppression systems is presented. The model analyzed is a two-dimensional typical section with various combinations of leading- and trailing-edge controllers. The relationship between the control surface placement and accelerometer placement is examined. The results for the numerical examples presented show that accelerometers must be on the same side of the center of gravity as the control surface or right half-plane transmission zeros will arise. The detrimental effects of the right half-plane zeros are discussed in the context of

linear-quadratic-regulator plus loop-transfer-recovered observer designs. Author

A87-53802
APPROACH TO STUDY OF PRF SENSITIVITY IN AIRBORNE PULSE-DOPPLER RADAR
J. CLARKE (Royal Signals and Radar Establishment, Malvern, England) and E. B. COWLEY (MEL, Crawley, England) IEE Proceedings, Part F - Communications, Radar and Signal Processing (ISSN 0143-7070), vol. 134, pt. F, no. 4, July 1987, p. 335-340. refs

An approach to the selection of an optimum pulse repetition frequency in an airborne pulse-Doppler radar is discussed. A radar simulation program is employed, and this is described in outline. A specific example is presented. Author

N87-28547# Royal Aircraft Establishment, Farnborough (England).
A FLIGHT EVALUATION OF VOICE INTERACTION AS A COMPONENT OF AN INTEGRATED HELICOPTER AVIONICS SYSTEM
R. LITTLE and R. COWAN Apr. 1986 44 p
(RAE-TM-FS(B)-637; BR100581; ETN-87-90266) Avail: NTIS HC A03/MF A01

A Wessex helicopter was used to develop and evaluate an integrated avionics system which incorporates advanced displays and a flight management system for military and civil applications. The system has automatic speech recognition and synthetic speech output. Flight tests were conducted to establish guidelines for the integration of these devices with advanced avionics such as color displays, digital maps, and touch overlays. The tests show that data input and retrieval can be achieved quickly, simply, and easily. ESA

N87-28548# Royal Aircraft Establishment, Farnborough (England).
THE FLIGHT DEVELOPMENT OF A COLOR ELECTRONIC DISPLAY FORMAT AND MONITORING SYSTEM OF HELICOPTER ENGINE AND TRANSMISSION DATA
R. LITTLE and R. COWAN Jun. 1986 26 p
(RAE-TM-FS(B)-638; BR100619; ETN-87-90267) Avail: NTIS HC A03/MF A01

A Wessex helicopter was used to develop and evaluate an integrated avionics system which incorporates electronic displays and a flight management system for military and civil applications. The system displays engine and transmission data, and a system monitor provides visual and audio warnings of limit exceedences, parameter mismatches, and failures. Flight tests show that the display of engine and transmission data can be suppressed and only shown when the pilot requests it or a monitor detects a problem. When used in combination with synthetic voice the monitoring system allows the pilot to concentrate upon tasks more relevant to the current phase of flight, enhancing safety and mission effectiveness. ESA

N87-29527# Royal Aircraft Establishment, Bedford (England).
THE FLIGHT EVALUATION OF A SPEECH RECOGNITION AND A SPEECH OUTPUT SYSTEM IN AN ADVANCED COCKPIT DISPLAY AND FLIGHT MANAGEMENT SYSTEM FOR HELICOPTERS
R. LITTLE *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 12 p Feb. 1987
Avail: NTIS HC A14/MF A01

A Wessex helicopter at RAE Bedford was used to develop and evaluate a set of electronic cockpit displays and a comprehensive suite of avionics which were integrated to form an advanced display and flight management system for both military and civil applications. Two important features of the system were automatic speech recognition and synthetic speech output. Flight trials were conducted to determine the ground rules and principles pertinent to the successful integration of these devices with other advanced avionics. The trial has shown that the combination of speech recognition and synthetic voice systems offers an element of redundancy and if correctly integrated into the cockpit will be capable of improving the man machine interface to a far greater degree than is achievable by hand or voice alone. Author

N87-29531*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A VECTOR-BASED FAILURE DETECTION AND ISOLATION ALGORITHM FOR A DUAL FAIL-OPERATIONAL REDUNDANT STRAPDOWN INERTIAL MEASUREMENT UNIT
FREDERICK R. MORRELL and MELVIN L. BAILEY (PRC Kentron, Inc., Hampton, Va.) Sep. 1987 46 p
(NASA-TM-100493; NAS 1.15:100493) Avail: NTIS HC A03/MF A01 CSCL 01D

A vector-based failure detection and isolation technique for a skewed array of two degree-of-freedom inertial sensors is developed. Failure detection is based on comparison of parity equations with a threshold, and isolation is based on comparison of logic variables which are keyed to pass/fail results of the parity test. A multi-level approach to failure detection is used to ensure adequate coverage for the flight control, display, and navigation avionics functions. Sensor error models are introduced to expose the susceptibility of the parity equations to sensor errors and physical separation effects. The algorithm is evaluated in a simulation of a commercial transport operating in a range of light to severe turbulence environments. A bias-jump failure level of 0.2 deg/hr was detected and isolated properly in the light and moderate turbulence environments, but not detected in the extreme turbulence environment. An accelerometer bias-jump failure level of 1.5 milli-g was detected over all turbulence environments. For both types of inertial sensor, hard-over, and null type failures were detected in all environments without incident. The algorithm functioned without false alarm or isolation over all turbulence environments for the runs tested. Author

N87-29532# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
EVALUATION OF THE F/A-18 HEAD-UP-DISPLAY FOR RECOVERY FROM UNUSUAL ATTITUDES Final Report
JERRY GUTTMAN Oct. 1986 48 p
(AD-A183303; NADC-86157-60) Avail: NTIS HC A03/MF A01 CSCL 01D

Maintaining situational awareness is a critical task in piloting an aircraft. Focusing on spatial orientation, the attitude displays provide information necessary for the pilot to control the aircraft's position in space. In the F/A-18 aircraft the Head-Up-Display (HUD) is the primary attitude indicator. This study compared electrically drawn attitude direction indicator (ADI), the current F/A-18 HUD, and the concurrent use of the ADI and HUD for recovery from unusual attitudes. Results indicated significantly faster recovery times for the ADI. Reasons may be attributed to the superiority of the color coding of the ADI for sky and ground over the dashed and solid pitch lines used for ground/sky coding on the HUD format. Pilot preferences were split between using the ADI as a convenient crosscheck and reduction of visual workload when using the HUD and ADI concurrently compared to using the HUD alone. The results from this study, which employed an electrically drawn ADI, parallel those found in earlier experiments comparing an electromechanical ADI to the F/A-18 HUD. They suggest that a centrally located ADI in the F/A cockpit would aid pilots during unusual attitude recovery. 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.

A87-51353
HOT CORROSION SITE ENVIRONMENT IN GAS TURBINES
C. G. MCCREATH (Huddersfield Polytechnic, England) (Conference on High-Temperature Corrosion of Superalloys, London, England, Feb. 11, 12, 1986) Materials Science and Technology (ISSN 0267-0836), vol. 3, July 1987, p. 494-500. Research supported by the Ministry of Defence (Procurement Executive). refs

The importance and complexity of environmental influences on the hot corrosion process in gas turbines is now recognized. The present paper seeks to emphasize that the hot corrosion phenomenon is the end product of a chain of events which starts at the air/sea interface (encompassing wind speed, relative humidity, intake siting, etc.) and which extends through filter performance, compressor operating characteristics, and flame tube design before terminating at the hot corrosion site, i.e., the high-pressure rotors. Attention is particularly drawn to the influence exerted by both salt and carbon particulate material and their interrelationship with each engine stage upstream of the turbine. Author

A87-51474
FUEL EFFECTS ON GAS TURBINE COMBUSTION
A. H. LEFEBVRE (Purdue University, West Lafayette, IN) International Journal of Turbo and Jet-Engines (ISSN 0334-0082), vol. 3, no. 2-3, 1986, p. 231-243. USAF-supported research. refs

Analysis of the experimental data acquired during Wright-Patterson Aero Propulsion Laboratory sponsored programs on the effects of fuel properties on gas turbine combustion has led to the derivation of quantitative relationships between several aspects of combustion performance and the relevant fuel properties, combustor design features, and combustor operating conditions. It is concluded that combustion efficiency, lean blowout limits, lean lightoff limits, and pattern factor are only slightly dependent on fuel chemistry, but are markedly affected by the physical fuel properties that govern atomization quality and fuel spray evaporation. Author

A87-51808#
COMPUTATION OF OPTIMUM TURBOFAN MIXING WITH A SUBACCURATE VARYING SPECIFIC HEAT SOLUTION
CHIH-YA TSUI (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 8, May 1987, p. 107-109. In Chinese, with abstract in English. refs

Optimum fan/mainstream-mixing total-pressure ratios are computed by means of a recently developed subaccurate varying-specific-heat method, based on the parameters k(kappa) at critical temperature and k(v) and k for the specific heats from total temperature to critical and to static temperatures, respectively. For inviscid parallel mixing, the optimum total pressure is obtained when the two mixing streams' total pressures are not far from equal, while there is a flat region of only slight variation with fan pressure ratio on either side. Some not unusual misleading conceptions are thus clarified. Author

A87-51810#
THE UNSTEADY FLOW EULER AMPLITUDE EQUATION IN VIBRATING CASCADES AND ITS NUMERICAL METHOD
ZIKANG JIANG, ZIQIN HU, and HONGRUI GONG (Qinghua University, Beijing, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 8, May 1987, p. 125-129. In Chinese, with abstract in English. refs

In this paper, the Euler amplitude equation is developed to obtain the unsteady flow field in vibrating cascades. Although this method is based on the ideal gas model, it is derived from the Euler equation, so it is not limited to nonvortex, slightly cambered, thin airfoils, low Mach number, etc. It can be used in transonic flow and highly cambered turbine cascades. The calculation of three examples is completed with this method, and one of them is compared with the experimental data. It is found that the computed phase of the pulsating pressure is well fitted with the experimental data. The computed amplitude of the pulsating pressure is somewhat less than the experimental results, but it is consistent with the computed result obtained with the time-marching method. This method is proved to be reliable in engineering uses. Author

A87-52245*# Lockheed-Georgia Co., Marietta.
STATIC TESTS OF THE PROPULSION SYSTEM
C. C. WITHERS, H. W. BARTEL (Lockheed-Georgia Co., Marietta), J. E. TURNBERG (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT), and E. J. GRABER (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 23rd, San Diego, CA, June 29-July 2, 1987. 12 p.
(Contract NAS3-24339)
(AIAA PAPER 87-1728)

Advanced, highly-loaded, high-speed propellers, called propfans, are promising to revolutionize the transport aircraft industry by offering a 15- to 30-percent fuel savings over the most advanced turbofans without sacrificing passenger comfort or violating community noise standards. NASA Lewis Research Center and industry have been working jointly to develop the needed propfan technology. The NASA-funded Propfan Test Assessment (PTA) Program represents a key element of this joint program. In PTA, Lockheed-Georgia, working in concert with Hamilton Standard, Rohr Industries, Gulfstream Aerospace, and Allison, is developing a propfan propulsion system which will be mounted on the left wing of a modified Gulfstream GII aircraft and flight tested to verify the in-flight characteristics of a 9-foot diameter, single-rotation propfan. The propfan, called SR-7L, was designed and fabricated by Hamilton Standard under a separate NASA contract. Prior to flight testing, the PTA propulsion system was static tested at the Rohr Brown Field facility. In this test, propulsion system operational capability was verified and data was obtained on propfan structural response, system acoustic characteristics, and system performance. This paper reports on the results of the static tests. Author

A87-52246*# General Electric Co., Evendale, Ohio.
A VARIABLE GEOMETRY COMBUSTOR FOR BROADENED PROPERTIES FUELS
W. J. DODDS (General Electric Co., Aircraft Engine Business Group, Evendale, OH) and J. S. FEAR (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 23rd, San Diego, CA, June 29-July 2, 1987. 9 p. refs
(AIAA PAPER 87-1832)

A program was conducted to design and develop a variable geometry combustor, sized for the cycle and envelope of a large commercial turbofan engine. The combustor uses a variable area swirl cup to control stoichiometry in the primary combustion zone. Potential advantages of this design include improved capability to burn non-standard fuels, short system length, and increased operating temperature range for advanced high performance engine cycles. After considerable development, key program emissons and performance goals were met with the variable geometry combustor. Primary development efforts were to evolve improved

variable swirl cup configurations. In particular, air leakage through the variable area swirl cup had a strong effect on low power emissions and performance, while smoke level at high power was affected by features for improved mixing of the fuel and swirler air flow. Additional design and development is still needed to evolve a practical variable geometry combustor. Author

A87-53423
T406-AD-400 FULL-SCALE DEVELOPMENT
J. R. ARVIN and J. R. FAGAN (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 7 p.

The development of the T406-AD-400 engine to power the V-22 Osprey tilt-rotor aircraft is discussed. The engine concept is based on T56-A-427 and T701 components to provide low development risk and a growth capability exceeding 28 percent. The T406 development requirements necessitated supercritical rig testing to minimize risk and empirical design optimization. Moreover, lube/sump/seal flow visualization and attitude test rigs were needed to evaluate the operation and optimize the design for a tilt-rotor environment. K.K.

A87-53424
ENGINE STRUCTURAL INTEGRITY PROGRAM (ENSIP) - A VIEWPOINT BASED ON EXPERIENCE
WILLIAM H. VOGEL (General Electric Co., Cincinnati, OH) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 8 p. refs

A viewpoint on the general application of the Engine Structural Integrity Program, as specified in USAF Mil Std 1783, to aircraft engine design and structural maintenance is presented. This view is discussed on the basis of experience in commercial and military engine programs, with specific examples taken from the Durability and Damage Tolerance Assessment Program conducted on the TF34-100 engine under USAF Contract. The TF34 program encompassed the analytical assessment of durability and fracture critical component lives and the development and implementation of an in-service structural maintenance program. Author

A87-53426
IMPROVED RELIABILITY AND MAINTAINABILITY (RAM) IN ADVANCED TECHNOLOGY ENGINES
PETER H. RENSON (Textron, Inc., Avco Lycoming Textron, Stratford Div., CT) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 6 p.

Means of achieving complete RAM involvement in the development of advanced-technology gas-turbine engines is discussed. It is noted that high RAM, supported via the design of basic engine components to last the life cycle of the program, is essential to cost reduction. An engine such as the APW800 provides the necessary elements to guarantee the satisfactory performance of airframe cost agreements. In addition, a 'balanced' power-plant system encompassing the technical and support needs to fulfill future missions is provided. K.K.

A87-53427
COMPRESSORS FOR ADVANCED TURBOSHAFT ENGINES
S. BAGHDADI (Pratt and Whitney, Engineering Div., West Palm Beach, FL) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 5 p. refs

Technologies which will be important in achieving durable lightweight high-performance turboshaft-engine compressor designs are discussed. Particular attention is given to three-dimensionally designed swept axial blading, low-friction low-specific-speed centrifugal compressors, techniques for assessing part-power operational characteristics of axicentrifugal compressors, and methods for improving compressor in-service performance retention. An analysis method developed for assessing the performance and stability characteristics of axial and axicentrifugal compression systems throughout their operating range is described. K.K.

A87-53428* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPOUND CYCLE ENGINE PROGRAM
G. A. BOBULA (NASA, Lewis Research Center; U.S. Army, Army Aviation Research and Technology Activity, Cleveland, OH), W. T. WINTUCKY (NASA, Lewis Research Center, Cleveland, OH), and J. G. CASTOR (Garrett Turbine Engine Co., Phoenix, AZ) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 22 p. Previously announced in STAR as N87-11790. refs

The Compound Cycle Engine (CCE) is a highly turbocharged, power compounded power plant which combines the lightweight pressure rise capability of a gas turbine with the high efficiency of a diesel. When optimized for a rotorcraft, the CCE will reduce fuel burn for a typical 2 hr (plus 30 min reserve) mission by 30 to 40 percent when compared to a conventional advanced technology gas turbine. The CCE can provide a 50 percent increase in range-payload product on this mission. A program to establish the technology base for a Compound Cycle Engine is presented. The goal of this program is to research and develop those technologies which are barriers to demonstrating a multicylinder diesel core in the early 1990's. The major activity underway is a three-phased contract with the Garrett Turbine Engine Company to perform: (1) a light helicopter feasibility study, (2) component technology development, and (3) lubricant and material research and development. Other related activities are also presented. Author

A87-53429
APPLICATION OF MODERN MATERIALS TECHNOLOGIES IN SMALL GAS TURBINE ENGINES
C. C. RHEMER (Pratt and Whitney, Engineering Div., West Palm Beach, FL) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 5 p. refs

Advances in materials and material processing technologies are being implemented in small gas turbine engines to provide improvements in performance, durability, reduction of cost and weight. Advancements in turbine and compressor disk materials have been incorporated in current designs to reduce weight and increase life. Turbine airfoils have been improved in performance and durability and continuing alloy development promises further increases. Ceramics and composites are also being introduced into current engines. Advanced high specific stiffness metallic shaft materials offer potential for higher rotor speeds and transmitted loads. The status of these material technologies is presented in this paper and engine system benefits are described. Author

A87-53430
A DESIGN SYSTEM FOR EROSION TOLERANT HELICOPTER ENGINES
BAILY R. VITTAL (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 10 p. refs

A design system which permits inertial inlet particle separators to remove sand particles from the air is described. A computational technique for assessing the erosion damage in compressor blades and vanes due to sand particles entering the compressor is presented. The erosion computation code integrates fully three-dimensional particle-trajectory calculations with statistical methods to obtain erosion patterns in blades using basic material erosion models. The erosion damage of the first-stage rotor of an axial flow compressor was computed, and the pattern obtained was comparable to that obtained during a sand-ingestion-rig test. K.K.

A87-53431
MULTI-VARIABLE CONTROL CONCEPTS FOR TURBOSHAFT ENGINES
WILLIAM H. PFEIL (General Electric Co., Lynn, MA) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 11 p. refs

In this paper, design concepts of multivariable feedback control systems for the Ge T700 turboshaft engine coupled to a helicopter rotor system are examined. A specific design methodology, the LQG/LTR methodology, is shown to be useful in obtaining a sequence of three feedback designs. A single-input single-output case is illustrated first merely to introduce the use of the LQG/LTR methodology in control design. Two multivariable design concepts are presented and evaluated utilizing linear and nonlinear transient simulations. The evaluations demonstrate the potential for performance improvement through the dynamic coordination of several variables. Author

A87-53442
FATIGUE OF GAS TURBINE BLADES UNDER RANDOM VIBRATIONS [USTALOST' LOPATOK GAZOVYKH TURBIN PRI SLUCHAINYKH KOLEBANIIAKH]
V. M. KAPRALOV Problemy Prochnosti (ISSN 0556-171X), July 1987, p. 47-50. In Russian. refs

Comparative experimental data are obtained on the fatigue behavior of nickel alloy gas turbine blades under random narrow-band and regular cyclic loading. The summation of fatigue damage during random loading is investigated. The data presented here provide a way to estimate the level of equivalent cyclic stresses from the histograms of random vibrational loading. V.L.

A87-53575
MEASUREMENT OF SPECTRAL EMISSIVITY OF TECHNICAL SURFACES IN HIGH-PERFORMANCE ENGINES [MESSWERTE DES SPEKTRALEN EMISSIONSGRADES TECHNISCHER OBERFLAECHEN VON HOCHLEISTUNGSTRIEBWERKEN]
A. BRAUN (Muenchen, Universitaet der Bundeswehr, Neubiberg, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 11, Mar.-Apr. 1987, p. 117-120. In German. refs

The use of noncontact pyrometric methods to measure the temperature of modern high-performance engines, in particular jet engines, is examined. The spectral emissivities of tungsten, chromium-nickel steel, and thermal paints were measured, as a function of temperature and wavelength, using three types of pyrometers. The instruments employed in the experiment are: (1) a total radiation pyrometer which records the thermal radiation of a surface; (2) a spectral pyrometer that measures surface temperatures by comparing the radiant emittance of an object with a blackbody of the same wavelength; and (3) a ratio radiation spectrometer that compares radiant emittance at two different wavelengths. Temperature errors observed when using the three pyrometers for cases where the spectral emissivity is unknown are analyzed. It is noted that pyrometric methods are applicable to the optimization of high-performance engines. I.F.

A87-53986#
A NUMERICAL STUDY OF FLOW IN GAS-TURBINE COMBUSTOR
WEI SHYY (National Cheng Kung University, Tainan, Republic of China) and MARK E. BRAATEN (GE Research and Development Center. Schenectady, NY) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 23rd, San Diego, CA, June 29-July 2, 1987. 10 p. refs
(AIAA PAPER 87-2132)

Numerical results for the single-phase turbulent flow-fields in a modern annular gas-turbine combustor, both with and without combustion, are presented. The numerical algorithm employs nonorthogonal curvilinear coordinates, a multigrid iterative solution procedure, the standard k-epsilon turbulence model, and a combustion model comprising an assumed probability density function and the conserved scalar variable formulation. Overall, reasonable agreement has been obtained between the numerical calculations and test-rig measurements for the exhaust gas temperature pattern. The temperature variations resulting from changes of the distribution of the dilution holes, and the effects of the combustion process on the transport mechanisms such as the jet penetration and the mixing processes are assessed. Detailed information obtained by such a numerical approach is valuable in combustor design. Author

N87-28549# Aeronautical Research Labs., Melbourne (Australia).
SMOKE EMISSION TESTS ON SERIES 2 AND SERIES 3 ALLISON T56 TURBOPROP ENGINES
F. W. SKIDMORE Dec. 1986 28 p
(AD-A182385; ARL-AERO-PROP-TM-438) Avail: NTIS HC A03/MF A01 CSCL 21E

This report presents the results of smoke emission tests on three Series 2 T56-A-7 and two Series 3 T56-A-15 Allison T56 Turboprop engines operating from idle to near full power. The results indicate a significant difference in the levels of emissions between the different engine series tested. GRA

N87-28550# Stuttgart Univ. (West Germany). Fakultaet Luft- und Raumfahrttechnik.
DEVELOPMENT AND TESTING OF HIGHLY LOADED ENGINE COMPONENTS MADE OF CARBON FIBER REINFORCED PLASTICS Ph.D. Thesis [ENTWICKLUNG UND ERPROBUNG VON HOCHBEANSPRUCHTEN TRIEBWERKSKOMPONENTEN AUS KOHLEFASERVERSTAERKTEM KUNSTSTOFF]
BERNHARD HINZ 1985 138 p In GERMAN
(ETN-87-90036) Avail: NTIS HC A07

Carbon fiber reinforced plastic (CFRP) engine components were developed and tested. Heat resistant epoxy systems and adhesives were investigated with respect to their oil and long term heat resistance. Pistons, piston rods, toggle levers, and valve springs were developed and successfully checked on a test motor. It is shown that the use of CFRP allows mass reductions between 50 percent and 70 percent. However, due to different construction principles, a simple substitution of conventional engine components by CFRP parts is not always possible. The different thermal dilatation of CFRP and metals causes substantial problems, especially for the design of bearing clearances. ESA

N87-28551*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TOWARD IMPROVED DURABILITY IN ADVANCED COMBUSTORS AND TURBINES: PROGRESS IN THE PREDICTION OF THERMOMECHANICAL LOADS
DANIEL E. SOKOLOWSKI and C. ROBERT ENSIGN 1986 31 p Presented at the 31st International Gas Turbine Conference and Exhibition, Dusseldorf, West Germany, 8-12 Jun. 1986; sponsored by ASME Previously announced in IAA as A86-48224
(NASA-TM-88932; E-3374; NAS 1.15:88932) Avail: NTIS HC A03/MF A01 CSCL 21E

NASA is sponsoring the Turbine Engine Hot Section Technology (HOST) Project to address the need for improved durability in advanced combustors and turbines. Analytical and experimental activities aimed at more accurate prediction of the aerothermal environment, the thermomechanical loads, the material behavior and structural responses to such loading, and life predictions for high temperature cyclic operation have been underway for several years and are showing promising results. Progress is reported in the development of advanced instrumentation and in the improvement of combustor aerothermal and turbine heat transfer models that will lead to more accurate prediction of thermomechanical loads. Author

N87-28552*# United Technologies Corp., East Hartford, Conn. Pratt and Whitney Engineering Div.
ADVANCED PROP-FAN ENGINE TECHNOLOGY (APET) SINGLE- AND COUNTER-ROTATION GEARBOX/PITCH CHANGE MECHANISM Final Report
C. N. REYNOLDS Jul. 1985 288 p
(Contract NAS3-23045)
(NASA-CR-168114-VOL-1; NAS 1.26:168114-VOL-1; PWA-5869-88-VOL-1) Avail: NTIS HC A13/MF A01 CSCL 21E

The preliminary design of advanced technology (1992) prop-fan engines for single-rotation prop-fans, the conceptual design of the entire propulsion system, and an aircraft evaluation of the resultant designs are discussed. Four engine configurations were examined. A two-spool engine with all axial compressors and a three-spool engine with axial/centrifugal compressors were selected. Integrated propulsion systems were designed in conjunction with airframe manufacturers. The design efforts resulted in 12,000 shaft horsepower engines installed in over the installations with in-line and offset gearboxes. The prop-fan powered aircraft used 21 percent less fuel and cost 10 percent less to operate than a similar aircraft powered by turbofan engines with comparable technology. Author

N87-28553*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
ADVANCED PROPFAN ENGINE TECHNOLOGY (APET) AND SINGLE-ROTATION GEARBOX/PITCH CHANGE MECHANISM
D. F. SARGISSON Jun. 1985 483 p
(Contract NAS3-23044)
(NASA-CR-168113; NAS 1.26:168113; R83AEB592) Avail: NTIS HC A21/MF A01 CSCL 21E

The projected performance, in the 1990's time period, of the equivalent technology level high bypass ratio turbofan powered aircraft (at the 150 passenger size) is compared with advanced turboprop propulsion systems. Fuel burn analysis, economic analysis, and pollution (noise, emissions) estimates were made. Three different cruise Mach numbers were investigated for both the turbofan and the turboprop systems. Aerodynamic design and performance estimates were made for nacelles, inlets, and exhaust systems. Air to oil heat exchangers were investigated for oil cooling advanced gearboxes at the 12,500 SHP level. The results and conclusions are positive in that high speed turboprop aircraft will exhibit superior fuel burn characteristics and lower operating costs when compared with equivalent technology turbofan aircraft. Author

N87-28554*# General Motors Corp., Indianapolis, Ind. Allison Gas Turbine Div.
ADVANCED PROPFAN ENGINE TECHNOLOGY (APET) DEFINITION STUDY, SINGLE AND COUNTER-ROTATION GEARBOX/PITCH CHANGE MECHANISM DESIGN
R. D. ANDERSON Jul. 1985 289 p
(Contract NAS3-23046)
(NASA-CR-168115; NAS 1.26:168115; EDR-11283) Avail: NTIS HC A13/MF A01 CSCL 21E

Single-rotation propfan-powered regional transport aircraft were studied to identify key technology development issues and programs. The need for improved thrust specific fuel consumption to reduce fuel burned and aircraft direct operating cost is the dominant factor. Typical cycle trends for minimizing fuel consumption are reviewed, and two 10,000 shp class engine configurations for propfan propulsion systems for the 1990's are presented. Recommended engine configurations are both three-spool design with dual spool compressors and free power turbines. The benefits of these new propulsion system concepts were evaluated using an advanced airframe, and results are compared for single-rotation propfan and turbofan advanced technology propulsion systems. The single-rotation gearbox is compared to a similar design with current technology to establish the benefits of the advanced gearbox technology. The conceptual design of the advanced pitch change mechanism identified a high pressure hydraulic system that is superior to the other contenders and completely external to the gearboxes. Author

N87-28555*# United Technologies Corp., Windsor Locks, Conn. Hamilton Standard Div.
ANALYSIS AND TEST EVALUATION OF THE DYNAMIC RESPONSE AND STABILITY OF THREE ADVANCED TURBOPROP MODELS Final Report
P. N. BANSAL, P. J. ARSENEAUX, A. F. SMITH, J. E. TURNBERG, and B. M. BROOKS Aug. 1985 182 p
(Contract NAS3-22393; NAS3-22755)
(NASA-CR-174814; NAS 1.26:174814; HSER-8945) Avail: NTIS HC A09/MF A01 CSCL 21E

Results of dynamic response and stability wind tunnel tests of three 62.2 cm (24.5 in) diameter models of the Prop-Fan, advanced turboprop, are presented. Measurements of dynamic response were made with the rotors mounted on an isolated nacelle, with varying tilt for nonuniform inflow. One model was also tested using a semi-span wing and fuselage configuration for response to realistic aircraft inflow. Stability tests were performed using tunnel turbulence or a nitrogen jet for excitation. Measurements are compared with predictions made using beam analysis methods for the model with straight blades, and finite element analysis methods for the models with swept blades. Correlations between measured and predicted rotating blade natural frequencies for all the models are very good. The IP dynamic response of the straight blade model is reasonably well predicted. The IP response of the swept blades is underpredicted and the wing induced response of the straight blade is overpredicted. Two models did not flutter, as predicted. One swept blade model encountered an instability at a higher RPM than predicted, showing predictions to be conservative. Author

N87-28556*# United Technologies Corp., East Hartford, Conn. Pratt and Whitney Engineering Div.
ADVANCED PROP-FAN ENGINE TECHNOLOGY (APET) SINGLE- AND COUNTER-ROTATION GEARBOX/PITCH CHANGE MECHANISM Final Report
C. N. REYNOLDS Jul. 1985 170 p
(Contract NAS3-23045)
(NASA-CR-168114-VOL-2; NAS 1.26:168114-VOL-2; PWA-5869-88-VOL-2) Avail: NTIS HC A08/MF A01 CSCL 21E

The preliminary design of advanced technology (1992) turboprop engines for single-rotation prop-fans and conceptual designs of pitch change mechanisms for single- and counter-rotation prop-fan application are discussed. The single-rotation gearbox is a split path, in-line configuration. The counter-rotation gearbox is an in-line, differential planetary design. The pitch change mechanisms for both the single- and counter-rotation arrangements are rotary/hydraulic. The advanced technology single-rotation gearbox yields a 2.4 percent improvement in aircraft fuel burn and a one percent improvement in operating cost relative to a current technology gearbox. The 1992 counter-rotation gearbox is 15 percent lighter, 15 percent more reliable, 5 percent lower in cost, and 45 percent lower in maintenance cost than the 1992 single-rotation gearbox. The pitch controls are modular, accessible, and external. Author

N87-28557*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MEASUREMENT UNCERTAINTY FOR THE UNIFORM ENGINE TESTING PROGRAM CONDUCTED AT NASA LEWIS RESEARCH CENTER
MAHMOOD ABDELWAHAB, THOMAS J. BIESIADNY, and DEAN SILVER (Air Force Systems Command, Cleveland, Ohio.) May 1987 54 p
(NASA-TM-88943; E-3234; NAS 1.15:88943) Avail: NTIS HC A04/MF A01 CSCL 21E

An uncertainty analysis was conducted to determine the bias and precision errors and total uncertainty of measured turbojet engine performance parameters. The engine tests were conducted as part of the Uniform Engine Test Program which was sponsored by the Advisory Group for Aerospace Research and Development (AGARD). With the same engines, support hardware, and instrumentation, performance parameters were measured twice, once during tests conducted in test cell number 3 and again during

tests conducted in test cell number 4 of the NASA Lewis Propulsion Systems Laboratory. The analysis covers 15 engine parameters, including engine inlet airflow, engine net thrust, and engine specific fuel consumption measured at high rotor speed of 8875 rpm. Measurements were taken at three flight conditions defined by the following engine inlet pressure, engine inlet total temperature, and engine ram ratio: (1) 82.7 kPa, 288 K, 1.0, (2) 82.7 kPa, 288 K, 1.3, and (3) 20.7 kPa, 288 K, 1.3. In terms of bias, precision, and uncertainty magnitudes, there were no differences between most measurements made in test cells number 3 and 4. The magnitude of the errors increased for both test cells as engine pressure level decreased. Also, the level of the bias error was two to three times larger than that of the precision error. Author

N87-28558*# National Aeronautics and Space Administration, Washington, D.C.
HIGH ACCURACY THRUST MEASUREMENT OF AERONAUTICAL PROPULSION SYSTEMS WITH PARTICULAR CONSIDERATION TO A HYDRAULIC FORCE MEASURING DEVICE, PART 1
JOACHIM FRUBOESE Sep. 1987 14 p Transl. into ENGLISH from Archiv fuer Technisches Messen und Industrielle Messtechnik (West Germany), Apr. 1971 p 69-72 Original language document was announced in IAA as A71-26991 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-4005)
(NASA-TT-20080; NAS 1.77:20080) Avail: NTIS HC A02/MF A01 CSCL 21E

Thrust measurement of aircraft and rocket propulsion systems is discussed. The costs as well as the characteristics of mechanical, electrical and hydraulic systems are compared. Author

N87-29534*# General Electric Co., Cincinnati, Ohio. Aircraft Enginer Business Group.
AERODYNAMIC PERFORMANCE INVESTIGATION OF ADVANCED MECHANICAL SUPPRESSOR AND EJECTOR NOZZLE CONCEPTS FOR JET NOISE REDUCTION Final Report, 1981-1984
C. D. WAGENKNECHT and E. D. BEDIAKO Feb. 1985 218 p
(Contract NAS3-23038)
(NASA-CR-174860; NAS 1.26:174860; R83AEB122-3) Avail: NTIS HC A10/MF A01 CSCL 21E

Advanced Supersonic Transport jet noise may be reduced to Federal Air Regulation limits if recommended refinements to a recently developed ejector shroud exhaust system are successfully carried out. A two-part program consisting of a design study and a subscale model wind tunnel test effort conducted to define an acoustically treated ejector shroud exhaust system for supersonic transport application is described. Coannular, 20-chute, and ejector shroud exhaust systems were evaluated. Program results were used in a mission analysis study to determine aircraft takeoff gross weight to perform a nominal design mission, under Federal Aviation Regulation (1969), Part 36, Stage 3 noise constraints. Mission trade study results confirmed that the ejector shroud was the best of the three exhaust systems studied with a significant takeoff gross weight advantage over the 20-chute suppressor nozzle which was the second best. Author

N87-29536*# Lockheed-Georgia Co., Marietta.
PROPFAN TEST ASSESSMENT PROPFAN PROPULSION SYSTEM STATIC TEST REPORT Contractor Report, Feb. - Jun. 1986
D. M. OROURKE Sep. 1987 238 p
(Contract NAS3-24339)
(NASA-CR-179613; NAS 1.26:179613; LG86ER0173; L87R1488) Avail: NTIS HC A11/MF A01 CSCL 21E

The propfan test assessment (PTA) propulsion system successfully completed over 50 hours of extensive static ground tests, including a 36 hour endurance test. All major systems performed as expected, verifying that the large-scale 2.74 m diameter propfan, engine, gearbox, controls, subsystems, and flight instrumentation will be satisfactory with minor modifications for the upcoming PTA flight tests on the GII aircraft in early 1987. A test envelope was established for static ground operation to maintain propfan blade stresses within limits for propfan rotational speeds up to 105 percent and power levels up to 3880 kW. Transient tests verified stable, predictable response of engine power and propfan speed controls. Installed engine TSFC was better than expected, probably due to the excellent inlet performance coupled with the supercharging effect of the propfan. Near- and far-field noise spectra contained three dominant components, which were dependent on power, tip speed, and direction. The components were propfan blade tones, propfan random noise, and compressor/propfan interaction noise. No significant turbine noise or combustion noise was evident. Author

N87-29537*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIRFLOW CALIBRATION AND EXHAUST PRESSURE/TEMPERATURE SURVEY OF AN F404, S/N 215-109, TURBOFAN ENGINE
MAUREEN E. BURNS and THOMAS A. KIRCHGESSNER Sep. 1987 31 p
(NASA-TM-100159; E-3447; NAS 1.15:100159) Avail: NTIS HC A03/MF A01 CSCL 21E

A General Electric F-404 turbofan engine was calibrated for thrust and airflow at the NASA Lewis Propulsion System Laboratory in support of future flight tests of the X-29 aircraft. Tests were conducted with and without augmentation, over a range of flight conditions, including the two design points of the airplane. Data obtained during the altitude tests will be used to correct two independent gross thrust calculation routines which will be installed and operated on the airplane to determine in-flight gross thrust. Corrected airflow data as a function of corrected fan speed collapsed onto a single curve. Similarly, trends were observed and defined for both augmented and dry thrust. Overall agreement between measured data and F-404 Engine Spec Deck data was within 2 percent for airflow and 6 percent for thrust. The results of an uncertainty analysis for thrust and airflow is presented. In addition to the thrust calibration, the exhaust gas boundary layer pressure and temperatures were surveyed at selected condition and engine power levels to obtain data for another NASA F-404 program. Test data for these surveys are presented. Author

N87-29538*# General Electric Co., Cincinnati, Ohio.
TURBOFAN AFT DUCT SUPPRESSOR STUDY. CONTRACTOR'S DATA REPORT OF MODE PROBE SIGNAL DATA Final Report
G. H. FISKE, R. E. MOTSINGER, A. A. SYED, M. C. JOSHI, and R. E. KRAFT (Douglas Aircraft Co., Inc., Long Beach, Calif.) Jul. 1983 74 p
(Contract NAS3-22766)
(NASA-CR-175067; NAS 1.26:175067) Avail: NTIS HC A04/MF A01 CSCL 21E

Acoustic modal distributions were measured in a fan test model having an annular exhaust duct for comparison with theoretically predicted acoustic suppression values. This report contains the amplitude and phase data of the acoustic signals sensed by the transducers of the two mode probes employed in the measurement. Each mode probe consisted of an array of 12 transducers sensing the acoustic field at three axial positions and four radial positions. M.G.

N87-29539*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
TURBOFAN AFT DUCT SUPPRESSOR STUDY
A. A. SYED, R. E. MOTSINGER, G. H. FISKE, M. C. JOSHI, and R. E. KRAFT (Douglas Aircraft Co., Inc., Long Beach, Calif.) Jul. 1983 202 p
(Contract NAS3-22766)
(NASA-CR-175067; NAS 1.26:175067; R83AEB566) Avail: NTIS HC A10/MF A01 CSCL 21E

Suppressions due to acoustic treatment in the annular exhaust duct of a model fan were theoretically predicted and compared with measured suppressions. The predictions are based on the modal analysis of sound propagation in a straight annular flow

duct with segmented treatment. Modal distributions of the fan noise source (fan-stator interaction only) were measured using in-duct modal probes. The flow profiles were also measured in the vicinity of the modal probes. The acoustic impedance of the single degree of freedom treatment was measured in the presence of grazing flow. The measured values of mode distribution of the fan noise source, the flow velocity profile and the acoustic impedance of the treatment in the duct were used as input to the prediction program. The predicted suppressions, under the assumption of uniform flow in the duct, compared well with the suppressions measured in the duct for all test conditions. The interaction modes generated by the rotor-stator interaction spanned a cut-off ratio range from nearly 1 to 7. Author

08

AIRCRAFT STABILITY AND CONTROL

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

A87-51981#
ON DESIGN OF RESTRUCTURABLE CONTROL SYSTEMS FOR AIRCRAFT WITH SOME FAILURES
KIMIO KANAI and YOSHIMASA OCHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 35, no. 401, 1987, p. 311-317. In Japanese, with abstract in English. refs

Computer simulations of a model of a large scale aircraft are used to design an aircraft control system which automatically restructures itself to accommodate failures and to restore safety and performance. The case of a broken vertical tail and failure of the hydropressure system is considered. The effects of the vertical tail breakage on the dynamic characteristics of the aircraft, and the effectiveness of thrust control using an optimum regulator, are evaluated. A restructurable control system composed of parameter identification and optimal regulator subsystems is then designed. R.R.

A87-52880#
JET SPOILER AS A YAW CONTROL DEVICE
D. A. TAVELLA, C. S. LEE, N. J. WOOD, and L. ROBERTS (Stanford University, CA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 611-615. Previously cited in issue 17, p. 2480, Accession no. A86-37829. refs

A87-52964#
INTERACTIONS BETWEEN AN AIRCRAFT STRUCTURE AND ACTIVE CONTROL SYSTEMS
R. FREYMANN (DFVLR, Institut fuer Aeroelastik, Goettingen, West Germany) (Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2, p. 517-524) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Sept.-Oct. 1987, p. 447-452. Previously cited in issue 18, p. 2613, Accession no. A86-38932. refs

A87-53079* Kansas Univ., Lawrence.
FLIGHT TEST OF A DIGITAL CONTROLLER USED IN A HELICOPTER AUTOLAND SYSTEM
DAVID R. DOWNING (Kansas, University, Lawrence) and WAYNE H. BRYANT (NASA, Langley Research Center, Hampton, VA) Automatica (ISSN 0005-1098), vol. 23, May 1987, p. 295-300. refs

This paper describes the flight test evaluation of an advanced digital helicopter flight control system. The controller was designed using an optimal control design procedure for a fully coupled lateral and longitudinal vehicle model. Explicit integrals of the guidance error were included to produce a type 1 characteristic. Gain scheduling was used to account for changes in the vehicle dynamics. The digital controller was exercised by combining it with state estimators, a trajectory generator, and a closed-loop guidance algorithm to form a helicopter autoland system. A CH-47 tandem rotor helicopter was equipped with sensors, on-board digital flight computers, and electrohydraulic actuators. The system was exercised by automatically flying straight-in descending decelerating trajectories typcial of VFR manual landing approaches. A description of the test-ground facilities, the flight hardware and software, and the velocity and position tracking performance is included. Author

A87-53583
HEAD-UP FLYING [LE PILOTAGE TETE HAUTE]
J.-F. GEORGES (Avions Marcel Dassault-Brequet Aviation, Vaucresson, France) Navigation (Paris) (ISSN 0028-1530), vol. 35, July 1987, p. 381-394. In French.

The history of the development of the HUD, and the advantages and disadvantages of HUD flying, are discussed. The efficiency and safety of HUDs have been demonstrated in military aircraft applications where they are used routinely for takeoff, navigation, combat maneuvering, approach, and landing. HUD disadvantages include limited field of view, the use of single cathode ray tubes, and the use of inertial-type sensors. Advantages include improvement in the precision and ease of enacting maneuvers, and improvement in the modification of flight parameters. Solutions proposed for the attainment of safety and performance standards should make HUDs applicable to civil aircraft and future spacecraft. R.R.

A87-54139
EFFECT OF DYNAMIC STALL ON HELICOPTER TRIM AND FLAP-LAG RESPONSE
D. A. PETERS and M. CHOUCHANE (Georgia Institute of Technology, Atlanta) Journal of Fluids and Structures (ISSN 0889-9746), vol. 1, July 1987, p. 299-318. refs
(Contract DAAG29-80-C-0092)

A unified lift model is used in the derivation of elastic blade equations. The resultant mathematical model predicts the aerodynamic forces on the helicopter blade and the flap-lag response before and after stall occurs. An ordering scheme is applied during the derivation so that only important terms are retained. The time history solution is obtained using Galerkin's method. The results agree qualitatively with the linear model for small angles of attack, and give a reasonable prediction of the flap-lag response including stall. Author

A87-54140
ON THE FEASIBILITY OF LOW-SPEED AIRCRAFT MANEUVERS INVOLVING EXTREME ANGLES OF ATTACK
H. ASHLEY (Stanford University, Ca) Journal of Fluids and Structures (ISSN 0889-9746), vol. 1, July 1987, p. 319-335. refs
(Contract AF-AFOSR-84-0099)

The feasibility of high-performance aircraft performing 'supermaneuvers' (maneuvers with angles of attack peaking near 90 deg) using aerodynamic controls and/or by rotation of the engine thrust vector is investigated. Generic supermanuevers are reconstructed based on published optimal point-mass trajectories. Euler's equations of rigid-body motion and assumed values of geometric and inertial properties are used to estimate the moment histories from previous kinematic data. Time histories of rolling, pitching, and yawing moments needed from the controls are estimated. The examples of a conventional vertical turn, a climbing turn into post-stall, and a reversal of the fuselage axis with a final position constraint are considered. The potential importance of thrust vector control in performing supermaneuvers is emphasized. R.R.

A87-54190#
SIMULTANEOUS ACTIVE CONTROLS ON WIND TUNNEL MODEL
R. DESTUYNDER, A. GRAVELLE, and I. LEGRAIN (ONERA, Chatillon-sous-Bagneux, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 2, 1987, p. 13-21. refs

A theoretical and experimental study was carried out to validate the of spoilers use in automatic multicontrol systems. Using a Froude scale model roughly representing an existing airplane, low speed wind tunnel tests were run to validate the theory for several control laws, applied simultaneously on the same control surfaces. The second objective was to compare the use of several control surfaces for the same type of control (flutter, gust, stability). Author

N87-28532# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
THE MODEL INVERSE AS AN ELEMENT OF A PREDETERMINED CONTROL SYSTEM FOR HELICOPTERS [DIE MODELLINVERSE ALS EIN ELEMENT EINES VORGABEREGE-LUNGSSYSTEMS FUER HUBSCHRAUBER]
HAGEN LEYENDECKER *In its* Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation p 19-38 Nov. 1986 In GERMAN
Avail: NTIS HC A10/MF A01; DFVLR, Cologne, West Germany DM 65

The modeling of dynamic anticipatory control as a decisive element of predetermined control systems is treated. An internal controller has to be included since the model behavior and the real systems behavior do not generally agree and since external perturbations are present. The model of the dynamic anticipatory control system is explained; it can theoretically be treated independently of the internal controller; the inverse of the controlled system was used as anticipatory control system. A control algorithm was developed for the helicopter BO 105-S3, equipped with a simplex fly-by-wire system including an in-flight computer. The measured data are sent to ground by PCM telemetry, and are digitally recorded. Flight tests show satisfactory results, the dynamic anticipatory control system substantially facilitates the task of the internal controller. ESA

N87-28559# National Aeronautical Establishment, Ottawa (Ontario).
DETERMINATION OF HANDLING QUALITIES AND DISPLAY REQUIREMENTS FOR HELICOPTER INSTRUMENT FLIGHT DURING DECELERATING APPROACHES TO SLOW SPEEDS Aeronautical Note
S. KERELIUK and D. E. SATTLER May 1987 39 p
(AD-A182797; NAE-AN-44) Avail: NTIS HC A03/MF A01 CSCL 01C

This paper discusses the most recent phase of a series of experiments performed jointly by the National Aeronautical Establishment and the United States Federal Aviation Administration. The experiment was aimed at determining the helicopter instrument flight handling qualities requirements when performing steep approaches to low decision heights to a landing area collocated with a Microwave Landing System. A total of 118 approaches were evaluated by three helicopter certification test pilots and one operational/training helicopter pilot. Results indicate that with simple rate damping augmentation in pitch, roll and yaw, and flight director guidance, a Bell 205A-1 exhibited borderline Level 1 (certifiable) handling qualities when performing decelerating approaches to 20 knots to decision heights representative of Category IIIA weather limits. GRA

N87-28561# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Flaechenflugzeuge.
AN IMPROVED DESIGN TECHNIQUE FOR MODEL FOLLOWING CONTROL SYSTEMS IN IN-FLIGHT SIMULATION
FROHMUT HENSCHEL and SHYAM CHETTY Feb. 1987 52 p
(DFVLR-FB-87-09; ISSN-0171-1342; ETN-87-90456) Avail: NTIS HC A04/MF A01; DFVLR, Cologne, West Germany DM 19

Improvements were made in an in-flight simulator design technique to obtain better performance. The feedforward branches include additional filters to make the forward loop gains independent of the model aircraft parameters. This permits the use of linear/nonlinear models for the model aircraft during inflight simulation. For determining the feedback gains robustness measures derived from singular value decomposition were used to supplement the time domain criteria during optimization. The technique yields designs with lower feedback gains and improved performance. ESA

N87-28562*# Florida Atlantic Univ., Boca Raton. Dept. of Mechanical Engineering.
TOWARD COMPARING EXPERIMENT AND THEORY FOR CORROBORATIVE RESEARCH ON HINGELESS ROTOR STABILITY IN FORWARD FLIGHT Final Technical Report, 1 Aug. 1985 - 31 Jul. 1987
G. GAONKAR Aug. 1987 61 p
(Contract NCC2-361)
(NASA-CR-181354; NAS 1.26:181354) Avail: NTIS HC A04/MF A01 CSCL 01C

For flap lag stability of isolated rotors, experimental and analytical investigations were conducted in hover and forward flight on the adequacy of a linear quasisteady aerodynamics theory with dynamic flow. Forward flight effects on lag regressing mode were emphasized. A soft inplane hingeless rotor with three blades was tested at advance ratios as high as 0.55 and at shaft angles as high as 20 deg. The 1.62 m model rotor was untrimmed with an essentially unrestricted tilt of the tip path plane. In combination with lag natural frequencies, collective pitch settings and flap lag coupling parameters, the data base comprises nearly 1200 test points (damping and frequency) in forward flight and 200 test points in hover. By computerized symbolic manipulation, a linear model was developed in substall to predict stability margins with mode identification. To help explain the correlation between theory and data it also predicted substall and stall regions of the rotor disk from equilibrium values. The correlation showed both the strengths and weaknesses of the theory in substall ((angle of attack) equal to or less than 12 deg). Author

N87-28563*# Boeing Commercial Airplane Co., Seattle, Wash.
INTEGRATED APPLICATION OF ACTIVE CONTROLS (IAAC) TECHNOLOGY TO AN ADVANCED SUBSONIC TRANSPORT PROJECT: TEST ACT SYSTEM VALIDATION Final Report
Aug. 1985 149 p
(Contract NAS1-15325)
(NASA-CR-172525; NAS 1.26:172525) Avail: NTIS HC A07/MF A01 CSCL 01C

The primary objective of the Test Active Control Technology (ACT) System laboratory tests was to verify and validate the system concept, hardware, and software. The initial lab tests were open loop hardware tests of the Test ACT System as designed and built. During the course of the testing, minor problems were uncovered and corrected. Major software tests were run. The initial software testing was also open loop. These tests examined pitch control laws, wing load alleviation, signal selection/fault detection (SSFD), and output management. The Test ACT System was modified to interface with the direct drive valve (DDV) modules. The initial testing identified problem areas with DDV nonlinearities, valve friction induced limit cycling, DDV control loop instability, and channel command mismatch. The other DDV issue investigated was the ability to detect and isolate failures. Some simple schemes for failure detection were tested but were not completely satisfactory. The Test ACT System architecture continues to appear promising for ACT/FBW applications in systems that must be

immune to worst case generic digital faults, and be able to tolerate two sequential nongeneric faults with no reduction in performance. The challenge in such an implementation would be to keep the analog element sufficiently simple to achieve the necessary reliability. B.G.

N87-28564*# Lockheed-California Co., Burbank.
DEVELOPMENT OF A REDUCED AREA HORIZONTAL TAIL FOR A WIDE BODY JET AIRCRAFT
JERRY J. RISING 1 Feb. 1984 93 p
(Contract NAS1-15326)
(NASA-CR-172278; NAS 1.26:172278) Avail: NTIS HC A05/MF A01 CSCL 01C

Commercial transport aircraft fuel consumption can be significantly reduced by decreasing the size of the horizontal tail. Work on reducing the horizontal tail area of the L-1011 is discussed. The reduced area horizontal tail program consisted of design, fabrication and wind tunnel testing of horizontal tails with reduced planform areas of 30 to 38 percent relative to the standard L-1011 tail. The total drag of the aircraft in cruise was reduced by approximately 2 percent. However, it was necessary to impose forward center of gravity limitations on the aircraft because the maximum lift goal of the reduced area tail was not achieved and sufficient nose-up control authority was not available. On a new design this problem could have been solved by moving the landing gear aft and enlarging the cut-out in the aft fuselage to allow for larger horizontal stabilizer deflections. However, since this is an existing design, these modifications were unfeasible and resulted in the center of gravity restriction. Author

N87-28565*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.
APPLICATION OF A SENSITIVITY ANALYSIS TECHNIQUE TO HIGH-ORDER DIGITAL FLIGHT CONTROL SYSTEMS
JAMES D. PADUANO and DAVID R. DOWNING Edwards, Calif. NASA Ames Research Center 1987 195 p
(Contract NCC2-293)
(NASA-CR-179429; NAS 1.26:179429) Avail: NTIS HC A09/MF A01 CSCL 01C

A sensitivity analysis technique for multiloop flight control systems is studied. This technique uses the scaled singular values of the return difference matrix as a measure of the relative stability of a control system. It then uses the gradients of these singular values with respect to system and controller parameters to judge sensitivity. The sensitivity analysis technique is first reviewed; then it is extended to include digital systems, through the derivation of singular-value gradient equations. Gradients with respect to parameters which do not appear explicitly as control-system matrix elements are also derived, so that high-order systems can be studied. A complete review of the integrated technique is given by way of a simple example: the inverted pendulum problem. The technique is then demonstrated on the X-29 control laws. Results show linear models of real systems can be analyzed by this sensitivity technique, if it is applied with care. A computer program called SVA was written to accomplish the singular-value sensitivity analysis techniques. Thus computational methods and considerations form an integral part of many of the discussions. A user's guide to the program is included. The SVA is a fully public domain program, running on the NASA/Dryden Elxsi computer. Author

N87-29526# British Aerospace Aircraft Group, Preston (England).
VOICE CONTROL OF COCKPIT SYSTEMS
P. BECKETT *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 8 p Feb. 1987 Sponsored by Royal Aircraft Establishment, Farnborough, England
Avail: NTIS HC A14/MF A01

The use of automatic speech recognition for cockpit management should allow more operations to be carried out head-up. In turn this should reduce the frequency and length of the periods spent looking into the cockpit. This would be particulary beneficial for the single seat pilot who could benefit from maintaining visual contact with a target or cooperating aircraft. In addition, it should generally allow more accurate flying performance and reduce the risk of collision with the ground or other aircraft. In order to assess these anticipated advantages, a simulator trial was set up at British Aerospace where a conventionally operated advanced fighter cockpit, containing electronic displays, was compared with one where Direct Voice Input (DVI) took over some of the roles normally carried out by tactile controls. The comparison was made during a simulated low level mission containing a cross section of typical cockpit activities. The comparison is discussed in detail. Author

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.

A87-51213
THE MEASUREMENT OF OSCILLATORY PRESSURES WITH DISCRETE AND SWEEP EXCITATION
D. G. MABEY and B. L. WELSH (Royal Aircraft Establishment, Aerodynamics Dept., Bedford, England) Journal of Fluids and Structures (ISSN 0889-9746), vol. 1, Jan. 1987, p. 95-105. refs

The influence of tunnel-flow and model-flow unsteadiness on two methods of oscillatory pressure measurement is investigated. For the standard method of constant frequency measurements (at 3, 12, 33, and 70 Hz), the coherence function between the measured pressures and the model pitching motion provides a sensitive check on the influence of flow unsteadiness, and indicates the measurement time which is appropriate to a particular frequency. Frequency-sweep measurements attempt to obtain oscillatory pressures over a continuous range (from 5-75 Hz) with reduced measurement time. Results for this method do not compare well with results obtained by the standard method at 12 and 33 Hz, as a consequence of (1) the level and scale of flow unsteadiness of the wind tunnel and (2) the shock waves on the model. R.R.

A87-51968
A METHOD FOR PRODUCING OBLIQUE SHOCK-BOW SHOCK INTERACTION IN DOUBLE-DRIVER SHOCK TUNNEL
ZHAOYUAN HAN, ZHENQIU WANG, XIEZHEN YIN, JIUCHENG YAO, ANDI DU (University of Science and Technology of China, Hefei, People's Republic of China) et al. Scientia Sinica, Series A - Mathematical, Physical, Astronomical and Technical Sciences (ISSN 0253-5831), vol. 30, June 1987, p. 620-628. refs

Based on discussing and analyzing the two types of experiments on the oblique shock/bow-shock interaction, a new method in a double-driver shock tunnel is presented. This method can not only form a planar moving shock for producing oblique interaction, but also record the transient pressure on the surface of a testing model and take the photographs simultaneously. It can be used to study the transition between regular and Mach reflection of a moving shock with a quasi-stationary flow ahead of it on the surface of a flat wedge or a cone. A modified method for measuring the moving-shock Mach number is presented. Author

A87-52290#
A SIMULATOR EVALUATION OF ALTERNATIVE HELIPORT APPROACH LIGHTING SYSTEMS
HARRY A. VERSTYNEN (FAA, Hampton, VA) and PAUL H. JONES (FAA, Technical Center, Atlantic City, NJ) AIAA, Flight Simulation Technologies Conference, Monterey, CA, Aug. 17-19, 1987. 7 p. refs
(AIAA PAPER 87-2635)

A simulator investigation has been conducted to evaluate alternative heliport approach lighting schemes under reduced visibility conditions. The approach lighting systems were evaluated to determine their ability to provide line-up guidance at decision height, to provide unique identification that would distinguish them from other approach lighting systems, and to provide reduced glare during the close-in deceleration phase of a helicopter approach. The systems differed with respect to the longitudinal spacing of the lights, the overall length of the lighting system, and the existence of extra-width 'wingbar' lights at 1000-foot intervals on the longest system. Nine subject pilots determined that each of the lighting systems evaluated was adequate for the visibility conditions in which it was tested. The subject pilots found deceleration along the glide path after breakout to be difficult due to the lack of external vertical guidance in those reduced visibility conditions in which the helipad was not visible at decision height. Author

A87-52494* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE NASA STRAIN GAGE LABORATORY
HOWARD F. HOBART and HERBERT A. WILL (NASA, Lewis Research Center, Cleveland, OH) IN: Annual Hostile Environments and High Temperature Measurements Conference, 3rd, Cincinnati, OH, Mar. 25, 26, 1986, Proceedings . Bethel, CT, Society for Experimental Mechanics, Inc., 1986, p. 5-9.

The goal of the NASA-sponsored high-temperature high-strain gage program (which combines in-house, contract, and grant work) is to develop a gage that will measure static strains up to 2000 microstrain to within 10 percent, and at temperatures up to 1250 K (typical for combustors and turbine blades and vanes of gas turbine engines) maintained over 50-h period. The basic equipment of the NASA in-house lab is described (with special attention given to the strain-gage testing system), and some examples of recent test results are discussed. Data are presented on following tests performed on four gages: apparent strain vs temperature at different cooling rates, gage factor at various strain and temperature levels, and drift and creep tests at 133 C. I.S.

A87-52879*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PILOT EVALUATION OF POPULATION-MINIMAL GROUND TRACKS IN THE AIRPORT COMMUNITY
RICHARD DELOACH and JACOB A. HOUCK (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 603-610. Previously cited in issue 23, p. 3416, Accession no. A86-47664. refs

A87-53569
PSI MULTITRANSDUCER IN LOW-VELOCITY WIND TUNNEL IN BRAUNSCHWEIG [PSI-MULTITRANSDUCER IM NIEDERGESCHWINDIGKEITS-WINDKANAL IN BRAUNSCHWEIG]
RUEDIGER SIEBERT (DFVLR, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), June 1987, p. 30-33. In German.

The benefits which multitransducer technology from Firma Pressure Systems Incorporated (PSI) can provide to low-velocity wind tunnels are discussed, using results from its insertion into the Braunschweig low-velocity wind tunnel. The PSI technology is described and compared with that from another firm. Its integration into wind tunnels and its specifications are shown. It is concluded that the PSI technology should replace existing technology in low-velocity wind tunnels. C.D.

A87-53779*# Southwest Research Inst., San Antonio, Tex.
DETECTION OF IN-FLIGHT PROPELLER-INDUCED STRUCTURE-BORNE NOISE
J. F. UNRUH (Southwest Research Institute, San Antonio, TX) Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 441-446. refs
(Contract NAS1-17921)

A potentially important source of structure-borne interior noise transmission in advanced turboprop aircraft is the impingement of the propeller wake/vortex on downstream aerodynamic surfaces. It can be safely assumed that this potential source of interior noise may well adversely affect achievable interior noise levels unless noise control measures are conscientiously incorporated into the aircraft design. Through the use of a laboratory-based test apparatus, techniques were developed to estimate the level of in-flight structure-borne noise transmission from combined frequency response function ground testing and in-flight structural response measurements. All phases of the procedure were simulated in the laboratory and the expected level of accuracy of the procedure is addressed. Author

A87-54189#
UNSTEADY TEST METHOD APPLIED TO WIND TUNNEL STUDIES OF FLUTTER
R. DESTUYNDER (ONERA, Chatillon-sous-Bagneux, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 2, 1987, p. 1-11.

Unsteady aerodynamic flutter tests in wind tunnels cover several domains and use a number of different techniques, such as pressure and force coefficient measurements on half-models at the wall used for theory-experiment comparisons. The excitation systems using hydraulic actuators cover a broad range of reduced frequencies, including the structural eigenmodes. The excitation methods are white noise, sweep frequency, fixed frequency excitation or ramps. Another sort of test aims at characterizing the efficiency of various types of control surfaces for use in control laws. Half-models with fixed root conditions (bending and torsion) or complete suspended models are used in flutter tests in Mach scale or Froude scale similitude. Large capacity computerized data acquisition and processing (several hundred pickups) permits online monitoring of a great many parameters. Author

N87-28566# Technische Univ., Berlin (West Germany). Inst. fuer Luft- und Raumfahrt.
THE PROBLEMS OF THE CALCULATION OF THE CAPACITY OF FLIGHT OPERATION SURFACES OF AIRPORTS [ZUR PROBLEMATIK DER KAPAZITAETSBERECHNUNG VON FLUGBETRIEBSFLAECHEN AUF FLUGPLAETZEN]
HEINRICH MENSEN and GERD STOEWER Aug. 1986 165 p In GERMAN
(ILR-MITT-170; ETN-87-90051) Avail: NTIS HC A08/MF A01

Air traffic capacity problems at airports are reviewed, emphasizing the calculation of hourly capacity. Technical and practical capacities are distinguished. The capacity of the three most important flight operation surfaces runways, taxiways, and parking places is discussed. Factors which influence the runway capacity are presented. Models for the calculation of the practical hourly runway capacity are explained. The change of the practical hourly capacity as a function of several factors was determined. The calculation of the practical annual capacity, starting from the hourly capacity, is explained. Possibilities of capacity enhancement are presented. ESA

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.

A87-53581
THE NAVSTAR/GPS PROGRAM - AN EVOLUTION OR A REVOLUTION IN THE WORLD OF NAVIGATION [LE PROGRAM NAVSTAR/GPS - UNE EVOLUTION OU UNE REVOLUTION DANS LE MONDE DE LA NAVIGATION]
NICOLAS DE CHEZELLES (Delegation Generale pour l'Armement, Direction de l'Electronique et de l'Informatique, Paris, France) Navigation (Paris) (ISSN 0028-1530), vol. 35, July 1987, p. 349-357. In French.

Characteristics of the Navstar/GPS system, the present status of its equipment and programs, and its impact on government administrations, public institutions, industry, and the user community are addressed. The positioning and synchronization services are considered, and the system infrastructure is discussed. Civil uses of the system include mapping, geodesy, scientific applications of time and frequency synchronization, and automobile and aircraft applications. The Navstar/GPS program projects three-dimensional navigation coverage with a constellation of 21 satellites by 1990. The selective availability and antispoofing access protection terms are also discussed, in addition to reference documentation of the system, such as the STANAG 4294 standardization agreement. R.R.

A87-54195
SIMULATING HERMES
LEE DAY (Singer Link-Miles, Ltd., Flight Simulation Div., Lancing, England) Space (ISSN 0267-954X), vol. 3, July-Aug. 1987, p. 4-7.

The simulation requirements for the Hermes spaceplane are considered. Hermes will require engineering and training simulation. The development simulation will involve design verification leading to the construction of a prototype of the spaceplane; the avionics integration laboratory has been designed for this phase of the simulation. The testing of the prototype and training of the personnel in reentry and in orbit activities will require an integrated simulator. The use of aircraft for simulating landing approaches is discussed. It is determined that Hermes will need a fully integrated training system consisting of a full mission simulator and a network simulation system; the design of the network simulation system is examined. I.F.

11

CHEMISTRY AND MATERIALS

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

A87-51177#
DESIGN OF HIGH-TEMPERATURE, ORDERED INTERMETALLIC ALLOYS
C. T. LIU (Oak Ridge National Laboratory, TN) Oak Ridge National Laboratory Review (ISSN 0048-1262), vol. 19, no. 3, 1986, p. 42-51.

Basic and applied research on ordered intermetallic alloys at Oak Ridge National Laboratory is reviewed, with an emphasis on microstructural studies of high-temperature alloys based on Ni3Al. Topics addressed include the general characteristics and potential applications of Ni3Al, grain-boundary fracture and microalloying with B, stoichiometric effects, environmental effects, high-temperature ductility, hardening mechanisms, and mechanical behavior. Diagrams, graphs, photographs, and micrographs are provided. T.K.

A87-51301
HIGH-STRENGTH, HIGH-TEMPERATURE INTERMETALLIC COMPOUNDS
R. L. FLEISCHER (GE Materials Laboratory, Schenectady, NY) Journal of Materials Science (ISSN 0022-2461), vol. 22, July 1987, p. 2281-2288. refs

Materials that are solid at high temperatures are in demand for high-temperature structural applications, and materials that have high values of strength-to-weight and stiffness-to-weight are desired for aircraft and space applications. Basic properties that are insensitive to processing history can be used to provide a preliminary ranking of single-phase substances. A compilation is presented of 293 intermetallic compounds (or metal-metalloid compounds) that melt at T not lower than 1500 C. By displaying the data by crystal structure on plots of T(m) against the specific gravity, candidates for optimum specific strength and specific stiffness can be recognized for materials that are likely to have similar plastic properties. Author

A87-51351
CONFERENCE ON HIGH-TEMPERATURE CORROSION OF SUPERALLOYS, LONDON, ENGLAND, FEB 11, 12, 1986, PROCEEDINGS
Materials Science and Technology (ISSN 0267-0836), vol. 3, July 1987, 120 p. For individual items see A87-51352 to A87-51360.

The present collection of selected papers from a conference on the high-temperature corrosion of superalloys such as those used in gas turbine hot section components addresses hot corrosion site environments in gas turbines, the thermodynamics of metal-gas-liquid reactions, corrosion reactions in molten sulfates, the oxidation of superalloys, and cyclic oxidation in high-temperature alloys. Also treated are vanadic and chloride attacks on superalloys, the modeling of creep-corrosion interactions in nickel-base superalloys, factors influencing gas turbine use and performance, coal-fired gas turbine corrosion, the effect of zinc additions to an NaCl-Na2SO4 molten salt mixture on the hot corrosion of Nimocast 713, and sodium vanadate-induced corrosion of nickel and MCrAlY coatings on Inconel 600. O.C.

A87-51400
NON-ISOTHERMAL FATIGUE CRACK GROWTH IN HASTELLOY-X
N. J. MARCHAND, B. ILSCHNER (Lausanne, Ecole Polytechnique Federale, Switzerland), and R. M. PELLOUX (MIT, Cambridge, MA) Fatigue and Fracture of Engineering Materials and Structures (ISSN 8756-758X), vol. 10, no. 1, 1987, p. 59-74. refs

Nonisothermal fatigue crack growth tests were performed on Hastelloy-X single edge notch specimens under simultaneous variation of strain and temperature. Under elastic straining, out-of-phase cycling showed faster crack growth rates than isothermal or in-phase cycling, while under fully plastic cycling, crack growth rates under isothermal cycling are found to be faster than under thermal mechanical fatigue (TMF) cycling. Results were rationalized using a corrected stress intensity factor, Delta K(eff), computed from the actual load, the closing bending moment caused by the increased compliance with crack length, and the effective opening stress. On a Delta K(eff) basis, the isothermal crack growth rates at T(min) and T(max) are used to provide an upper and lower bound for the TMF crack growth rates. R.R.

A87-51634
THE PREPARATION AND PROPERTIES OF VAPOR DEPOSITED AL-CR-FE ALLOYS
R. L. BICKERDIKE, D. CLARK, G. HUGHES, M .C. MCCONNELL, W. N. MAIR (Royal Aircraft Establishment, Farnborough, England) et al. IN: Rapidly solidified materials; Proceedings of the International Conference, San Diego, CA, Feb. 3-5, 1986 . Metals Park, OH, American Society for Metals, 1986, p. 145-151. refs

New aluminium alloys have been developed using vacuum evaporation techniques. Alloy vapour was condensed on temperature controlled collectors to obtain rapidly quenched deposits with homogeneous metastable microstructures. Non-porous deposits of Al-Cr-Fe alloys up to 40 mm thick were produced. Material from these deposits was rolled directly to 1.6 mm thick sheet. The alloy exhibited considerable advances in mechanical properties and corrosion resistance over those of conventional aircraft alloys. Room temperature strengths in excess of 800 MPa were obtained and at 250 C the alloy retained 65 percent of this strength. The tensile properties were unaffected by 1000 hours exposure at temperatures up to 250 C. Author

A87-51648
MECHANICAL PROPERTIES OF THICK SECTION AF2-1DA-6 POWDER METAL TURBINE ROTORS
DAVID F. GRAY (Teledyne CAE, Toledo, OH) IN: Rapidly solidified materials; Proceedings of the International Conference, San Diego, CA, Feb. 3-5, 1986 . Metals Park, OH, American Society for Metals, 1986, p. 387-395. USAF-sponsored research. refs

It is often necessary to design small engine turbine rotors with thick axial bore sections to carry the loads imposed by the rotating assemblies. In this paper, the mechanical properties of thick-section powder metal superalloy AF2-1DA-6 turbine disks were evaluated at four temperatures and compared with the parent alloy in thin sections. The results on tensile, stress-rupture, fatigue, and fracture properties of these samples are presented for temperatures up to 1400 F. The results indicate that the material may provide greater strength if processing parameters are further refined. I.S.

A87-51757
STRUCTURAL CHANGES OCCURRING IN COMPOSITE RING-DISK FLYWHEELS UNDER HIGH SPEED ROTATION
ANTHONY P. COPPA (General Electric Co., Space Systems Div., Philadelphia, PA) IN: Composites '86: Recent advances in Japan and the United States; Proceedings of the Third Japan-U.S. Conference on Composite Materials, Tokyo, Japan, June 23-25, 1986 . Tokyo, Japan Society for Composite Materials, 1986, p. 297-306. refs

This paper describes stress-induced changes that have been observed to occur in composite ring-disk flywheels under high-speed rotation. The flywheels consist of two major components: (1) a central laminated disk constructed of glass/epoxy unidirectional plies so arranged as to obtain quasi-isotropic material properties in the plane, and (2) a filament-wound graphite/epoxy ring that is slightly thicker than the disk and interference-fitted to the disk periphery. A small metallic hub elastomerically bonded to the disk completes the construction. The simple solid construction not only obtains high energy storage but also permits accurate structural analysis of the flywheel components and identification of limiting failure modes. This makes it possible to investigate the consequences of material and design variables on structural behavior under high-speed rotation. Data obtained from cyclic endurance and ultimate (burst) spin tests of such flywheels were examined to explain the unexpectedly high performance levels that were demonstrated. Stress-induced microcracking in the matrix of the laminated disk, leading to reduction in elastic moduli in concentric regions, was found to be the key element in establishing a consistent description of rotor behavior. Author

A87-51792
APPLICATION STUDIES OF A NEW GRAPHITE/EPOXY MATERIAL FOR THE VERTICAL FIN OF A COMMERCIAL TRANSPORT AIRCRAFT
N. TSUDA (Japan Aircraft Development Corp., Tokyo), Y. HIROSE, S. BANDO, and H. MASAEDA (Kawasaki Heavy Industries, Ltd., Aircraft Div., Kagamihara, Japan) IN: Composites '86: Recent advances in Japan and the United States; Proceedings of the Third Japan-U.S. Conference on Composite Materials, Tokyo, Japan, June 23-25, 1986 . Tokyo, Japan Society for Composite Materials, 1986, p. 683-691.

The objective of this study was to evaluate an HE Gr/E (high-elongation graphite/epoxy) material which was to be applied to the vertical fin of a future transport aircraft. The material showed more than a 30 percent increase in tensile elongation and strength compared with a conventional Gr/E material. However, the research activities were limited to fundamental material tests and therefore the application study to a primary structure was conducted. In this study, the HE Gr/E material has revealed that its design allowables are comparable to those of a conventional material and a 30 percent weight reduction can be achieved compared to the metal structure. The durability and damage tolerance of the HE Gr/E material structure were evaluated in the subcomponent tests conforming to the FAA Advisory Circular AC20-107A. Author

A87-51807
COMPOSITES - WHAT NEXT
MICHAEL J. SALKIND (USAF, Office of Scientific Research, Washington, DC) IN: Composites '86: Recent advances in Japan and the United States; Proceedings of the Third Japan-U.S. Conference on Composite Materials, Tokyo, Japan, June 23-25, 1986 . Tokyo, Japan Society for Composite Materials, 1986, p. 845-862. refs

A comprehensive characterization is undertaken of development trends in the application of advanced composite materials to high-performance vehicles such as military fixed- and rotary-wing aircraft primary and secondary structures, lightweight automobiles, and propulsion-system components. Attention is given to pathbreaking developments in specific tailoring of microstructural properties for unique applications by means of chemically based processes. The insights gained into the microstructural bases of toughness characteristics promise to transform structural materials development. O.C.

A87-52403
MILITARY AIRCRAFT 4-CST GAS TURBINE ENGINE OIL DEVELOPMENT
LOIS J. GSCHWENDER, CARL E. SNYDER, JR., and G. A. BEANE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) Lubrication Engineering (ISSN 0024-7154), vol. 43, Aug. 1987, p. 654-659. refs

The United States Air Force anticipates oxidative/thermal stability limitations with currently used MIL-L-7808J gas-turbine engine oil for future turbine engine applications. Future aircraft are anticipated to require hotter, more efficiently burning engines which will tax the oxidative/thermal stability of the engine oil present for both cooling and lubricating functions. The Air Force has embarked on a program to develop a -51 to 20 C bulk oil temperature gas-turbine engine oil with a minimum viscosity of 4 cSt at 100 C. This paper presents target properties for this development program and data on highly promising candidates investigated to date. The fully developed lubricant, aassuming continued success, is anticipated to replace MIL-L-7808 by 1988 in Air Force aircraft. Author

A87-52658
MECHANICAL PROPERTIES OF RAPIDLY SOLIDIFIED AL-4BE
D. C. VAN AKEN, P. KURATH, and H. L. FRASER (Illinois, University, Urbana) IN: Aluminum alloys: Their physical and mechanical properties; Proceedings of the International Conference, Charlottesville, VA, June 15-20, 1986. Volume 1 . Warley, England, Engineering Materials Advisory Services, Ltd., 1986, p. 295-306. refs
(Contract AF-AFOSR-85-0191)

Mechanical properties for melt-spun (MS) Al-4Be were obtained for ribbon consolidated by dynamic compaction (DC) and by thermomechanical extrusion (Extr). The ribbon was extruded at 375 C with a reduction in area of 18:1. Extruded microstructures exhibited a dynamically recrystallized grain size of 1-2 microns dispersed with Be particles. A Young's modulus of 71.5 GPa was experimentally measured; this value was consistent with calculations based on a materials composite theory. Monotonic and cyclic properties for the extrusion were also reported. The yield stress for as-cast, MS-DC, and MS-Extr Al-4Be was 65, 248, and 126 MPa, respectively. Mechanical strengths were related to the size and distribution of the Be particles. Author

A87-52661
DEVELOPMENT OF FINE-GRAINED 7075-O SHEET FOR AIRCRAFT TAPER-ROLLED STRINGER
T. UNO, H. YOSHIDA, and Y. BABA (Sumitomo Light Metal Industry, Ltd., Technical Research Laboratories, Nagoya, Japan) IN: Aluminum alloys: Their physical and mechanical properties; Proceedings of the International Conference, Charlottesville, VA, June 15-20, 1986. Volume 1 . Warley, England, Engineering Materials Advisory Services, Ltd., 1986, p. 371-385. refs

Fine-grained 7075-O sheets for aircraft taper-rolled stringers have been developed. The new material exhibits fine grain size (40 microns) and no grain-growth after slight cold-reduction followed by solution treatment. Because of the fine grain size, the new material exhibits excellent properties compared with coarse-grained material (200 microns) fabricated by conventional process. The new material is now mass-produced and applied to taper-rolled stringers for the latest civil transports. Author

A87-52673
THE EFFECT OF COMPOSITION AND HEAT TREATMENT UPON MICROSTRUCTURE/PROPERTY RELATIONSHIPS IN AL-LI-CU-MG ALLOYS
H. M. FLOWER, A. K. MUKHOPADHYAY (Imperial College of Science and Technology, London, England), P. J. GREGSON, and C. N. J. TITE (Southampton, University, England) IN: Aluminum alloys: Their physical and mechanical properties; Proceedings of the International Conference, Charlottesville, VA, June 15-20, 1986. Volume 2 . Warley, England, Engineering Materials Advisory Services, Ltd., 1986, p. 743-754. refs

Solution treatment conditions together with variation in subsequent age hardening procedures are shown to influence significantly the microstructure and mechanical properties of Al-Li-Cu-Mg-Zr alloys encompassing the composition ranges of commercial Lital A and B materials. The synergistic relationship between delta-prime and S phase precipitation reactions and free vacancy concentration is discussed in relation to the observations reported. Author

A87-52683
THE EFFECT OF PRESTRAIN AND OF AGEING AT ROOM TEMPERATURE ON THE MECHANICAL PROPERTIES OF AN AL-LI-CU-MG ALLOY
P. J. E. BISCHLER and J. W. MARTIN (Oxford University, England) IN: Aluminum alloys: Their physical and mechanical properties; Proceedings of the International Conference, Charlottesville, VA, June 15-20, 1986. Volume 2 . Warley, England, Engineering Materials Advisory Services, Ltd., 1986, p. 963-973. Research supported by the Ministry of Defence (Procurement Executive). refs

Room temperature aging tests have been conducted for periods of up to 2 years on a solution-treated and quenched alloy, and on one which has received a 2.5 percent stretch after solution-treatment. A significantly lower peak hardness is achieved in the stretched material due, it is thought, to the elimination by the stretch of quenched-in vacancies. Further specimens have been artificially aged after various periods at room temperature. Microstructures, tensile properties and failure modes have been compared. Author

A87-53352* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STRUCTURAL CERAMICS IN HEAT ENGINES - THE NASA VIEWPOINT
H. B. PROBST (NASA, Lewis Research Center, Cleveland, OH) IN: Ceramic components for engines . London and New York, Elsevier Applied Science, 1986, p. 45-58. refs

The interest of NASA in the application of ceramics in heat engines is reviewed. This interest started in the early 1950s with attempts to apply oxides, borides, and cermets as gas turbine components. These attempts, as other similar efforts around the world at that time, generally met with failure due to the brittle nature of the materials and a lack of understanding of how to accommodate brittleness by appropriate design approaches. More recent efforts of the 1970s have concentrated on the silicon nitride and silicon carbide family of ceramics. This class of materials demonstrated thermal stability and thermal shock resistance in gas turbine environments. Subsequent programs funded by the DOE and managed by NASA have demonstrated great strides in material fabricability and the application of FEM design concepts. However, the materials remain brittle and lacking in reliability and reproducibility. This reliability/reproducibility problem is viewed as the major current impediment to the application of ceramics in heat engines; approaches to its solution are discussed. Author

A87-53354
ALPHA SILICON CARBIDE COMPONENTS FOR HEAT ENGINE APPLICATIONS
ROGER S. STORM (Carborundum Resistant Materials Co., Advanced Materials Div., Niagara Falls, NY) IN: Ceramic components for engines . London and New York, Elsevier Applied Science, 1986, p. 170-176.

The use of alpha SiC as a material for engine components is evaluated by comparing the performance of ceramic and alpha SiC pistons and cylinders. Previous research on the development of a sintered alpha SiC turbocharger rotor and the fabrication of rotors by brazing SiC to metal is discussed. The evaluation reveals that SiC pistons run uncooled and unlubricated in a SiC cylinder and the unlubricated SiC parts have a lower coefficient of friction than lubricated metal parts. It is noted that the use of SiC engine components provides significant gains in engine output and friction reduction. I.F.

A87-53373
HOT ISOSTATIC PRESSING - ITS APPLICATION IN HIGH PERFORMANCE CERAMICS
T. FUJIKAWA, M. MORITOKI, T. KANDA, K. HOMMA, and H. OKADA (Kobe Steel, Ltd., Japan) IN: Ceramic components for engines . London and New York, Elsevier Applied Science, 1986, p. 425-433.

Recent advances in hot isostatic pressing (HIP) equipment technology have led HIP to be one of the most promising processes for the production of fully dense and reliable parts. Newly developed high-temperature HIP equipment and the success in the commercial production of alumina cutting-tool inserts offer a possible solution to the manufacture of ceramic components for engines. The design concept of high-temperature HIP equipment and some experimental results of HIP-processed silicon nitride are discussed. Author

A87-53441
FATIGUE STRENGTH OF 30KHGSN2A STEEL LUGS UNDER PROGRAMMED LOADING [SOPROTIVLENIE USTALOSTI PROUSHIN IZ STALI 30KHGSN2A PRI PROGRAMMNOM NAGRUZHENII]
V. L. DROZHZHIN Problemy Prochnosti (ISSN 0556-171X), July 1987, p. 36-39. In Russian. refs

Experimental data are presented on the effect of programmed loading simulating the loading of aircraft landing gear components on the fatigue damage characteristics of 30KhGSN2A steel lugs. It is found that the linear fatigue damage summation hypothesis provides an accurate description of the results obtained in the case where stresses below the endurance limit are disregarded in calculating the sum of relative fatigue lives. It is also shown that the sum of relative fatigue lives depends on the structure and composition of a loading block and the stress level within the block. V.L.

A87-53623* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NEW ZRO2-YB2O3 PLASMA-SPRAYED COATINGS FOR THERMAL BARRIER APPLICATIONS
STEPHAN STECURA (NASA, Lewis Research Center, Cleveland, OH) Thin Solid Films (ISSN 0040-6090), vol. 150, 1987, p. 15-40. refs

New thermal barrier coatings, whose compositions were chosen on the basis of a limited study of the ZrO2-Yb2O3 system, were evaluated by cyclic testing in a furnace at 1120 C. On Ni-16.2Cr-5.9Al-0.15Y bond coating, ZrO2-12.4Yb2O3, ZrO2-14.7Yb2O3 and ZrO2-17.4Yb2O3 coatings have respectively 60, 30, and 15 percent longer lives than the near-optimum ZrO2-6.1Y2O3 coating. On Ni-18.3Cr-6.4Al-0.22Yb coating, ZrO2-12.4Yb2O3 has about 40 percent longer life than the ZrO2-6.1Y2O3 coating. The optimum Yb2O3 concentration in ZrO2 at which the maximum life is obtained is believed to be between 12.4 and 14.7 wt. pct. The ZrO2-Yb2O3 thermal barrier systems failed through the formation of a crack or cracks in the thermal barrier coating near the bond coating interface. As-received ZrO2-Yb2O3 plasma spray powders had a nonhomogeneous distribution of Yb2O3. Monoclinic, cubic, and tetragonal phases in addition to Zr3Yb4O12 and an unknown phase were present. C.D.

A87-53785#
RESIDUAL STRESSES IN 2024-T81 ALUMINUM USING CAUSTICS AND MOIRE INTERFEROMETRY
BASIL P. LEFTHERIS and ROBERT SCHWARZ (Grumman Corporate Research Center, Bethpage, NY) Journal of Aircraft (ISSN 0021-8669), vol. 24, July 1987, p. 474-476.

It is demonstrated experimentally that aluminum 2024-T81 has an unpredictable fatigue behavior attributable to residual stresses in the material. From the limited number (10) of specimens tested, a 2.5 times advantage in fatigue life was evident for specimens loaded in the long transverse over the longitudinal direction. The advantage of the LT direction was maintained in specimens with cold-worked holes. However, some specimens showed no differences in fatigue life between LT and L directions, indicating that residual stresses in sheets of 2024-T81 are not uniform and, hence, not predictable. It was also shown that the sleeve method of cold working has an area sector spreading radially out from the sleeve seam, where the strains are near zero after cold work. B.J.

A87-53823
LOCAL RECOATING OF COMPONENTS OF HIGH-PRESSURE JET AIRCRAFT ENGINES [LOKALES WIDERBESCHICHTEN VON KOMPONENTEN DER HOCHDRUCKTURBINE GAENGIGER FLUGZEUGTRIEBWERKE]
G. FRIELINGHAUS, W. JUERGENS, and M. MALIK (VDI Gesellschaft Werkstofftechnik, Symposium ueber Beschichtungen fuer Hochleistungsbauteile, Hagen, West Germany, Nov. 6, 7, 1986) Powder Metallurgy International (ISSN 0048-5012), vol. 19, Aug. 1987, p. 52-55. In German.

Examples are used to illustrate the possibility of local recoating as an alternative to total repair of guide blades in jet aircraft engines. The problems associated with both the 'tape' and 'touch-up' coating techniques are described. The practical results of applying various recoating approaches under various conditions are depicted and discussed. C.D.

A87-53888
HIGH-TEMPERATURE POLYMERS FOR ADHESIVE AND COMPOSITE APPLICATIONS
S. J. SHAW (Royal Armament Research and Development Establishment, Waltham Abbey, England) Materials Science and Technology (ISSN 0267-0836), vol. 3, Aug. 1987, p. 589-599. refs

The aerospace industry is currently making extensive use of both structural adhesives and composite materials in aircraft and space vehicle construction. Within the past decade, there has been a growing requirement for adhesives and composites capable of withstanding temperatures in excess of 150 C for both short- and long-term applications. Substantial efforts have been made to develop high-temperature resistant polymers having considerably improved processing characteristics. In this paper, a critical assessment is given of the use of high-temperature polymers in both adhesive and composite applications with particular emphasis on some of the newer, more easily processed types which are, or will probably be, commercially acceptable. Author

A87-53892
ALUMINIUM-LITHIUM ALLOYS FOR HELICOPTER STRUCTURES
A. F. SMITH (Westland, PLC, Materials Laboratory, Yeovil, England) Metals and Materials (ISSN 0266-7185), vol. 3, Aug. 1987, p. 438-444. Research supported by the Ministry of Defence (Procurement Executive). refs

The use of Al-Li alloys in the manufacturing of helicopter structures is studied. The characteristics and properties of these alloys are described and compared to Al alloys. The depletion of elemental Li and Mg from the surface regions of the alloys and the formation of a subsurface pore band parallel to the metal surface at high temperatures in the presence of air are examined. The manufacturing and fabrication of Al-Li alloys, in particular the ingot fabrication process, are discussed. It is noted that Al-Li alloys can achieve a 10 percent density reduction and their properties are superior to those of Al alloys currently used in the aircraft industry. I.F.

A87-53893
DEVELOPMENT OF ALUMINIUM-LITHIUM ALLOYS IN THE UK
C. J. PEEL, B. EVANS, and D. S. MCDARMAID (Royal Aircraft Establishment, Materials Structures Dept., Farnborough, England) Metals and Materials (ISSN 0266-7185), vol. 3, Aug. 1987, p. 449-455. refs

The progress achieved in developing aluminum-lithium alloys 8090 and 8091 is reviewed in this article, showing how engineering and metallurgical considerations have influenced the compositions and thermal treatments chosen. The core of the development has been to optimize the relationship between strength, fracture toughness and fatigue resistance while retaining the desired 10-percent reduction in density. The successful outcome of the development of 8090 and 8091 alloys naturally leads to their incorporation in the next generation of materials with promise for aerospace applications, metal matrix composites. Simplistic design studies suggest that without lightweight aluminum-lithium matrices

the metal matrix composites, particularly those promising an isotropic bulk material performance, will offer little mass savings.
Author

A87-53894
DISPERSION STRENGTHENED ALLOYS FOR AEROSPACE
G. A. J. HACK (Inco Alloys International, Ltd., Hereford, England) Metals and Materials (ISSN 0266-7185), vol. 3, Aug. 1987, p. 457-462. refs

The characteristics and fabrication of oxide dispersion strengthened (ODS) alloys are examined. The forming, joining, and forging steps in the fabrication of ODS superalloys are described. Consideration is given to mechanical and thermomechanical processing of alloys and the secondary recrystallization in ODS alloys. The benefits of mechanically alloyed ODS superalloys include their strength at higher temperatures and increased operating life and corrosion resistance; mechanically alloyed Al alloys provide low densities, high strength, and good corrosion resistance. Various aerospace applications for ODS superalloys are discussed. I.F.

A87-54316
IS FATIGUE TESTING OF IMPACT DAMAGED LAMINATES NECESSARY?
R. JONES (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia), J. F. WILLIAMS, and T. E. TAY (Melbourne, University, Parkville, Australia) Composite Structures (ISSN 0263-8223), vol. 8, no. 1, 1987, p. 1-12. refs

The fatigue testing of impact-damaged graphite-epoxy aircraft structural materials is examined, and the ability of such testing to provide a rationale for inspection intervals is assessed. An effort is made to develop a new philosophy for the damage-tolerant management of impact-damaged composites. If a component is known to be fatigue-prone, the emphasis in research should be on estimating a repair/reject criterion and on the development of advanced repair techniques. It is shown that uniaxial S-N curves for damaged laminates have a generic shape with a pronounced threshold level, and it is concluded that further research is needed to understand the physical reasons for such a threshold value.
B.J.

N87-28605* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE 1-((DIORGANOOXY PHOSPHONYL) METHYL)-2,4- AND -2,6-DIAMINO BENZENES AND THEIR DERIVATIVES Patent
JOHN A. MIKROYANNIDIS, inventor (to NASA) and DEMETRIUS A. KOURTIDES, inventor (to NASA) (National Academy of Sciences - National Research Council, Washington, D. C.) 25 Aug. 1987 7 p Filed 16, Aug. 1984 Supersedes N86-20499 (24 - 11, p 1737) Continuation-in-part of US-Appl-SN-522629, filed 12 Aug. 1983, abandoned
(NASA-CASE-ARC-11425-2; US-PATENT-4,689,421; US-PATENT-APPL-SN-641152; US-PATENT-CLASS-558-145; US-PATENT-CLASS-558-190; US-PATENT-CLASS-558-193)
Avail: US Patent and Trademark Office CSCL 07C

The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-dinitro- and diamino benzenes are prepared by nitrating an (organo phosphenyl) methyl benzene to produce the dinitro compounds which are then reduced to the diamino compounds. The organo groups (alkyl, haloalkyl, aryl) on the phosphorus may be removed to give the free acids (HO)2P(=0)-. The diamino compounds may be polymerized with dianhydrides or diacyl halides to produce fire and flame resistant polymers which are useful in the manufacture of aircraft structures.
Official Gazette of the U.S. Patent and Trademark Office

N87-28606# British Aerospace Public Ltd. Co., Kingston-upon-Thames (England). Structures Dept.
THE EFFECT OF LOAD DWELLS ON THE FATIGUE OF CARBON FIBER COMPOSITES Final Report
D. J. CROPPER Jun. 1986 21 p
(Contract MOD-A93B/1336)
(BAE-MSM-R-GEN-0547; BR100026; ETN-87-90271) Avail: NTIS HC A02/MF A01

The effect of dwells representative of aircraft service loading on the continuous fatigue endurance of carbon fiber specimens under constant amplitude loading was studied. The endurance of the test including dwells is 3.5 times the endurance of the equivalent continuous fatigue test. Dwells can be detrimental and life factors down to 0.72 are found. It is concluded that higher dwell stresses are not as beneficial as lower dwell stresses. The dwell time, however, (10 min compared to 150 min) does not have a noticeable effect upon test endurances. ESA

N87-28607# Plessey Research (Caswell) Ltd., Towcester (England).
A DESIGNERS' GUIDE TO THE ACHIEVEMENT OF ELECTRICAL CONTINUITY IN CARBON FIBRE COMPOSITE STRUCTURES
K. J. LODGE Mar. 1986 89 p
(Contract MOD-A81A/2038)
(CD6500551; BR100178; ETN-87-90272) Avail: NTIS HC A05/MF A01

The design guide provides nonelectrical specialists with the information needed to fulfil the electrical requirements of an aircraft structure which includes carbon fiber composites. It outlines the mechanisms of conduction in composites and in hybrid materials, and the techniques for making joints in such materials and at composite/metal interfaces. Achievable electrical conductivities, environmental effects, and the electrical demands on the airframe are discussed. The associated electrical specifications, and techniques for measuring bond and joint impedances are included. ESA

N87-28613*# McDonnell-Douglas Corp., Long Beach, Calif.
ACEE COMPOSITE STRUCTURES TECHNOLOGY
M. KLOTZSCHE, comp. Aug. 1984 125 p
(Contract NAS1-17701; NAS1-16857; NAS1-14869)
(NASA-CR-172359; NAS 1.26:172359) Avail: NTIS HC A06/MF A01 CSCL 11D

The NASA Aircraft Energy Efficiency (ACEE) Composite Primary Aircraft Structures Program has made significant progress in the development of technology for advanced composites in commercial aircraft. Commercial airframe manufacturers have demonstrated technology readiness and cost effectiveness of advanced composites for secondary and medium primary components and have initiated a concerted program to develop the data base required for efficient application to safety-of-flight wing and fuselage structures. Oral presentations were compiled into five papers. Topics addressed include: damage tolerance and failsafe testing of composite vertical stabilizer; optimization of composite multi-row bolted joints; large wing joint demonstation components; and joints and cutouts in fuselage structure. B.G.

N87-28614*# Boeing Commercial Airplane Co., Seattle, Wash.
ACEE COMPOSITE STRUCTURES TECHNOLOGY
JOHN T. QUINLIVAN, ROBERT D. WILSON, PETER J. SMITH, and RONALD W. JOHNSON Aug. 1984 142 p
(Contract NAS1-15025; NAS1-16863; NAS1-17740)
(NASA-CR-172358; NAS 1.26:172358) Avail: NTIS HC A07/MF A01 CSCL 11D

Toppics addressed include: advanced composites on Boeing commercial aircraft; composite wing durability; damage tolerance technology development; heavily loaded wing panel design; and pressure containment and damage tolerance in fuselages. B.G.

N87-28615*# Lockheed-California Co., Burbank.
ACEE COMPOSITE STRUCTURES TECHNOLOGY
A. M. JAMES Aug. 1984 160 p
(Contract NAS1-17698)
(NASA-CR-172360; NAS 1.26:172360) Avail: NTIS HC A08/MF A01 CSCL 11D

Topics addressed include: strength and hygrothermal response of L-1011 fin components; wing fuel containment and damage tolerance development; impact dynamics; acoustic transmission; fuselage structure; composite transport wing technology development; spar/assembly concepts. B.G.

N87-28616*# Lockheed-California Co., Burbank.
ADVANCED MANUFACTURING DEVELOPMENT OF A COMPOSITE EMPENNAGE COMPONENT FOR L-1011 AIRCRAFT. PHASE 3: PRODUCTION READINESS VERIFICATION TESTING Final Report
A. JACKSON, J. SANDIFER, P. SANDORFF, and R. VANCLEAVE Aug. 1984 109 p
(Contract NAS1-14000)
(NASA-CR-172383-PH-3; NAS 1.26:172383-PH-3) Avail: NTIS HC A06/MF A01 CSCL 11D

Twenty-two specimens of each of two key structural elements of the Advance Composite Vertical Fin (ACVF) were fabricated and tested. One element represented the front spar at the fuselage attachment area and the other element represented the cover at the fuselage joint area. Ten specimens of each element were selected for static testing. The coefficient of variation resulting from the tests was 3.28 percent for the ten cover specimens and 6.11 percent for the ten spar specimens, which compare well with metallic structures. The remaining twelve cover and twelve spar specimens were durability tested in environmental chambers which permitted the temperature and humidity environment to be cycled as well as the applied loads. Results of the durability tests indicated that such components will survive the service environment. Author

N87-28617*# Lockheed-California Co., Burbank.
ADVANCED COMPOSITE VERTICAL FIN FOR L-1011 AIRCRAFT
A. C. JACKSON Washington NASA Sep. 1984 60 p
(Contract NAS1-14000)
(NASA-CR-3816; NAS 1.26:3816) Avail: NTIS HC A04/MF A01 CSCL 11D

The structural box of the L-1011 vertical fin was redesigned using advanced composite materials. The box was fabricated and ground tested to verify the structural integrity. This report summarizes the complete program starting with the design and analysis and proceeds through the process development ancillary test program production readiness verification testing, fabrication of the full-scale fin boxes and the full-scale ground testing. The program showed that advanced composites can economically and effectively be used in the design and fabrication of medium primary structures for commercial aircraft. Static-strength variability was demonstrated to be comparable to metal structures and the long term durability of advanced composite components was demonstrated. Author

N87-28618*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STANDARD TEST EVALUATION OF GRAPHITE FIBER/RESIN MATRIX COMPOSITE MATERIALS FOR IMPROVED TOUGHNESS
ANDREW J. CHAPMAN Sep. 1984 51 p
(NASA-TM-86298; NAS 1.15:86298) Avail: NTIS HC A04/MF A01 CSCL 11D

Programs sponsored by NASA with the commercial transport manufacturers to develop a technology data base are required to design and build composite wing and fuselage structures. To realize the full potential of composite structures in these strength critical designs, material systems having improved ductility and interlaminar toughness are being sought. To promote systematic evaluation of new materials, NASA and the commercial transport manufacturers have selected and standardized a set of five common tests. These tests evaluate open hole tension and compression performance, compression performance after impact at an energy level of 20 ft-lb, and resistance to delamination. Ten toughened resin matrix/graphite fiber composites were evaluated using this series of tests, and their performance is compared with a widely used composite system. Author

N87-28619*# Lockheed-California Co., Burbank.
STUDY OF UTILIZATION OF ADVANCED COMPOSITES IN FUSELAGE STRUCTURES OF LARGE TRANSPORTS Final Report
A. C. JACKSON, M. C. CAMPION, and G. PEI Sep. 1984 107 p
(Contract NAS1-17415)
(NASA-CR-172404; NAS 1.26:172404; LR-30786) Avail: NTIS HC A06/MF A01 CSCL 11D

The effort required by the transport aircraft manufacturers to support the introduction of advanced composite materials into the fuselage structure of future commercial and military transport aircraft is investigated. Technology issues, potential benefits to military life cycle costs and commercial operating costs, and development plans are examined. The most urgent technology issues defined are impact dynamics, acoustic transmission, pressure containment and damage tolerance, post-buckling, cutouts, and joints and splices. A technology demonstration program is defined and a rough cost and schedule identified. The fabrication and test of a full-scale fuselage barrel section is presented. Commercial and military benefits are identified. Fuselage structure weight savings from use of advanced composites are 16.4 percent for the commercial and 21.8 percent for the military. For the all-composite airplanes the savings are 26 percent and 29 percent, respectively. Commercial/operating costs are reduced by 5 percent for the all-composite airplane and military life cycle costs by 10 percent. Author

N87-28643*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THERMAL FATIGUE TESTS OF A RADIATIVE HEAT SHIELD PANEL FOR A HYPERSONIC TRANSPORT
GRANVILLE L. WEBB, RONALD K. CLARK, and ELLSWORTH L. SHARPE Sep. 1985 31 p
(NASA-TM-87583; NAS 1.15:87583) Avail: NTIS HC A03/MF A01 CSCL 11F

A pair of corrugation stiffened, beaded skin Rene 41 heat shield panels were exposed to 20,000 thermal cycles between room temperature and 1450 F to evaluate the thermal fatigue response of Rene 41 metallic heat shields for hypersonic cruise aircraft applications. At the conclusion of the tests, the panels retained substantial structural integrity; however, there were cracks and excessive wear in the vicinity of fastener holes and there was an 80-percent loss in ductility of the skin. Shrinkage of the panel which caused the cracks and wear must be considered in design of panels for Thermal Protection Systems (TPS) applications. Author

N87-28658# J and A Associates, Inc., Golden, Colo.
EVALUATION OF NAPHTHENE RICH TURBINE FUELS AS HEAT SINKS FOR HYPERSONIC AIRCRAFT Final Report, Jul. - Dec. 1986
BRIAN J. LILLIS Jan. 1987 101 p
(Contract F33615-86-C-2664)
(AD-A182118; AFWAL-TR-87-2026) Avail: NTIS HC A06/MF A01 CSCL 21D

A three phase program was undertaken to evaluate the current domestic production of naphthene rich turbine fuels. The first phase was a refinery survey to determine the magnitude of this production and its quality. Hydrocracker effluents are the chief source of these streams, and their turbine fuel cut is approximately 500,000 barrels per day. Samples were obtained from 20 domestic refiners and characterized for their naphthene and sulfur contents. Most sulfur contents were low, less than 2wppm, and the naphthene contents ranged from 18 to 52 mole percent. GRA

N87-29227# Defense Technical Information Center, Alexandria, Va. Iac Program Office.
PTFE (POLYTETRAFLUOROETHYLENE) RESIN SELECTION FOR HIGH PERFORMANCE WIRE AND CABLE
R. L. BAILLIE, J. J. BEDNARCZYK, and P. MEHTA *In* Army Communications-Electronics Command, Proceedings of the 35th International Wire and Cable Symposium, held in Reno, Nevada on 18-20 November 1986 p 47-54 Nov. 1986
(AD-P005211) Avail: NTIS HC A99/MF A01 CSCL 11C

Polytetrafluoroethylene (PTFE) resins have been used for over 30 years in high performance wire and cable applications because of their unique electrical, thermal and chemical properties. Wire insulated with PTFE is used successfully in aircraft, computers, military and industrial electronics, and other demanding applications. In some instances however, PTFE insulation has cracked during service. The following discussion deals with this problem by comparing the stress crack resistance of six different commercial grades of PTFE resin using insulated wire samples in an accelerated stress cracking test. Results are related to important resin properties including standard specific gravity (SSG) and thermal stability (TII). A theory describing the cracking mechanism is discussed and a new test for stress crack susceptibility is developed based on that theory. Author (GRA)

N87-29604*# Texas A&M Univ., College Station. Dept. of Mechanical Engineering.
MICROMECHANICS OF COMPRESSION FAILURES IN OPEN HOLE COMPOSITE LAMINATES Annual Progress Report, Apr. 1986 - Aug. 1987
E. GAIL GUYNN and WALTER L. BRADLEY Sep. 1987 227 p
(Contract NAG1-659)
(NASA-CR-181278; NAS 1.26:181278) Avail: NTIS HC A11/MF A01 CSCL 11D

The high strength-to-weight ratio of composite materials is ideally suited for aerospace applications where they already are used in commercial and military aircraft secondary structures and will soon be used for heavily loaded primary structures. One area impeding the widespread application of composites is their inherent weakness in compressive strength when compared to the tensile properties of the same material. Furthermore, these airframe designs typically contain many bolted or riveted joints, as well as electrical and hydraulic control lines. These applications produce areas of stress concentration, and thus, further complicate the compression failure problem. Open hole compression failures which represent a typical failure mode for composite materials are addressed. B.G.

N87-29609*# *Boeing Commercial Airplane Co., Seattle, Wash.*
THE 737 GRAPHITE COMPOSITE FLIGHT SPOILER FLIGHT SERVICE EVALUATION Progress Report, 1 Jan. 1985 - 31 Dec. 1986
RANDY L. COGGESHALL Aug. 1987 43 p
(Contract NAS1-11668)
(NASA-CR-178322; NAS 1.26:178322; PR-9) Avail: NTIS HC A03/MF A01 CSCL 11D

The ninth flight service report was prepared in compliance with the requirements of Contract NAS1-11668. It covers the flight service experience of 111 graphite-epoxy spoilers on 737 transport aircraft and related ground-based environmental exposure of graphite epoxy material specimens for the period 1 Jan. 1985 through 31 Dec. 1986. Spoilers have been installed on 28 aircraft representing seven major airlines operating throughout the world. An extended flight service evaluation program of 15 years is presently underway. As of 31 Dec. 1986, a total of 3,339,608 spoiler flight-hours and 3,320,952 spoiler landings had been accumulated by this fleet. Author

N87-29612*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE ACEE PROGRAM AND BASIC COMPOSITES RESEARCH AT LANGLEY RESEARCH CENTER (1975 TO 1986): SUMMARY AND BIBLIOGRAPHY
MARVIN B. DOW Oct. 1987 147 p
(NASA-RP-1177; L-16290; NAS 1.61:1177) Avail: NTIS HC A07/MF A01 CSCL 11D

Composites research conducted at the Langley Research Center during the period from 1975 to 1986 is described, and an annotated bibliography of over 600 documents (with their abstracts) is presented. The research includes Langley basic technology and the composite primary structures element of the NASA Aircraft Energy Efficiency (ACEE) Program. The basic technology documents cited in the bibliography are grouped according to the research activity such as design and analysis, fatigue and fracture, and damage tolerance. The ACEE documents cover development of composite structures for transport aircraft. Author

N87-29629# Illinois Univ., Urbana. Dept. of Mechanical and Industrial Engineering.
HIGH-SPEED REACTING FLOWS: RESEARCH TO UNDERSTAND PROCESSES IN SUPERSONIC COMBUSTORS Annual Letter Report, 1 Jun. 1986 - 31 May 1987
H. KRIER, J. C. DUTTON, and J. P. RENIE 31 May 1987 4 p
(Contract N00014-86-K-0434)
(AD-A183952) Avail: NTIS HC A02/MF A01 CSCL 21B

The objective of this program is to determine the fundamental fluid dynamic mechanisms occurring in the mixing and entrainment processes in the free shear layer formed between two high-speed (supersonic/sonic) streams. How the fluid mixing and subsequent combustion depends upon compressibility, as well as other parameters of the free shear layer process, is currently being investigated in an experimental study of the two-dimensional, compressible, turbulent reactive free shear layer. Use of non-intrusive, laser-based diagnostics including laser Schlieren for flow visualization, Laser Doppler Velocimetry (LDV) for velocity and turbulence measurement, and Planar Laser-Induced Fluorescence (PLIF) for temperature and concentration measurements are being employed. GRA

N87-29650*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ELEVATED TEMPERATURE ALUMINUM ALLOYS Patent Application
PETER MESCHTER, inventor (to NASA), RICHARD J. LEDERICH, inventor (to NASA), and JAMES E. ONEAL, inventor (to NASA) (McDonnell-Douglas Corp., St. Louis, Mo.) 30 Jul. 1987 12 p
(NASA-CASE-LAR-13632-1; NAS 1.71:LAR-13632-1; US-PATENT-APPL-SN-079316) Avail: NTIS HC A02/MF A01 CSCL 11F

Three aluminum-lithium alloys are provided for high performance aircraft structures and engines. All three alloys contain 3 wt% copper, 2 wt% lithium, 1 wt% magnesium, and 0.2 wt% zirconium. Alloy 1 has no further alloying elements. Alloy 2 has the addition of 1 wt% iron and 1 wt% nickel. Alloy 3 has the addition of 1.6 wt% chromium to the shared alloy composition of the three alloys. The balance of the three alloys, except for incidental impurities, is aluminum. These alloys have low densities and improved strengths at temperatures up to 260 C for long periods of time. NASA

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.

A87-50872
AN APPROACH TO THE NUMERICAL MODELING OF THE DYNAMICS OF REACTING GASES IN NOZZLES [OB ODNOM PODKHODE V CHISLENNOM MODELIROVANII DINAMIKI REAGIRUIUSHCHIKH GAZOV V SOPLAKH]
T. V. BASHUTSKAIA (Nauchno-Issledovatel'skii Institut Neftianoi Promyshlennosti, USSR), A. E. GRISHCHENKO, and V. N. SKLEPOVOI (Kievskii Gosudarstvennyi Universitet, Kiev, Ukrainian SSR) Vychislitel'naia i Prikladnaia Matematika (ISSN 0321-4117), no. 58, 1986, p. 89-95. In Russian. refs

An approach is proposed for the computer simulation of gasdynamic processes involving chemical nonequilibrium flows in supersonic nozzles. Algorithms for calculating gasdynamic parameters are proposed. The convergence of iteration processes and the stability of the linearized problem are investigated. The results of the study are relevant to gasdynamic and chemical lasers. V.L.

A87-50974
PULSATION STRUCTURE OF THE MIXING LAYER OF UNDEREXPANDED JETS [PUL'SATSIONNAIA STRUKTURA SLOIA SMESHENIIA NEDORASSHIRENNYKH STRUI]
S. A. NOVOPASHIN, A. L. PEREPELKIN, and V. N. IARYGIN PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), May-June 1987, p. 124-126. In Russian. refs

Density pulsation in the initial section of an underexpanded supersonic jet issuing from a sonic nozzle is investigated using a local density measurement technique based on the Rayleigh scattering of light. Longitudinal and transverse density and density pulsation profiles are measured; the turbulent flow region is determined. It is shown that the turbulent flow zone in the mixing layer expands with increasing Reynolds number and may reach a suspended shock wave, causing the latter to fluctuate relative to its middle position. V.L.

A87-51158
A NEW MODEL OF A SELF-CONTROLLED SYSTEM
ALES TONDL (Statni Vyzkumny Ustav Konstrukce Stroju, Bechovice, Czechoslovakia) Acta Technica CSAV (ISSN 0001-7043), vol. 32, no. 3, 1987, p. 243-256.

This paper is a contribution to the bluff body aeroelasticity. A simple mathematical model is proposed describing behavior of the system consisting of an elastically suspended body excited by a cross-flow. The body itself is supposed to have only one degree of freedom and its position is determined by the cross deflection. The model is described by two coupled differential equations of the second order. The model expresses the experimentally defined behavior of systems of this type; that holds both for the dependence of vibration amplitude and vibration frequency on flow velocity. Author

A87-51469
MEASUREMENT OF SWIRLING FLOW FIELD USING THE SINGLE SLANTED HOT-WIRE TECHNIQUE
H. W. SHIN (MIT, Cambridge, MA) and Z. A. HU (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) International Journal of Turbo and Jet-Engines (ISSN 0334-0082), vol. 3, no. 2-3, 1986, p. 139-145. refs

This paper presents the use of a single slanted hot wire to measure the three velocity components of a swirling flow field. In its usage, the hot wire probe has been calibrated in a subsonic air jet for both speed and direction. It was then used to measure the swirling flow field associated with the presence of an inlet model. Using Hybrid Method, the final velocity components are obtained via the solution of a set of simultaneous nonlinear equations given the voltage readings at three orientations of the hot wire probe at a point in the flow field. The distortions of total pressure and velocity were also measured in the same inlet model. Author

A87-51471
AN EXPERIMENTAL AND THEORETICAL INVESTIGATION OF AN UNCENTRALIZED SQUEEZE-FILM DAMPER BEARING AND THE TEST RESULTS ON A JET ENGINE
X. H. FENG, C. G. FU, S. A. XU, and X. F. LI (Gas Turbine Establishment, Jiangyou County, People's Republic of China) International Journal of Turbo and Jet-Engines (ISSN 0334-0082), vol. 3, no. 2-3, 1986, p. 191-206. Research supported by the Ministry of Aviation Industry and Gas Turbine Establishment of People's Republic of China. refs

The present theoretical and experimental investigation of squeeze-film damper effects on both model and actual gas turbine engine rotors has revealed that the uncentralized squeeze-film damper employed in supporting non-Jeffcott flexible rotors can be an effective means of inhibiting vibration transmission into adjacent structures. A design method is proposed for uncentalized squeeze-film dampers in view of the results obtained, which show good agreement between theory and experiment. An optimal damper of this type is projected to be capable of yielding a better than 60-percent reduction in vibration. O.C.

A87-51472
A TWO-DIMENSIONAL FINITE ELEMENT STRESS ANALYSIS OF RADIAL IMPELLERS
K. SHAN SUNDER (Aeronautical Development Establishment, Bangalore, India) International Journal of Turbo and Jet-Engines (ISSN 0334-0082), vol. 3, no. 2-3, 1986, p. 217-221. refs

A two-dimensional finite element technique is proposed, to analyze the stress distribution in centrifugal impellers. It is applicble to impellers having radial blades in relatively large number. Stress distributions obtained with the aid of this technique are compared against those available using a three-dimensional finite element solution, and have been shown to be in quite good agreement, as a two-dimensional approximation. Author

A87-51475
TRANSPIRATION COOLING - CONTRIBUTION OF FILM COOLING TO THE OVERALL COOLING EFFECTIVENESS
G. E. ANDREWS, A. A. ASERE, M. C. MKPADI, and A. TIRMAHI (Leeds University, England) International Journal of Turbo and Jet-Engines (ISSN 0334-0082), vol. 3, no. 2-3, 1986, p. 245-256. refs
(Contract SERC-GR/B/00336; SERC-GR/C/59192)

The overall cooling effectiveness of a plane 152 mm square transpiration wall was measured on a simulated gas turbine combustion chamber. Boundary layer temperature traverses were used to determine the film temperature adjacent to the wall, and a pseudo 'adiabatic' film cooling effectiveness. The ratio of this to the overall cooling effectiveness was used as a measure of the proportion of the overall cooling attributable to film cooling. Rigid mesh porous walls were used with three different porosities and film cooling was found to be of major importance at all coolant flow rates and dominant at high flows. Comparison of the equivalent data for full coverage discrete hole wall cooling showed that at low coolant flow rate these designs could match the film cooling effectiveness of the transpiration wall but their inferior internal wall cooling resulted in a reduced overall cooling performance. Author

A87-51614
DYNAMICS OF A HIGH-SPEED ROTOR TOUCHING A BOUNDARY
W. SZCZYGIELSKI and G. SCHWEITZER (Zuerich, Eidgenoessische Technische Hochschule, Zurich, Switzerland) IN: IUTAM/IFToMM Symposium on Dynamics of Multibody Systems, Udine, Italy, Sept. 16-20, 1985, Proceedings . Berlin and New York, Springer-Verlag, 1986, p. 287-298. refs

When a rotor touches upon a boundary its motion depends on impact, friction, and gyroscopic effects. They result in a typical self-excitation leading to a variety of phenomena. For a gyro-pendulum touching a rigid plane wall the equations for small motions are derived. They are piecewise linear, globally however, strongly nonlinear. An energy balance for the different phases of the motion helps to explain stationary, quasi-stationary and chaotic solutions, containing cascades of period doubling and Feigenbaum structures. The solutions can be classified for a whole set of parameters. Author

A87-52189#
RADIATION RESISTANCE OF THIN ANTENNAS OF ARBITRARY ELEVATION AND CONFIGURATION OVER PERFECTLY CONDUCTING GROUND
RICHARD A. PAPPERT (U.S. Naval Ocean Systems Center, San Diego, CA) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. AP-35, July 1987, p. 863-866. DNA-supported research. refs

Dipole segmentation is used to estimate the radiation resistance of thin antennas of arbitrary elevation and configuration over a perfectly conducting ground plane. Utility of the method for estimating the radiation resistance of VLF/LF trailing wire antennas from aircraft depends upon the extent to which the current distribution deviates from a sinusoid. That deviation is due in part to finite wire thickness as well as the finite conductivity of both wire and ground. The influence of those effects requires further study. Author

A87-52314
APPLICATION OF PARTICLE IMAGING VELOCIMETRY IN WINDTUNNELS
J. KOMPENHANS and J. REICHMUTH (DFVLR, Institut fuer Experimentelle Stroemungsmechanik, Goettingen, West Germany) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 133-138. refs

Recently the instantaneous and nonintrusive measurement of the flow velocity in a large area of the flow field (two-dimensional plane) became possible by means of particle imaging velocimetry (PIV). Up to now PIV has mainly been used for model experiments at low flow velocities in order to test and to improve the measuring technique. The present aim is the application of PIV in large wind tunnels at high flow velocities. Author

A87-52334
DIGITAL VIDEO IMAGE PROCESSING APPLICATIONS TO DROP SIZE AND CONCENTRATION MEASUREMENTS
Y. BISCOS, F. BISMES, P. HEBRARD, G. LAVERGNE, and G. TOULOUSE (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 253-259. refs

The use of visualization techniques associating video and microcomputer to study the spray characteristics of different kinds of injectors is briefly discussed. The flow to be studied is illuminated with a thin sheet of light, and the light diffused by the spray is observed by a video camera synchronized with a microcomputer either directly or with an optical device providing sufficient magnification. The measurement is obtained by analyzing a whole or part of a video frame in real time. Two methods are described, concentration measurement by densitometry and drop size analysis. Results are presented for the effect of various parameters on injector performance. The correlations are in good agreement with results reported in the literature. C.D.

A87-52370
VISUAL STUDIES OF CHARACTERISTICS OF SLIP STREAM IN MACH REFLECTION OF A SHOCK WAVE
KAZUYASU MATSUO, TOSHIYUKI AOKI, and HIROYUKI HIRAHARA (Kyushu University, Fukuoka, Japan) IN: Flow visualization IV; Proceedings of the Fourth International Symposium, Paris, France, Aug. 26-29, 1986 . Washington, DC, Hemisphere Publishing Corp., 1987, p. 543-548. refs

The slip stream in the Mach reflection of a shock wave is presently visualized by the shadowgraph method. The effect of Reynolds number on the transition from laminar to turbulent mixing layers is experimentally considered, together with the growth rate of a fully developed turbulent mixing layer with a large difference in component velocities. The visual transition length from laminar to turbulent mixing layers is noted to strongly depend on the velocity-difference parameter, whose increase leads to a decrease of the transition number based on the transition length, the velocity difference on both sides of the layer, and the kinematic viscosity of the high velocity side. O.C.

A87-52393
FINITE ELEMENT METHODS FOR INCOMPRESSIBLE VISCOUS FLOW
GENKI YAGAWA and YUZURU EGUCHI (Tokyo, University, Japan) JSME International Journal (ISSN 0913-185X), vol. 30, July 1987, p. 1009-1017. refs

The present paper reviews the current research activities of the finite element methods for the incompressible viscous fluid flow. The status of the finite element flow analysis is discussed in comparison with the finite difference methods through the surveillance of the latest literature. The focus is placed upon the treatments of the incompressibility constraint and the nonlinear convection term, both of which pose inherent difficulties in applying the finite element methods to the flow problems. Some fresh computational concepts which are intended to improve the efficiency and robustness are also scrutinized. Author

A87-52517
1986 IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY, SAN DIEGO, CA, SEPT. 16-18, 1986 SYMPOSIUM RECORD
Symposium sponsored by IEEE. New York, Institute of Electrical and Electronics Engineers, Inc., 1986, 534 p. For individual items see A87-52518 to A87-52527.

The conference presents papers on EMC measuring sets and sensors, shielding and evaluation measurements, EMI analysis, EMC modeling, and electromagnetic field generation. Other topics include electromagnetic environments, open area test sites, electrostatic discharge, and NEMP and transients. Particular attention is given to the assessment of communication system susceptibility to the PAVE PAWS radar, cross-polarization components in interantenna coupling calculations, ground testing of an operational aircraft for p-static discharge effects, projected susceptibilities of VHSIC/VLSIC devices to the year 2000 elecromagnetic environment, shielding characteristics of honeycomb filters, choice of rational methods for digital information transmission over HF radio communication links, and how surveillance testing ensures EMP hardness of military systems. K.K.

A87-52678
AGE FORMING ALUMINUM IN AN AUTOCLAVE
DENISE M. HAMBRICK (Avco Aerostructures Textron, Nashville, TN) IN: Aluminum alloys: Their physical and mechanical properties; Proceedings of the International Conference, Charlottesville, VA, June 15-20, 1986. Volume 2 . Warley, England, Engineering Materials Advisory Services, Ltd., 1986, p. 883-900.

Development of the autoclave forming aluminum (AFA) process has advanced current technology of age forming. Using an autoclave for application of aging heat and forming pressure, the

process has been used to form 15 m long, 2124 and 2419 aluminum wing skins containing integrally machined stiffeners and varying in thickness from 2.5 to 63.5 mm with thick pads in the middle of thin sections. The process produces smooth contours with no visible evidence of abrupt changes in thickness. The skins are believed to be the largest and most complex parts ever to be age creep formed in the history of the aircraft industry. Author

A87-53416
FUTURE IMPACT OF MANUFACTURING TECHNOLOGY AND AUTOMATION IN PRATT & WHITNEY CANADA
J. K. GANNON (Pratt and Whitney Canada, Longueuil) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 10 p.

Major trends in the manufacturing environment include stronger international competition which brings increased pressure on competiveness, demands for better performance, and relatively cheap microprocessor and communication technologies. The implementation of a computer integrated manufacturing (CIM) capability to respond to these trends is discussed with attention given to the pilot project FMS 1 and a new socio-technical design. The primary goal of this CIM system is to deal effectively with the real-time analysis, planning, and control of the manufacturing processes from product concepts to finished products. K.K.

A87-53418
DESIGN AND DEVELOPMENT OF A HIGH CONTACT RATIO HELICOPTER TRANSMISSION UTILIZING SELF-ALIGNING BEARINGLESS PLANETARY (SABP)
D. J. FOLENTA (Transmission Technology Co., Inc., Fairfield, NJ) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 15 p. refs

The development of a quiet high-contact gear-tooth ratio power transmission arrangement called the SABP is discussed. The SABP utilizes a sun gear, compound spindle gear assemblies, ring gears, and rolling rings. It is shown that, as long as the three gears of the spindle are spaced so that the center of each gear face lies along the balance line, the spindle will remain in equilibrium and will automatically compensate for any disturbance from such equilibrium. A weight reduction of over 10 percent is anticipated with SABP. K.K.

A87-53419
ADVANCES AND APPLICATIONS OF PYROWEAR 53 IN HELICOPTER TRANSMISSION SYSTEMS
ROBERT DIRUSSO (Kaman Aerospace Corp., Bloomfield, CT) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 8 p. refs

The objective of the Pyrowear 53 program was to develop an alternative case carburizeable bearing material to replace the current M-50 through hardened material. The application was the SH-2F helicopter main-transmission planet-bearing inner race. The failure characteristics of the bearing inner race were associated with the carbide morphology of the M-50 material combined with the low elastohydrodynamic film thickness inherent to the final-stage planetary systems used in helicopter transmissions. While classical 9310 and Pyrowear 53 both eliminated the carbide distribution condition, the surface wear and degradation resistance of the Pyrowear 53 were slightly superior. K.K.

A87-53420* Illinois Univ., Chicago.
NEW GENERATION METHODS FOR SPUR, HELICAL, AND SPIRAL-BEVEL GEARS
F. L. LITVIN, W.-J. TSUNG (Illinois, University, Chicago), J. J. COY, R. F. HANDSCHUH (NASA, Lewis Research Center; U.S. Army, Army Aviation Research and Technology Activity, Cleveland, OH), and C.-B. P. TSAY (National Chiao Tung University, Hsinchu, Republic of China) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 25 p. Previously announced in STAR as N87-15466. refs

New methods for generating spur, helical, and spiral-bevel gears are proposed. These methods provide the gears with conjugate gear tooth surfaces, localized bearing contact, and reduced sensitivity to gear misalignment. Computer programs have been developed for simulating gear meshing and bearing contact. Author

A87-53576
EXPERIMENTAL COMPARISON OF RADIOMETRIC SCALES FROM LABORATORY STANDARDS AND SOLAR RADIATION [EXPERIMENTELLER VERGLEICH DER RADIOMETRISCHEN SKALEN VON LABORNORMALEN UND DER SONNENSTRAHLUNG]
K.-H. SUEMNICH and H. SCHWARZER (Akademie der Wissenschaften der DDR, Institut fuer Kosmosforschung, Berlin, East Germany) Zeitschrift fuer Meteorologie (ISSN 0804-5361), vol. 37, no. 3, 1987, p. 156-160. In German.

Radiance values calibrated in the laboratory using standard lamps are compared with solar radiation values based on the data of Neckel and Labs (1984). The aircraft measuring equipment used to obtain the solar radiation values and the lamp apparatus for the laboratory calculations are described. The spectral characteristics of the solar and lamp radiations are analyzed. It is observed that the two measurements have a mean deviation of both radiometric scales of about 1.6 percent and a measuring uncertainty of about 3.0 percent. I.F.

A87-53585
PRACTICAL APPLICATION TO COMPOSITE MATERIALS OF A PORTABLE DIGITAL ULTRASOUND DEVICE CONTROLLED BY A MICROPROCESSOR [UTILIZATION PRATIQUE POUR LES MATERIAUX COMPOSITES D'UN APPAREIL A ULTRASONS PORTATIF NUMERIQUE GERE PAR MICROPROCESSEUR]
J. G. CASTEL and V. HUSAREK (Societe Francaise d'Electrophysique, France) Materiaux et Techniques (ISSN 0032-6895), vol. 75, May-June 1987, p. 229-233. In French.

The usefulness of a portable microprocessor-controlled ultrasound device for the periodic assessment of aircraft parts made of composite materials is shown. The performance of the device is demonstrated with the examples of a metallic honeycomb with a carbon-fiber skin, a phenolic honeycomb with a carbon skin, and a phenolic honeycomb with a Kevlar skin. Also considered are assessments of homogeneous carbon-fiber parts, including the study of artificial defects consisting of 1-2 mm diameter holes, and the assessment of the behavior of a carbon-titanium interface with separated zones. Advantages of the device include ease of adjustment, automated evaluation of the depth of defects, and the nearly-absolute reproducibility of adjustments. R.R.

N87-28833* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ELECTRO-EXPULSIVE SEPARATION SYSTEM Patent
LEONARD A. HASLIM, inventor (to NASA) and ROBERT D. LEE, inventor (to NASA) 1 Sep. 1987 24 p Filed 31 May 1985 Supersedes N85-29150 (23 - 18, p 3094) (NASA-CASE-ARC-11613-1; US-PATENT-4,690,353; US-PATENT-APPL-SN-739792; US-PATENT-CLASS-244-134-D; US-PATENT-CLASS-318-116) Avail: US Patent and Trademark Office CSCL 09A

An electro-expulsive system has one or more overlapped conductors, each comprising a flexible ribbon conductor, which is folded back on itself. The conductors are embedded in an

elastomeric material. Large current pulses are fed to the conductors from power storage units. As a result of the antiparallel currents, the opposed segments of a conductor are forcefully separated and the elastomeric material is distended. Voids in the elastomer aid the separation of the conductor segments. The distention is almost instantaneous when a current pulse reaches the conductor and the distention tends to remove any solid body on the surface of the elastomeric material.

Official Gazette of the U.S. Patent and Trademark Office

N87-28835# Flow Research, Inc., Kent, Wash.
LARGE-EDDY NUMERICAL SIMULATION OF AN ARRAY OF THREE-DIMENSIONAL IMPINGING JETS Final Report, May 1985 - Jul. 1986
M. H. RIZK and S. MENON Apr. 1987 189 p
(Contract F49620-85-C-0084)
(AD-A182459; FLOW-RR-403; AFOSR-87-0900TR) Avail: NTIS HC A09/MF A01 CSCL 01A

Numerical simulations of a row of impinging jets are performed. Both the impinging jets and the fountains caused by the collision of the wall jets are modeled in the simulations. The problem considered contains the essential features of twin jets impinging on the ground, simulating the hovering configuration of a VTOL aircraft. The flow is assumed to be governed by the time-dependent, incompressible Navier-Stokes equations. The large-eddy simulation approach is followed in which all scales resolvable by the grid resolution are computed explicitly, while the small-scale turbulence structures, which are nearly universal in character, are modeled by an eddy viscosity formulation that simulates the energy cascade into the small scales. The Navier-Stokes equations are solved using a staggered computational mesh. Central finite differencing is used to discretize all terms except the convective terms, which are discretized using the QUICK scheme. The Adams-Bashforth scheme is used to advance the solution in time. The pressure Poisson equation is used in place of the continuity equation. Efficient direct solutions are obtained for the pressure field, which allows the continuity equation to be satisfied at each time step. This study focuses on the motion and dynamics of large-scale structures that have been experimentally observed in jet flows. The behavior of the jets and the fountain due to introducing axisymmetric, azimuthal and random disturbances at the jet exits is investigated. GRA

N87-28845# Gesamthochschule, Duisburg (West Germany). Fachbereich Maschinenbau.
CONTRIBUTION TO THE DESCRIPTION OF ROTATING FLOW INSTABILITIES AND INLET PERTURBATIONS IN AXIAL FLOW COMPRESSORS Ph.D. Thesis [BEITRAG ZUR DARSTELLUNG UMLAUFENDER STROEMUNGSINSTABILITAETEN UND EINLAUFSTOERUNGEN IN AXIALVERDICHTERN]
HEINZ GEORG NEUHOFF 1985 167 p In GERMAN
(ETN-87-90040) Avail: NTIS HC A08/MF A01

A calculation method for the description of aerodynamic cascade instabilities and the phenomena of rotating flow separation in axial flow compressors was developed. The solution of the unsteady, two-dimensional flow in convergent-divergent channels with variable cross section is an initial value and boundary value problem. The integration of the equation system was performed with an explicit time-step method of second order. The calculated global pressure perturbation in a transonic axial flow compressor agrees with the measurements. The calculated periodically varying flow phenomena have a similar behavior to the observed rotating separations. The prediction capability of the calculation results was demonstrated. The quantitative evaluation of the stability analysis for a highly loaded rotor shows agreement with experimental data. The method seems to be too complicated for the calculation of multistage machines. ESA

N87-28866# Texas Technological Univ., Lubbock. Dept. of Mechanical Engineering.
A NUMERICAL MODEL FOR UNSTEADY TWO-DIMENSIONAL FLOW CALCULATIONS WITH FLOW SEPARATION
J. W. OLER, J. H. STRICKLAND, and B. J. IM Jun. 1987 122 p
(Contract DE-AC04-76DP-00789)
(DE87-012316; SAND-86-7183) Avail: NTIS HC A06/MF A01

A numerical model for two-dimensional airfoils in unsteady motion with boundary layer separation is described. The airfoil and wake surfaces are represented by a finite set of combined source and vortex panels. The source strengths are prescribed to have the same magnitude as the normal relative velocity on the surface due to the freestream and motion of the airfoil. The vortex strengths on the airfoil surface are determined by applying a kinematic surface tangency condition to a Green's function representation of the potential field while simultaneously enforcing the Kutta condition. Wake shedding is governed by a dynamic free surface condition and the characteristics of the flow near any boundary layer separation points. Wake deformation is predicted by applying a geometric free surface condition. Calculation results are presented for steady motion, impulsively started rectilinear motion, harmonic pitch oscillations, and constant pitching motions. Experimental data and analytical solutions are also presented for comparison. DOE

N87-28869*# United Technologies Research Center, East Hartford, Conn.
HIGH TEMPERATURE STATIC STRAIN GAGE DEVELOPMENT CONTRACT, TASKS 1 AND 2 Interim Report
C. O. HULSE, R. S. BAILEY, H. P. GRANT, and J. S. PRZYBYSZEWSKI Jul. 1987 82 p
(Contract NAS3-23722)
(NASA-CR-180811; NAS 1.26:180811; R87-916527-1) Avail: NTIS HC A05/MF A01 CSCL 14B

Results are presented for the first two tasks to develop resistive strain gage systems for use up to 1250 K on blades and vanes in gas turbine engines under tests. The objective of these two tasks was to further improve and evaluate two static strain gage alloys identified as candidates in a previous program. Improved compositions were not found for either alloy. Further efforts on the Fe-11.9Al-10.6Cr weigth percent alloy were discontinued because of time dependent drift problems at 1250 K in air. When produced as a 6.5 micrometer thick sputtered film, the Pd-13Cr weight percent alloys is not sufficiently stable for this use in air at 1250 K and a protective overcoat system will need to be developed. B.G.

N87-28883*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Engineering Dept.
THIN FILM STRAIN GAGE DEVELOPMENT PROGRAM Final Program
H. P. GRANT, J. S. PRZYBYSZEWSKI, W. L. ANDERSON, and R. G. CLAING Dec. 1983 194 p
(Contract NAS3-21262)
(NASA-CR-174707; NAS 1.26:174707; PWA-5628-69) Avail: NTIS HC A09/MF A01 CSCL 14B

Sputtered thin-film dynamic strain gages of 2 millimeter (0.08 in) gage length and 10 micrometer (0.0004 in) thickness were fabricated on turbojet engine blades and tested in a simulated compressor environment. Four designs were developed, two for service to 600 K (600 F) and two for service to 900 K (1200 F). The program included a detailed study of guidelines for formulating strain-gage alloys to achieve superior dynamic and static gage performance. The tests included gage factor, fatigue, temperature cycling, spin to 100,000 G, and erosion. Since the installations are 30 times thinner than conventional wire strain gage installations, and any alteration of the aerodynamic, thermal, or structural performance of the blade is correspondingly reduced, dynamic strain measurement accuracy higher than that attained with conventional gages is expected. The low profile and good adherence of the thin film elements is expected to result in

improved durability over conventional gage elements in engine tests. Author

N87-28923# European Space Agency, Paris (France).
NONDESTRUCTIVE TESTS OF CARBON FIBER REINFORCED PLASTICS (CFRP) IN THE FRAMEWORK OF DAMAGE MECHANICS INVESTIGATIONS
RAINER SCHUETZE *In its* Proceedings of a Structural Mechanics Colloquium on Nondestructive Testing of Fiber Reinforced Structures p 6-21 Jan. 1987 Transl. into ENGLISH from "Zerstoerungsfreie Pruefug von Verbundstrukturen', DFVLR, Brunswick, West Germany, Jun. 1986 p 11-27 Original language document was announced as N87-14438
(DFVLR-MITT-86-09) Avail: NTIS HC A08/MF A01; original German version available from DFVLR, Cologne, West Germany DM 50

Nondestructive testing of CFRP structures for damage mechanics investigations is discussed. The most important requirements for nondestructive testing procedures are high resolution and high reproducibility in order to get indications even of very small changes in the material between, e.g., two load levels. Among the large number of nondestructive testing methods, the ultrasonic test, acoustic emission, X-ray techniques, and the optical reflection method were chosen. The combination of all four methods provides nearly complete information of the state of damage of the material. ESA

N87-29434*# Army Research and Technology Labs., Moffett Field, Calif.
TRANSONIC ROTOR FLOW-MEASUREMENT TECHNIQUE USING HOLOGRAPHIC INTERFEROMETRY
JOHN K. KITTLESON and YUNG H. YU *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms p 49-51 May 1987 Previously announced in IAA as A86-17069
Avail: NTIS HC A99/MF A01 CSCL 14E

Holographic interferometry is used to record interferograms of the flow near a hovering transonic rotor blade. A pulsed ruby laser recorded 40 interferograms with a 2 ft dia. view field near the model rotor blade tip operating at a tip Mach number of 0.90. The experimental procedure is presented and example interferograms recorded in the rotor's tip path plane. In addition, a method currently being pursued to obtain quantitative flow information using computer assisted tomography (CAT) with the holographic interferogram data, is outlined. Author

N87-29435*# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
HOLOGRAPHIC INTERFEROMETRY AT WRIGHT AERONAUTICAL LABORATORIES Abstract Only
MEL ROQUEMORE *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms p 67 May 1987
Avail: NTIS HC A99/MF A01 CSCL 01A

The optical diagnostics requirements and plans for the Aero Propulsion Lab. are described. This laboratory is performing work in combustion as related to aero propulsion systems. They would like to use holography and other types of optical instrumentation for combustion diagnostics and flow visualization. A movie of a laser light sheet flow visualization of a combustor in operation was shown. This movie showed extremely clear examples of vortical and unsteady flow, and it would be of interest to use image analysis to quantify such data. Author

N87-29436*# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
STATUS OF HOLOGRAPHIC INTERFEROMETRY AT WRIGHT PATTERSON AIR FORCE BASE Abstract Only
GEORGE SEIBERT *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms p 69 May 1987
Avail: NTIS HC A99/MF A01 CSCL 14E

At Wright Patterson AFB, holographic interferometry has been used for nearly 15 years in a variety of supersonic and hypersonic wind tunnels. Specifically, holographic interferometry was used to study boundary layers, shock boundary layer interaction, and general flow diagnostics. Although a considerable amount of quantitative work was done, the difficulty of reducing data severely restricted this. In the future, it is of interest to use holographic interferometry in conjunction with laser Doppler velocimetry to do more complete diagnostics. Also, there is an interest to do particle field diagnostics in the combustion research facility. Finally, there are efforts in nondestructive testing where automated fringe readout and analysis would be extremely helpful. Author

N87-29447*# Aerometrics, Inc., Mountain View, Calif.
OPTICAL INTERFEROMETRY IN FLUID DYNAMICS RESEARCH
W. D. BACHALO and M. J. HOUSER *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms p 193-247 May 1987 Previously announced in IAA as A85-35203
Avail: NTIS HC A99/MF A01 CSCL 14E

Optical interferometry techniques were applied to the investigation of transonic airfoil flow fields in large wind tunnels. Holographic interferometry techniques were used to study 2 dimensional symmetric NACA 64A010 and Douglas Aircraft Co. DSMA671 supercritical airfoil performance in the NASA Ames 2 x 2 ft transonic wind tunnel. Quantitative data obtained from the interferograms were compared to the surface pressure data. The agreement obtained verified the accuracy of the flow visualization and demonstrated the potential for acquiring quantitative scalar results. Measurements of the inviscid flow speed and the boundary layer and wake velocity profiles were extracted from the interferograms and compared to laser Doppler velocimeter measurements. These results were also in good agreement. A method for acquiring real time interferometric data in large scale facilities was developed. This method, based on the point diffraction interferometer, was successfully tested in the 2 x 2 ft transonic wind tunnel. The holographic and real time interferometry methods were applied to the investigations of circulation control airfoils utilizing the Coanda effect. These results reveals the details of the jet interacting with the trailing edge boundary layer and the other parameters affecting the lift augmentation. Author

N87-29451*# Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.
APPLICATION OF DIGITAL INTERFEROGRAM EVALUATION TECHNIQUES TO THE MEASUREMENT OF 3-D FLOW FIELDS
FRIEDHELM BECKER and YUNG H. YU *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms p 369-431 May 1987 Previously announced in IAA as A85-20852
Avail: NTIS HC A99/MF A01 CSCL 14E

A system for digitally evaluating interferograms, based on an image processing system connected to a host computer, was implemented. The system supports one- and two-dimensional interferogram evaluations. Interferograms are digitized, enhanced, and then segmented. The fringe coordinates are extracted, and the fringes are represented as polygonal data structures. Fringe numbering and fringe interpolation modules are implemented. The system supports editing and interactive features, as well as graphic visualization. An application of the system to the evaluation of double exposure interferograms from the transonic flow field around a helicopter blade and the reconstruction of the three dimensional flow field is given. Author

N87-29452*# Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
THE FRINGE READING FACILITY AT THE MAX-PLANCK-INSTITUT FUER STROEMUNGSFORSCHUNG
F. BECKER, G. E. A. MEIER, H. WEGNER, R. TIMM, and R. WENSKUS *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms p 433-436 May 1987
Avail: NTIS HC A99/MF A01 CSCL 14E

A Mach-Zehnder interferometer is used for optical flow measurements in a transonic wind tunnel. Holographic

interferograms are reconstructed by illumination with a He-Ne-laser and viewed by a video camera through wide angle optics. This setup was used for investigating industrial double exposure holograms of truck tires in order to develop methods of automatic recognition of certain manufacturing faults. Automatic input is achieved by a transient recorder digitizing the output of a TV camera and transferring the digitized data to a PDP11-34. Interest centered around sequences of interferograms showing the interaction of vortices with a profile and subsequent emission of sound generated by this process. The objective is the extraction of quantitative data which relates to the emission of noise.

Author

N87-29454*# Spectron Development Labs., Inc., Costa Mesa, Calif.

KC-135 AERO-OPTICAL TURBULENT BOUNDARY LAYER/ SHEAR LAYER EXPERIMENT REVISITED

J. CRAIG and C. ALLEN (Air Force Weapons Lab., Kirtland AFB, N. Mex.) *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms p 461-503 May 1987

Avail: NTIS HC A99/MF A01 CSCL 20D

The aero-optical effects associated with propagating a laser beam through both an aircraft turbulent boundary layer and artificially generated shear layers are examined. The data present comparisons from observed optical performance with those inferred from aerodynamic measurements of unsteady density and correlation lengths within the same random flow fields. Using optical instrumentation with tens of microsecond temporal resolution through a finite aperture, optical performance degradation was determined and contrasted with the infinite aperture time averaged aerodynamic measurement. In addition, the optical data were artificially clipped to compare to theoretical scaling calculations. Optical instrumentation consisted of a custom Q switched Nd:Yag double pulsed laser, and a holographic camera which recorded the random flow field in a double pass, double pulse mode. Aerodynamic parameters were measured using hot film anemometer probes and a five hole pressure probe. Each technique is described with its associated theoretical basis for comparison. The effects of finite aperture and spatial and temporal frequencies of the random flow are considered.

Author

N87-29479# Naval Air Development Center, Warminster, Pa. Strapdown Navigation Lab.

JOINT DEVELOPMENT OF THE MULTI-FUNCTION INTEGRATED INERTIAL SENSOR ASSEMBLY (MIISA)

JACK JANKOVITZ, DAVID KRASNJANSKI, and ANDREW S. GLISTA, JR. (Naval Air Systems Command, Washington, D. C.) *In* AGARD, Advances in Guidance and Control Systems and Technology 9 p Jul. 1987

Avail: NTIS HC A07/MF A01

The U.S. Navy, Air Force, and Army are in the process of formalizing the joint service development and flight evaluation of the Multi-Function Integrated Inertial Sensor Assembly (MIISA). The MIISA concept will provide a reliable, standardized, fault-tolerant, system which will serve as a common source of inertial data. MIISA wil provide data for flight control, navigation, weapon delivery, automatic terrain following terrain avoidance, sensor/tracker stabilization, flight instruments, and displays. A primary goal of this joint service activity is to resolve all technical issues and make this capability available for the next generation fighter and attack aircraft and for advanced helicopters. The Navy program to design, build, and evaluate an IISA Advanced Development Model was begun. To insure that the IISA is suitable for installlation and flight test in an Air Force F-15, extensive laboratory testing will be undertaken at the NAVAIRDEVCEN Strapdown Navigation Laboratory. These tests involve the examination of IISA system performance for navigation and flight control. These tests are discussed.

Author

N87-29646# Royal Aircraft Establishment, Farnborough (England). Materials and Structures Dept.

DIFFUSION BONDING OF METALS

P. G. PARTRIDGE *In* Advisory Group for Aerospace Research and Superplasticity 23 p Aug. 1987

Avail: NTIS HC A10/MF A01

The need to reduce the cost and weight of aerospace metallic structures has led to an increased interest in solid state and liquid phase diffusion bonding processes, especially in combination with superplastic forming. The bonding mechanisms and bonding techniques are reviewed and the process variables that affect bond quality and strength are described with reference to bonds between Ti-alloys, Al-alloys and dissimilar metals. The importance of quality control and the limitations of current nondestructive evaluation techniques for diffusion bonding are emphasized. Finally, some trends and priorities in diffusion bonding technology are indicated.

Author

N87-29842# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

REAL TIME SIMULTANEOUS IN-LINE WEAR AND LUBRICANT CONDITION MONITORING Final Report, Jun. 1986 - Dec. 1986

PHILLIP W. CENTERS and F. D. PRICE Jun. 1987 23 p

(AD-A183286; AFWAL-TR-87-2015) Avail: NTIS HC A02/MF A01 CSCL 11H

An in-line Complete Oil Breakdown Rate Analyzer (COBRA) and Quantitative Debris Monitor (QDMR) were installed in the oil system of an aircraft turbine engine lubricant simulator. The in-line COBRA readings correlated well with those of a standard laboratory model COBRA and total acid number of the deteriorating lubricant. Increases in QDMR particle counts corresponded with increases in trace iron content, which reflected abnormal wear occurring in the simulator. Analytical and direct reading ferrographic data confirmed the rapid increase and eventual modest decrease in wear debris concentration. After test completion, it was determined that a mainshaft bearing had experienced abnormal wear. Thus, for the first time successful capability for real-time simultaneous in-line wear and lubricant condition monitoring was demonstrated.

GRA

N87-29893# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Mathematics.

MODELING AND COMPUTATIONAL ALGORITHMS FOR PARAMETER ESTIMATION AND OPTIMAL CONTROL OF AEROELASTIC SYSTEMS AND LARGE FLEXIBLE STRUCTURES Final Report, 30 Sep. 1985 - 30 Sep. 1986

J. A. BURNS and E. M. CLIFF 1 Nov. 1986 5 p

(Contract AF-AFOSR-0287-85)

(AD-A183302; AFOSR-87-0956TR) Avail: NTIS HC A02/MF A01 CSCL 20K

The goal of this research is to develop computational algorithms for identifications and control, especially with application to aeroelastic and viscoelastic systems. The research has emphasized development of Chandresekhar algorithms for optimal control of distributed systems and state models and computational algorithms for aeroelastic control systems. During this period, the investigators developed fast algorithms for the general linear quadratic optimal control problems for functional differential equations using Chandresekhar factorization techniques. The resulting algorithms show improved rates of convergence over Ricatti techniques and for certain large problems is the only algorithms which was shown to converge in practice. Nine publications were produced during this period under this grant, including Factorization and Reduction Methods for Optimal Control of Hereditary Systems and Modeling and Approximation for a Viscoelastic Control Problem.

GRA

13

GEOSCIENCES

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

A87-51195
THE PROBLEM OF THE AVIATION-METEOROLOGICAL PREDICTION OF STRONG SURFACE WINDS IN EASTERN BULGARIA [K'M V'PROSA ZA AVIOMETEOROLOGICHNATA PROGNOZA NA ZASILENI PRIZEMNI VETROVE V IZTOCHNA B'LGARIIA]
V. ANDREEV, D. KOZAREV, and I. IVANOV (Glavno Upravlenie Khidrologiia i Meteorologiia, Sofia, Bulgaria) B'lgarsko Geofizichno Spisanie (ISSN 0323-9918), vol. 13, no. 2, 1987, p. 31-37. In Bulgarian. refs

Strong winds with a southern and northern component are of significant practical interest for aircraft motion in eastern Bulgaria since they are actually cross winds during takeoff and landing. An attempt was made to determine the synoptic situations and meteorological parameters which influence this phenomenon. Strong southern winds in eastern Bulgaria are observed only during Mediterranean cyclones which pass through Hungary or northern Bulgaria as they move northeastward. The concept of the active part of the cyclone trajectory as well as the significant correlation between the strong wind velocities and pressure tendencies are of prognostic importance. K.K.

A87-51232
WIND SHEAR [LE CISAILLEMENT DE VENT]
MICHEL R. REDDAN (Air France, Paris, France) Navigation (Paris) (ISSN 0028-1530), vol. 34, Oct. 1986, p. 441-456. In French.

A review is presented of the types, causes, and detection technology of wind shear. The three types of wind shear (vertical wind shear, wind shear of vertical wind, and horizontal wind shear) and their respective degrees of hazard are discussed. Wind shear episodes deriving from sources such as storms, gust fronts, breezes, and frontal masses can generally be predicted with existing equipment up to several hours in advance. Microbursts, characterized by their intensity and their limited dimensions and duration, are, however, more difficult to predict. It is noted that the LLWSS detection system, in which horizontal measurements of surface winds from a network of anemometers are compared, cannot detect microbursts. It is suggested that measurements of the vertical structure of the wind using Doppler sodar systems may provide additional useful information. Onboard wind-shear detection devices are also considered. R.R.

A87-52064* Bionetics Corp., Hampton, Va.
COMMUNITY REACTIONS TO HELICOPTER NOISE - RESULTS FROM AN EXPERIMENTAL STUDY
JAMES M. FIELDS (Bionetics Corp., Hampton, VA) and CLEMANS A. POWELL (NASA, Langley Research Center, Hampton, VA) Acoustical Society of America, Journal (ISSN 0001-4966), vol. 82, Aug. 1987, p. 479-492. refs

Community reactions to low numbers of helicopter noise events (less than 50 per day) are investigated using a new type of study design. Although the effect of maximum noise level and number of noise events on helicopter noise annoyance was found to be similar to that represented by the energy summation principle contained in L(eq)-based noise indices, it is noted that the possibility that the number of noise events has only a small effect on annoyance cannot be rejected at the conventional p of less than 0.05 level. The effect of the duration of noise events was also shown to be consistent with L(eq)-based indices. After removing the effects of differences in duration and noise levels, little difference is found between reactions to impulsive and nonimpulsive types of helicopters. R.R.

A87-53115* National Aeronautics and Space Administration. Wallops Flight Center, Wallops Island, Va.
AIRBORNE MULTIBEAM RADAR ALTIMETRY
CHESTER L. PARSONS (NASA, Wallops Flight Center, Wallops Island, VA) IN: IGARSS '87 - International Geoscience and Remote Sensing Symposium, Ann Arbor, MI, May 18-21, 1987, Digest. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 161-165.

A study of the components of the ocean's circulation using radar altimetry is discussed. The use of a wide-swath radar altimeter to investigate the dynamics of the ocean is examined. The design and operation of the Aircraft Multibeam Altimeter are described. I.F.

A87-53159* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PRELIMINARY SIMULTANEOUS L/C-BAND IMAGES FROM THE JPL AIRCRAFT SYNTHETIC APERTURE RADAR
YUNLING LOU and QUYEN NGUYEN (California Institute of Technology, Jet Propulsion Laboratory, Pasadena) IN: IGARSS '87 - International Geoscience and Remote Sensing Symposium, Ann Arbor, MI, May 18-21, 1987, Digest. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 511-514.

A squint mode processor for the processing of JPL aircraft SAR data collected in L-band and C-band is described which meets the criteria of optimum SNR, polarization isolation, and resolution. A steerable prefilter maximizes SNR while reducing the amount of data for processing efficiency. The resolution of images produced from data recorded at nonzero drift angle is improved by range migration compensation. The standard output products include high resolution images (with a range resolution of 7.5 m and an azimuth resolution of 2.74 m), four-look images (produced by averaging every four pixels in the azimuth direction for speckle reduction), and magnitude/phase-difference images (produced by correlating images of similar polarizations). R.R.

A87-53206* Department of Agriculture, Beltsville, Md.
RESULTS FROM THE PUSHBROOM MICROWAVE RADIOMETER FLIGHTS OVER THE KONZA PRAIRIE IN 1985
T. J. SCHMUGGE (USDA, Hydrology Laboratory, Beltsville, MD), J. R. WANG (NASA, Goddard Space Flight Center, Greenbelt, MD), and R. W. LAWRENCE (NASA, Langley Research Center, Hampton, VA) IN: IGARSS '87 - International Geoscience and Remote Sensing Symposium, Ann Arbor, MI, May 18-21, 1987, Digest. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 877-881.

Four flights were conducted by the NASA C-130 aircraft sensor platform bearing the 'pushbroom' microwave radiometer (PBMR) over the Konza Prairie in central Kansas in 1985, in order to monitor soil surface variations. When the brightness temperature maps thus obtained were analyzed, a striking difference was noted between burned and unburned watersheds; the latter had a very high emissivity despite having saturated soils, while the former had low values that increased with the gradual drying of the soils. The lack of sensitivity for the unburned watershed is tentatively attributed to the build-up of a thatch layer by the decaying vegetation, which serves as a good microwave absorber when wet. O.C.

A87-53269
AIRCRAFT MICROWAVE RADIOMETRY OF LAND
R. BONSIGNORI (Officine Galileo S.p.A., Florence, Italy), L. CHIARANTINI (Segnalamento Marittimo ed Aereo S.p.A., Florence, Italy), S. PALOSCIA, P. PAMPALONI (CNR, Istituto di Ricerca sulle onde Elettromagnetiche, Florence, Italy), P. FERRAZZOLI (Roma II, Universita, Italy) et al. IN: IGARSS '87 - International Geoscience and Remote Sensing Symposium, Ann Arbor, MI, May 18-21, 1987, Digest. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1429-1433. CNR-supported research. refs

A sensor package composed of two radiometers at 10 and 36 GHz, a thermal IR sensor, and a color TV camera has been

arranged to fly on a small aircraft. The system, designed to be chiefly employed for the study of vegetation emission, was tested in summer 1986 during the 'Agrisar Campaign' on the Italian test site 'Oltrepo Pavese'. Since the 10-GHz antenna angular resolution was somewhat coarse with respect to the scale of emissivity variations, an enhancement of spatial resolution has been achieved by using a retrieval algorithm based on singular function analysis. Crop emissivities, retrieved by measurements on agricultural fields, have been compared with ground-truth data and are reported in this paper. Author

A87-53969
DETERMINATION OF WIND VELOCITY AND DIRECTION IN THE LOWER PART OF THE ATMOSPHERIC BOUNDARY LAYER ON THE BASIS OF GROUND DATA [OPREDELENIE SKOROSTI I NAPRAVLENIIA VETRA V NIZHNEI CHASTI POGRANICHNOGO SLOIA ATMOSFERY PO NAZEMNOI INFORMATSII]
L. R. ORLENKO and V. M. STEPANOVA IN: Physics of the atmospheric boundary layer . Leningrad, Gidrometeoizdat, 1987, p. 3-17. In Russian. refs

Calculation methods for determining wind velocity and direction at standard heights in the lower 60-meter layer of the atmosphere are described. The initial information used is the surface-wind level at a height of 10 meters, the air temperature difference at 2 meters and the 850 hPa surface, and the type of surface. The methods considered are recommended for use in the prediction of aircraft takeoff and landing conditions. B.J.

N87-28950# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Abteilung Infrarottechnik.
INFRARED SIMULATION MODEL SENSAT-2
RUDOLF RICHTER Feb. 1987 93 p
(DFVLR-FB-87-10; ISSN-0171-1342; ETN-87-90457) Avail: NTIS HC A05/MF A01; DFVLR, Cologne, West Germany DM 29.50

The computer model SENSAT-2 was developed for remote sensing applications of passive sensors in the infrared spectral region 1 to 28 microns. The model calculates the IR signature of up to three homogeneous objects in the instantaneous field of view of the sensor. For the atmospheric part, LOWTRAN-6 is used within SENSAT-2. Model SENSAT-2 can be used for mission analysis of sensor on platforms like ground-based, aircraft, or satellite. It is a useful design tool for simulating and assessing radiometric relations in designing sensors. Applications include the comparison of measurements with simulation results and the radiometric correction of measurements. ESA

N87-29057# Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.
PRELIMINARY MEMPHIS FAA (FEDERAL AVIATION ADMINISTRATION)/LINCOLN LABORATORY OPERATIONAL WEATHER STUDIES RESULTS Project Report
R. E. RINEHART, J. T. DISTEFANO, and M. M. WOLFSON 22 Apr. 1987 192 p
(Contract DTFA01-80-Y-10546)
(AD-A182730; ATC-141; DOT/FAA/PM-86-40) Avail: NTIS HC A09/MF A01 CSCL 04B

The principal sensor for the measurement program was the S-band FAA-Lincoln Laboratory Testbed Doppler Weather Radar (FL2). Both FL2 and a C-band Doppler Weather Radar operated by the University of North Dakota obtained reflectivity, mean velocity and spectrum width measurements with a radar geometry and scan sequences to facilitate determining the surface outflow features of microbursts at the anticipated ranges. This report describes the principal initial results from the Memphis operations, stressing the results from 1985 when the FL2 radar was fully operational. These results are compared to those from previous studies of wind-shear programs, e.g., NIMROD near Chicago, JAWS and CLAWS near Denver. During 1985, 102 microbursts were identified in real time along with 81 gust fronts. One of the dominant results is that most microbursts in the mid-south are wet; that is, they are accompanied by significant rainfall. This is in contrast, for example, to the results from Denver where more than half of all microbursts have little or no appreciable rain reaching the ground. Aside from this major difference, microbursts near Memphis were similar to those found elsewhere in the country in terms of wind shear magnitude. The report also gives more representative results from the aircraft operations and discusses the effectiveness of the ground-clutter filters used on the FL-2 radar. GRA

N87-29060# National Center for Atmospheric Research, Boulder, Colo. Research Applications Program.
A HIGH RESOLUTION SPATIAL AND TEMPORAL MULTIPLE DOPPLER ANALYSIS OF A MICROBURST AND ITS APPLICATION TO AIRCRAFT FLIGHT SIMULATION
K. L. ELMORE, J. MCCARTHY, WALTER FROST, and HO-PEN CHANG (FWG Associates, Inc., Tullahoma, Tenn.) Mar. 1987 60 p Previously announced in IAA as A87-28020
(Contract DTFA01-82-Y-10513)
(DOT/FAA/PM-87/11) Avail: NTIS HC A04/MF A01

Multiple Doppler radar data collected during the Joint Airport Weather Studies (JAWS) Project is used to synthesize the three dimensional wind in the region of a microburst. The microburst used is the strongest to date for which three dimensional winds have been recorded. As a diagnostic tool, a six-DOF numerical aircraft model having characteristics similar to 727 series aircraft is used to investigate jet transport aircraft response to observed microburst winds during simulated approaches and departures. Simple pilot control laws are used to adjust thrust, pitch, roll, and yaw so as to maintain given approach or departure parameters. Generally, when horizontal wind shear along the approach or departure path is 0.01/s or greater, the model is unable to maintain the desired approach path and suffers a significant reduction in climb performance during a go-around or departure. Although the mean wind shear along a path gives a good qualitative measure of the wind shear threat to a jet transport, different paths with similar mean shears can yield markedly different results, as do the same paths through the microburst at different times. These findings are a direct consequence of the fine temporal and spatial scale of microburst winds. During any given modeled aircraft traverse through the region of highest horizontal shear, time variations in the microburst wind field are shown to have an insignificant effect on the modeled flight path. This is because the traverse period is short (30s) compared to the lifetime of a microburst (300 to 600s). Author

N87-29065# National Oceanic and Atmospheric Administration, Boulder, Colo. Environmental Sciences Group.
WEATHER RESEARCH PROGRAM Annual Report, FY 1986
Jan. 1987 30 p
(PB87-196390) Avail: NTIS HC A03/MF A01 CSCL 04B

The Weather Research Program (WRP) conducts research to understand the genesis, evolution, dissipation, structure, motion, and predictability of synoptic-scale and mesoscale weather systems, and to improve forecasts of their attendant weather phenomena such as lightning, high wind, wind shear, excessive rains, and flash floods. WRP actively participates in planning and conducting scientific field experiments involving sophisticated research aircraft and complex networks of remote sensing and conventional meteorological instrumentation. GRA

N87-29068*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SPACE/COHMEX DATA INVENTORY DOCUMENT
S. F. WILLIAMS, H. M. GOODMAN, K. R. KNUPP, and J. E. ARNOLD Aug. 1987 477 p
(NASA-TM-4006; NAS 1.15:4006) Avail: NTIS HC A21/MF A01 CSCL 04B

During the period June to July 1986, NASA conducted the Satellite Precipitation and Cloud Experiment (SPACE) in the central Tennessee, northern Alabama, and northeastern Mississippi area. In addition to SPACE, the Microburst and Severe Thunderstorm (MIST) Program, sponsored by the National Science Foundation, and the FAA-Lincoln Laboratory Operational Weather Study (FLOWS) sponsored by the Federal Aviation Administration,

operated concurrently under the acronym of COHMEX (Cooperative Huntsville Meteorological Experiment). The COHMEX field program incorporated measurements from remote sensors flown on high altitude aircraft (ER-2 and U-2), Doppler and conventional radars, rawinsondes, satellites, cloud physics research aircraft, and various surface observational systems. Author

N87-29956*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE AND POWER REGULATION CHARACTERISTICS OF TWO AILERON-CONTROLLED ROTORS AND A PITCHABLE TIP-CONTROLLED ROTOR ON THE MOD-O TURBINE Final Report
ROBERT D. CORRIGAN, CLINTON B. F. ENSWORTH, III, and DEAN R. MILLER Oct. 1987 21 p
(Contract DE-AI01-76ET-20320)
(NASA-TM-100136; DOE/NASA/20320-73; E-3686; NAS 1.15:100136) Avail: NTIS HC A02/MF A01 CSCL 10B

Tests were conducted on the DOE/NASA mod-0 horizontal axis wind turbine to compare and evaluate the performance and the power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor. The two aileron-controlled rotor configurations used 20 and 38 percent chord ailerons, while the tip-controlled rotor had a pitchable blade tip. The ability of the control surfaces to regulate power was determined by measuring the change in power caused by an incremental change in the deflection angle of the control surface. The data shows that the change in power per degree of deflection angle for the tip-controlled rotor was four times the corresponding value for the 2- percent chord ailerons. The root mean square power deviation about a power setpoint was highest for the 20 percent chord aileron, and lowest for the 38 percent chord aileron. Author

14

LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

A87-50949
THE PROBLEMS OF AIRCRAFT MICROCLIMATE (REVIEW OF THE LITERATURE) [PROBLEMY MIKROKLIMATA V SAMOLETAKH /OBZOR LITERATURY/]
A. N. AZHAEV, I. D. MALININ, and E. A. LUSHCHIKOV Voenno-Meditsinskii Zhurnal (ISSN 0026-9050), April 1987, p. 37, 38. In Russian. refs

The changes of temperature inside the front and back compartments of an aircraft during different stages of flight are discussed with emphasis on low-altitude flights in hot environments, which pose the particular danger of heat stress to aircraft personnel. Consideration is given to the ranges of ambient temperature necessary for the maintenance of comfort and of the ability to safely operate an aircraft during normal flight as well as during high-speed maneuvers. Special attention is given to preventive measures, such as air-conditioned clothing and clothing equipped with a portable water-cooling system. I.S.

N87-29115# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Anthropotechnik und Simulation.
REFINEMENT OF THE EYE-POINT-OF-REGARD MEASUREMENTS WITH HELICOPTER PILOTS IN A FLIGHT EXPERIMENT
RAINER UCKERMANN, HANS RADKE, and KLAUS WENDIGGENSEN Nov. 1986 54 p In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-1073)
(DFVLR-FB-86-61; ISSN-0171-1342; ETN-87-90049) Avail: NTIS HC A04/MF A01; DFVLR, Cologne, West Germany DM 23

The NAC-4 Eye Mark Recorder was tested in flight in order to make eye-point-of-regard measurements in helicopters simple and accurate. Twelve pilots served as subjects. It was tested whether a helmet mounting of the apparatus improves the wearing quality without deteriorating the accuracy of the measurements. The results show that the helmet-mounted apparatus can work much better, while the quality of the measurements is as good as with the original equipment. The new configuration is especially suitable for use in long duration experiments. ESA

N87-29504# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
AUTOMATION AT THE MAN-MACHINE INTERFACE
WALTER M. HOLLISTER *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 10 p Feb. 1987
Avail: NTIS HC A14/MF A01

There is a recognized need for automation. However, detailed analysis shows that the term automation is too broad for making specific research recommendations. The specific characteristics vary in kind and degree as a function of the piloting tasks. In some cases, the task should be left entirely to the pilot. In many cases, computer aiding is the best choice. A method for allocating functions between automated systems and the pilot is presented using the theory of divided attention. It describes a structured approach for reducing the control dwell fraction with improved flying qualities. There is a need for fundamental research into the understanding of how the human pilot operates as part of the aircraft and weapons control system. Author

N87-29507# Washington Univ., St. Louis, Mo.
CLOSING THE MAN-MACHINE LOOP: ON THE USE OF PHYSIOLOGICAL MEASURES TO AFFECT COMPUTER-CONTROLLED DEVICES
J. A. STERN, G. F. WILSON, and M. THEISSEN (General Dynamics Corp., Fort Worth, Tex.) *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 5 p Feb. 1987
Avail: NTIS HC A14/MF A01

Results suggest that physiological information: heart rate, eye blink, etc., as well as information about operator performance and system characteristics, could be used to alert the operator, change displays, or permit the hardware to take over certain functions. Utilization of physiological data from the operator must be used with certain cautions in mind. For example, physical exertion causes changes in heart rate. The system would have to be provided with information concerning physical exertion, so that the heart rate data could be appropriately interpreted in a larger context. This is true of the information concerning aircraft performance as well, where the pattern of inputs from various sensors is analyzed in order to make a decision about an action to be taken. Author

N87-29510# Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).
SOPHISTICATED INTEGRAL CONTROL METHODS FOR USE IN FLIGHT [LES MOYENS DE COMMANDE INTEGRES SOPHISTIQUES SERONT-ILS CONCUS POUR ETRE UTILISABLES EN VOL]
J.-P. MENU, G. SANTUCCI, and R. AMALBERTI *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 6 p Feb. 1987 In FRENCH
Avail: NTIS HC A14/MF A01

The changing nature of display and control requirements for modern aircraft and the various means by which information is transferred to and from the pilot are reviewed. Some of the known factors affecting human performance are discussed including: (1) desaturation and contrast loss in electronically generated information during high illumination inflight conditions; (2) the effects of high acceleration on both foveal and peripheral presentations of information; (3) manual control designs which obscure some settings when engaged; and (4) the improper labelling of display and control devices. The potential use of voice interactive control devices, especially in overcoming problems inherent in multitask situations, is also discussed. Finally, the relative merits of dedicated and multifunctional displays and controls are examined along with the theoretical causes of increased higher cognitive workloads required by multifunction devices. M.G.

N87-29516# Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France). Lab. Central de Biologie Aerospatiale.
ORGANIZATION OF DISPLAYS IN THE VISUAL SPACE OF THE COMBAT AIRCRAFT PILOT [ORGANISATION DES VISUALISATIONS DANS L'ESPACE VISUEL DU PILOTE D'AVION DE COMBAT]
J.-P. MENU and R. AMALBERTI *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 12 p Feb. 1987 In FRENCH
Avail: NTIS HC A14/MF A01

The psychophysiological problems associated with the specific organization of cockpit displays were examined through laboratory studies and pilot surveys. The response time associated with the transition between head-up and head-down displays was measured under various conditions. It was found that reduced transition times could be obtained through the use of intermediate display concepts. Illumination level and visual adaptation were identified as important factors in the optimal integration of displays. M.G.

N87-30051# Naval Aerospace Medical Research Lab., Pensacola, Fla.
TRACKING A LASER-PROJECTED HORIZON INDICATOR Interim Report
J. M. LENTZ, G. T. TURNIPSEED, and W. C. HIXSON May 1987 20 p
(AD-A183384; NAMRL-1330) Avail: NTIS HC A02/MF A01
CSCL 01D

We did not evolve in motion and acceleration environments typical of military aviation, and we lack sense organs to cope with these environments. Even though the vestibular and visual system function properly in these environments, the brain accurately interprets them without visual or tactile contact with some fixed spatial reference point such as the Earth's horizon. In the airplane, this reference is provided by a gyro-stabilized artificial horizon instrument. Individuals differ widely in their ability to extract visual information from this attitude indicator and mentally integrate it with information from other body sensors. Consequently, failure to assimilate all of this information can result in disorientation, erratic motor performance, or intuitively correct but grossly incorrect control decisions. One of the more promising recent attempts to combat inflight spatial disorientation has focused on the development of Peripheral Vision Horizon Devices (PVHD) suitable for installation in operational aircraft. This paper describes a series of laboratory experiments directed at explaining some of the psychophysiological characteristics of the PVHD significant to its operational application. GRA

N87-30072# Naval Aerospace Medical Research Lab., Pensacola, Fla.
INCOMPATIBILITY OF THE M-1 MANEUVER WITH US NAVY TACTICAL AIRCRAFT OXYGEN SYSTEMS Final Report
J. T. WHITE and L. M. MORIN Sep. 1986 9 p
(AD-A183731; NAMRL-TM-86-1) Avail: NTIS HC A02/MF A01
CSCL 06J

A spectrum of clinical symptoms consisting of grey-out, black-out, and G-induced loss of consciousness has been identified in pilots of high performance aircraft. The M-1 maneuver used in conjunction with reclined seats and inflated G-suit provides significant protection against these symptoms. Centrifuge-trained United States Navy tactical aircraft pilots have recently reported a decreased ability to perform the M-1 maneuver while using the MBU-12P oxygen mask and CRU-79/P oxygen regulator. This report reviewed the performance specifications of these devices and compared them with published pulmonary flow rates. We found this oxygen system to interfere with the performance of the M-1 and other anti-G maneuvers. Further research is needed to characterize pulmonary flow rates during the performance of the M-1 maneuver in order to make recommendations for breathing system standards aboard high performance aircraft. GRA

15

MATHEMATICAL AND COMPUTER SCIENCES

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

A87-52233
DIRECT VARIATIONAL METHOD IN FLIGHT DYNAMICS BOUNDARY VALUE PROBLEMS [PRIAMOI VARIATSIONNYI METOD V KRAEVYKH ZADACHAKH DINAMIKI POLETA]
VASILII TROFIMOVICH TARANENKO and VLADIMIR GEORGIEVICH MONDZHI Moscow, Izdatel'stvo Mashinostroenie, 1986, 128 p. In Russian. refs

The direct variational method is applied to boundary value problems in flight dynamics, with allowance made for constraints on phase coordinates and control functions. The problems examined include the well-known problems of altitude gain and velocity in the vertical plane with specified final conditions, as well as optimal boundary value problems in the horizontal plane. Particular attention is given to solving problems concerning optimal three-dimensional turns and climb along spatial trajectories, with the boundary conditions satisfied not only with respect to all phase coordinates but also with respect to three control functions (i.e., normal overload, angle of roll, and engine thrust). Computational algorithms implemented in computer software written in FORTRAN IV are included. V.L.

A87-52534*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MATHEMATICAL MODEL PARTITIONING AND PACKING FOR PARALLEL COMPUTER CALCULATION
DALE J. ARPASI and EDWARD J. MILNER (NASA, Lewis Research Center, Cleveland, OH) IN: 1986 International Conference on Parallel Processing, University Park, PA, Aug. 19-22, 1986, Proceedings . Washington, DC, IEEE Computer Society Press, 1986, p. 67-74. refs

This paper deals with the development of multiprocessor simulations from a serial set of ordinary differential equations describing a physical system. The identification of computational parallelism within the model equations is discussed. A technique is presented for identifying this parallelism and for partitioning the equations for parallel solution on a multiprocessor. Next, an algorithm which packs the equations into a minimum number of

processors is described. The results of applying the packing algorithm to a turboshaft engine model are presented. Author

A87-52796* Massachusetts Univ., Amherst.
PROCESSOR TRADEOFFS IN DISTRIBUTED REAL-TIME SYSTEMS
C. M. KRISHNA (Massachusetts, University, Amherst), KANG G. SHIN (Michigan, University, Ann Arbor), and INDERPAL S. BHANDARI (Carnegie-Mellon University, Pittsburgh, PA) IEEE Transactions on Computers (ISSN 0018-9340), vol. C-36, Sept. 1987, p. 1030-1040. refs
(Contract NAG1-296; N0014-85-K-0122)

The problem of the optimization of the design of real-time distributed systems is examined with reference to a class of computer architectures similar to the continuously reconfigurable multiprocessor flight control system structure, CM2FCS. Particular attention is given to the impact of processor replacement and the burn-in time on the probability of dynamic failure and mean cost. The solution is obtained numerically and interpreted in the context of real-time applications. V.L.

A87-52823
A METHOD FOR CONTROLLING A CENTRIFUGE CABIN [OB ODNOM SPOSOBE UPRAVLENIIA KABINOI TSENTRIFUGI]
V. I. KORNEV and A. V. MAMASUEV Moskovskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika (ISSN 0579-9368), May-June 1987, p. 83-85. In Russian.

The paper examines the problem of finding a control signal optimal according to the criterion of Krasovskii et al. (1977) for the centrifuge cabin in a dynamic flight simulation system. It is shown that the method of Krasovskii et al. makes it possible to optimize the control system through the use of dc drives. B.J.

A87-52832
INVESTIGATION OF THE LIFE CYCLES OF COMPLEX ENGINEERING SYSTEMS USING PETRI NETS [ISSLEDOVANIE ZHIZNENNYKH TSIKLOV SLOZHNYKH TEKHNICHESKIKH SISTEM POSREDSTVOM SETEI PETRI]
A. V. ANISIMOV and IU. E. BOREISHA Avtomatika i Telemekhanika (ISSN 0005-2310), April 1987, p. 90-101. In Russian. refs

Specially interpreted Petri nets are proposed for the description and investigation of the life cycle of complex engineering systems (ships, aircraft, etc.) through the design, construction, and operation stages. Consideration is given to the software implementation of these nets, and to the methodology for simulating the life cycles of the complex engineering systems and their combinations on the basis of the proposed approach. B.J.

A87-52960*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
TIME-SCALE SYNTHESIS OF A CLOSED-LOOP DISCRETE OPTIMAL CONTROL SYSTEM
D. S. NAIDU and D. B. PRICE (NASA, Langley Research Center, Hampton, VA) (Guidance, Navigation and Control Conference, Williamsburg, VA, Aug. 18-20, 1986, Technical Papers, p. 138-143) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Sept.-Oct. 1987, p. 417-421. Previously cited in issue 23, p. 3486, Accession no. A86-47417. refs

A87-53062#
PROBLEMS ASSOCIATED WITH THE INTEGRATION OF ARTIFICIAL INTELLIGENCE INTO CREW SYSTEMS
JACK B. SHELNUTT, LAWRENCE D. POHLMANN, and J. DAVID GILMOUR (Boeing Military Airplane Co., Seattle, WA) IN: AAAIC '86 - Aerospace Applications of Artificial Intelligence; Proceedings of the Second Annual Conference, Dayton, OH, Oct. 14-17, 1986. Volume 1 . Dayton, OH, AAAIC Conference Secretariat, 1986, p. 23-29.

AI, in particular expert systems and natural language technology, has the potential to be used in several roles in the supercockpits of future military aircraft. As with the initial application of any new technology, however, the integration of AI into crew system design is not being accomplished without problems. Based on experience gained from the ongoing development of a crew station information manager using expert system technology, two general problems (and approaches to solving them) are discussed: (1) the specification of functions to be performed by the expert system (since it will be performing a role that is, for the most part, unprecedented); and (2) development of tools to aid construction of the expert system (given the unique requirements of avionics systems relative to more conventional expert systems). Solutions to these problems share a common theme: the need to integrate expert system development with systems engineering techniques and tools traditionally employed in crew station design. Author

A87-53066#
IN REAL TIME WITH A PILOT IN THE LOOP
ROBERT SCHUDY, BRUCE WILCOX, and RICHARD SHU (BBN Laboratories, Inc., Cambridge, MA) IN: AAAIC '86 - Aerospace Applications of Artificial Intelligence; Proceedings of the Second Annual Conference, Dayton, OH, Oct. 14-17, 1986. Volume 1 . Dayton, OH, AAAIC Conference Secretariat, 1986, p. 62-66.

An account is given of the design features of an intercept tactical advisor, as well as of the interface between the advisor and the dome simulator used for its verification. The beyond-visual-range intercept tactics advisor identifies courses of action that a pilot can take, optimizes those courses, evaluates them against mission criteria, selects the optimal tactic (encompassing flight path, targeting sequence, and missile launch times), and presents its recommendations to the pilot. Advantages are seen for the system in high-threat/high-workload environments in which the automation of target designation, threat assessment, evaluation of missile envelopes, etc., can shorten reaction times. O.C.

A87-53069#
SOME PRINCIPLES OF PARALLEL PROGRAMMING
GUY L. STEELE, JR. (Thinking Machines Corp., Cambridge, MA) IN: AAAIC '86 - Aerospace Applications of Artificial Intelligence; Proceedings of the Second Annual Conference, Dayton, OH, Oct. 14-17, 1986. Volume 1 . Dayton, OH, AAAIC Conference Secretariat, 1986, p. 142-148. refs

Principles and pigeonholes used as guidelines in the design and categorization of parallel programming languages are discussed. Parallelism can arise in a variety of kinds and scales. Parallelism may be synchronous or asynchronous; it is also possible to design a serial programming model that has an underlying parallel implementation. The possible scale of parallelism ranges from the very small (bits within a word) to the very large (tasks in a multitasking system). Cooperating processes executing in parallel can also be classified as mutually exclusive or mutually supportive; usually mutually exclusive processes execute best asynchronously, and mutually supportive processes execute best synchronously, but this may be a historical accident of language and system design. Not all programming languages and systems support all kinds of parallelism well. Possible directions for identifying better parallel abstractions are considered. Illustrations are drawn from a number of programming languages, including ADA, C, FORTRAN 8x, LISP, and VAL. Author

A87-53075#
APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) TO AEROSPACE MANUFACTURING - A USER PERSPECTIVE
H. H. KING (McDonnell Aircraft Co., Saint Louis, MO) IN: AAAIC '86 - Aerospace Applications of Artificial Intelligence; Proceedings of the Second Annual Conference, Dayton, OH, Oct. 14-17, 1986. Volume 1 . Dayton, OH, AAAIC Conference Secretariat, 1986, p. 233-242. refs

An evaluation is made of the prospective performance improvements in aerospace manufacturing due to the application of AI expert systems. Functions for such systems are foreseen to encompass apprentice planners, which select cutting tools for metal working; buy-decision support systems, to determine what work should be subcontracted; expert machine selectors, which help in the selection and scheduling of numerically controlled machines;

generative process planning systems, which will automate process planning functions associated with composites; and human factors analysis expert models, which will allow designers to graphically simulate labor requirements for manufacturing tasks. O.C.

A87-53231* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
JPL MULTIPOLARIZATION WORKSTATION - HARDWARE, SOFTWARE AND EXAMPLES OF DATA ANALYSIS
FRED BURNETTE and LYNNE NORIKANE (California Institute of Technology, Jet Propulsion Laboratory, Pasadena) IN: IGARSS '87 - International Geoscience and Remote Sensing Symposium, Ann Arbor, MI, May 18-21, 1987, Digest. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1087-1090.

A low-cost stand-alone interactive image processing workstation has been developed for operations on multipolarization JPL aircraft SAR data, as well as data from future spaceborne imaging radars. A recently developed data compression technique is used to reduce the data volume to 10 Mbytes, for a typical data set, so that interactive analysis may be accomplished in a timely and efficient manner on a supermicrocomputer. In addition to presenting a hardware description of the work station, attention is given to the software that has been developed. Three illustrative examples of data analysis are presented. O.C.

A87-53957
PRINCIPLES OF THE COMPUTER-AIDED DESIGN OF AIRCRAFT [OSNOVY AVTOMATIZIROVANNOGO PROEKTIROVANIIA SAMOLETOV]
SERGEI MIKHAILOVICH EGER, NIKOLAI KONSTANTINOV LISEITSEV, and OLEG SERGEEVICH SAMOILOVICH Moscow, Izdatel'stvo Mashinostroenie, 1986, 232 p. In Russian. refs

The fundamentals of the computer-aided design of aircraft and some specific problems associated with the use of CAD systems are examined. The discussion covers the objectives and functions of CAD systems in aircraft design, software support of CAD systems, principal design procedures, methods of design optimization, characteristics of the design of multipurpose aircraft. Particular attention is given to the computer-aided design of the general aircraft layout and load-bearing structures. The principal modules of a CAD system for aircraft design are described. V.L.

N87-29140*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AI AT AMES: ARTIFICIAL INTELLIGENCE RESEARCH AND APPLICATION AT NASA AMES RESEARCH CENTER, MOFFETT FIELD, CALIFORNIA, FEBRUARY 1985
ALISON E. ANDREWS, ed. *In* NASA, Washington, Proceedings: Computer Science and Data Systems Technical Symposium, Volume 1 27 p Aug. 1985
Avail: NTIS HC A16/MF A01 CSCL 09B

Charts are given that illustrate function versus domain for artificial intelligence (AI) applications and interests and research area versus project number for AI research. A list is given of project titles with associated project numbers and page numbers. Also, project descriptions, including title, participants, and status are given. Author

N87-29174# Research Inst. of National Defence, Stockholm (Sweden).
NYANS: A PACKAGE FOR TIME VARYING CONTROL SYSTEMS
HANS STRENGNELL Jan. 1987 87 p In SWEDISH; ENGLISH summary
(FOA-C-20642-2.1; ISSN-0347-3694; ETN-87-90067) Avail: NTIS HC A05/MF A01

An interactive computer program for design of time varying control systems based on linear-quadratic-gaussian theory using a state feedback regulator is described. The control theory aspects of the program are emphasized. Examples are given of different matrix management operations and use for the dimensional analysis of automatic pilots for aircraft and flight control. ESA

N87-29186*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE SIFT HARDWARE/SOFTWARE SYSTEMS. VOLUME 1: A DETAILED DESCRIPTION
DANIEL L. PALUMBO Sep. 1985 36 p
(NASA-TM-87574; NAS 1.15:87574) Avail: NTIS HC A03/MF A01 CSCL 09B

This report contains a detailed description of the software implemented fault-tolerant computer's operating system and hardware subsystems. The Software Implemented Fault-Tolerant (SIFT) computer system was developed as an experimental vehicle for fault-tolerant systems research. The SIFT effort began with broad, in-depth studies stating the reliability and processing requirements for digital computers which would, in the aircraft of the 1990's, control flight-critical functions. Author

N87-30099*# SRI International Corp., Menlo Park, Calif. Computer Science Lab.
DESIGN VERIFICATION OF SIFT Final Report
LOUISE MOSER, MICHAEL MELLIAR-SMITH, and RICHARD SCHWARTZ Washington NASA Sep. 1987 84 p
(Contract NAS1-15528)
(NASA-CR-4097; NAS 1.26:4097) Avail: NTIS HC A05/MF A01 CSCL 09B

A SIFT reliable aircraft control computer system, designed to meet the ultrahigh reliability required for safety critical flight control applications by use of processor replications and voting, was constructed for SRI, and delivered to NASA Langley for evaluation in the AIRLAB. To increase confidence in the reliability projections for SIFT, produced by a Markov reliability model, SRI constructed a formal specification, defining the meaning of reliability in the context of flight control. A further series of specifications defined, in increasing detail, the design of SIFT down to pre- and post-conditions on Pascal code procedures. Mechanically checked mathematical proofs were constructed to demonstrate that the more detailed design specifications for SIFT do indeed imply the formal reliability requirement. An additional specification defined some of the assumptions made about SIFT by the Markov model, and further proofs were constructed to show that these assumptions, as expressed by that specification, did indeed follow from the more detailed design specifications for SIFT. This report provides an outline of the methodology used for this hierarchical specification and proof, and describes the various specifications and proofs performed. Author

N87-30102*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SMALL-SCALE ROTOR TEST RIG CAPABILITIES FOR TESTING VIBRATION ALLEVIATION ALGORITHMS
STEPHEN A. JACKLIN and JANE ANNE LEYLAND Aug. 1987 387 p
(NASA-TM-100002; A-87271; NAS 1.15:100002) Avail: NTIS HC A17/MF A01 CSCL 09B

A test was conducted to assess the capabilities of a small scale rotor test rig for implementing higher harmonic control and stability augmentation algorithms. The test rig uses three high speed actuators to excite the swashplate over a range of frequencies. The actuator position signals were monitored to measure the response amplitudes at several frequencies. The ratio of response amplitude to excitation amplitude was plotted as a function of frequency. In addition to actuator performance, acceleration from six accelerometers placed on the test rig was monitored to determine whether a linear relationship exists between the harmonics of N/Rev control input and the least square error (LSE) identification technique was used to identify local and global transfer matrices for two rotor speeds at two batch sizes each. It was determined that the multicyclic control computer system interfaced very well with the rotor system and kept track of the input accelerometer signals and their phase angles. However, the current high speed actuators were found to be incapable of providing sufficient control authority at the higher excitation frequencies. Author

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.

A87-50915
OPTIMIZATION OF THE CONTROLLED ROTATIONS OF A RIGID BODY WITH AN ELASTIC ROD USING FIRST INTEGRALS OF A FREE SYSTEM [OPTIMIZATSIIA UPRAVLIAEMYKH VRASHCHENII TVERDOGO TELA S UPRUGIM STERZHNEM S POMOSHCH'IU PERVYKH INTEGRALOV SVOBODNOI SISTEMY]
V. E. BERBIUK Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), May-June 1987, p. 8-16. In Russian. refs

The paper is concerned with the optimal control of the rotational motions of a system consisting of a rigid body and an elastic rod rigidly connected with the body. The motion of the system is described by integrodifferential equations and boundary conditions using assumptions of the linear theory of thin, straight, inextensible elastic rods. Optimal control problems for the system investigated are formulated and solved by using the first integrals of equations of motion for a free system. The problem of the optimal (with respect to the quadratic functional) turn of the body-rod system from a position of rest to a specified angle, with rod vibration damping, is analyzed as an example. V.L.

A87-51215
SELF-EXCITED OSCILLATIONS IN JET ENGINE TEST CELLS
M. S. HOWE (BBN Laboratories, Inc., Cambridge, MA) Journal of Fluids and Structures (ISSN 0889-9746), vol. 1, Jan. 1987, p. 121-148. refs
(Contract F40600-84-C-0004)

An exploratory theoretical investigation is made of flow-acoustic interactions responsible for the generation and sustaining of low frequency resonant oscillations in jet engine altitude test cells. Longitudinal 'organ pipe' acoustic modes within the test cell diffuser are known to be important at low frequencies, and a theory is developed for calculating the corresponding resonance frequencies when allowance is made for the interaction of the jet with the acoustic field within the diffuser. The theory is initially worked out for a nondiverging jet, which does not wet the walls of the diffuser. This simple model can be treated analytically. The general case, involving a divergent jet which ultimately wets the diffuser walls, is treated numerically as a generalization of the uniform mean flow theory. Theoretical predictions are in limited agreement with available experimental data. It is concluded that reliable predictions of operating conditions likely to favor the production of low frequency self-excited oscillations are possible only when the pressure, temperature and velocity of the mean flow within the diffuser are accurately known upstream of the impingement zone. Author

A87-51483
FICK'S FIRST LAW CORRECTION BY AN EXACT SOLUTION OF THE BOLTZMANN EQUATION
D. STRAUB, R. GRAUE, F. HEITMEIR, P. NEBENDAHL, and TH. K. WURST (Universitaet der Bundeswehr, Munich, West Germany) Propellants, Explosives, and Pyrotechnics (ISSN 0721-3115), vol. 12, June 1987, p. 105-112. refs

It is shown that there exists a dominant solution of the Boltzmann equation for an artificial model gas in terms of a relation for the diffusion flux differing from the regular formulation of Fick' first law. Its mathematical structure corresponds to the Cattaneo-formulation based on heuristics of the Fourier heat flux vector. This dominant solution allows a realistic estimation of a diffusion relaxation time and serves as the basis for valuable information concerning two actual problems of hypersonic gas dynamics: first, a useful relation for the calculation of collision integrals for diffusion coefficients, especially at high temperatures; second, a new type of a chemical reaction equation, which is particularly relevant in very fast relaxation processes encountered in the chemistry of fuels. Author

A87-51812#
CALCULATION OF NOISE CAUSED BY INTERACTION OF SUPERSONIC CASCADE AND VARIED ONCOMING GUST
FEIDA FAN (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 8, May 1987, p. 133-135. In Chinese, with abstract in English. refs

A87-52069* Florida State Univ., Tallahassee.
STOCHASTIC MODEL THEORY OF BROADBAND SHOCK ASSOCIATED NOISE FROM SUPERSONIC JETS
C. K. W. TAM (Florida State University, Tallahassee) Journal of Sound and Vibration (ISSN 0022-460X), vol. 116, July 22, 1987, p. 265-302. refs
(Contract NAG1-421)

A method based on the work of Tam and Tanna (1982) for calculating the near field noise spectrum and the spatial distribution of broadband shock associated noise from supersonic jets is proposed. Multiple-scales expansion is used to decompose the quasi-periodic shock cells into time-independent waveguide modes of the jet flow, and the interaction of the instability waves with each of the waveguide modes is shown to generate unsteady disturbances which become part of the broadband shock associated noise when radiated to the far field. The observed broadband shock associated noise is composed of a superposition of the various distinct spectra of the different waveguide modes, and the multispectra can be easily identified in many of the existing far and near field noise measurements. R.R.

A87-52846
SCATTERING OF SOUND BY A SEMI-INFINITE ELASTIC PLATE WITH A SOFT BACKING - A MATRIX WIENER-HOPF PROBLEM
I. D. ABRAHAMS (Newcastle-upon-Tyne, University, England) IMA Journal of Applied Mathematics (ISSN 0272-4960), vol. 37, no. 3, 1986, p. 227-245. refs

This paper looks at the acoustic edge scattering of a semiinfinite thin elastic plate. The plate is backed by an acoustically soft layer, so that pressure fluctuations vanish on one side. This is an example of a problem where the influence of an absorbent liner may reduce the acoustic far-field pressure levels, and has obvious applications in the area of jet-noise research. The problem is formulated into a matrix Wiener-Hopf equation for which no general method of solution has yet been found. However, studies have been made for restricted classes of these equations, and this paper shows that an exact solution is obtainable in the present case. The exact solution is found using a technique whereby the Wiener-Hopf equation is converted into a scalar Hilbert problem. The asymptotic form of this solution is determined when the influence of the fluid on plate deflections is very large. Author

A87-52876#
DOPPLER FREQUENCY SHIFT IN A REFRACTIVE ATMOSPHERE
DIPANKAR ROY (Boeing Commercial Airplane Co., Seattle, WA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 577-586. Previously cited in issue 01, p. 76, Accession no. A85-10890.

A87-52877#
ACOUSTIC MODE MEASUREMENTS IN THE INLET OF A TURBOFAN ENGINE
P. D. JOPPA (Boeing Commercial Airplane Co., Seattle, WA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Sept. 1987, p. 587-593. Previously cited in issue 01, p. 75, Accession no. A85-10879. refs

A87-53903
SUPERSONIC ROTOR NOISE CALCULATION WITH SONIC BOOM PREDICTION METHODS
R. STUFF (University of Petroleum and Minerals, Dhahran, Saudi Arabia) Vertica (ISSN 0360-5450), vol. 11, no. 3, 1987, p. 591-600. refs

The nonlinear wave propagation from the blade tip of an open supersonic rotor is dealt with by the analytical method of characteristics using bicharacteristics as independent variables. Shocks are found from the condition that they are in first order bisectors of the characteristic slopes in front of and behind the shock. The increases in pulse duration are given by strained coordinates. It is shown that dissipation in the shock waves accounts for the differences between noise levels found from measurements and those predicted from linear theory. An arbitrary three-dimensional configuration and a length distribution of lift and drag can be described with the equivalent body of revolution. An explicit formula for the shock pressure is presented and the applicability of sonic boom minimization concepts to the design of a supersonic rotor blade tip is discussed. Author

A87-54239
AN EXPERIMENTAL INVESTIGATION OF THE GENERATION AND CONSEQUENCES OF ACOUSTIC WAVES IN AN AXIAL-FLOW COMPRESSOR - THE EFFECT OF VARIATIONS IN THE AXIAL SPACING BETWEEN BLADE ROWS
R. PARKER and S. A. T. STONEMAN (Swansea, University College, Wales) Journal of Sound and Vibration (ISSN 0022-460X), vol. 116, Aug. 8, 1987, p. 509-525. Research supported by Rolls-Royce Ltd., and SERC. refs

The excitation of acoustic resonances in axial-flow compressors was investigated experimentally on a low speed, single stage test rig. It was found that the axial spacing between blade rows had a marked effect on the acoustic amplitudes and on the speeds at which the various resonances were excited. A simple model which is consistent with the experimental results is proposed. Author

N87-29308# Air Force Occupational and Environmental Health Lab., Brooks AFB, Tex.
FIRST ARTICLE NOISE SURVEY OF THE A/F32T-9 LARGE TURBO FAN ENGINE ENCLOSED NOISE SUPPRESSOR SYSTEM, FAR-FIELD NOISE, MCCONNELL AFB, KANSAS Final Report
TERRY M. FAIRMAN May 1987 162 p
(AD-A182475; USAFOEHL-87-068E0118ENA) Avail: NTIS HC A08/MF A01 CSCL 20A

This report presents the results of noise measurements made on the A/F32T-9 Large Turbo Fan Engine, Enclosed Noise Suppressor System, during First Article Tests at McConnell AFB, Kansas. Noise measurements obtained at 100 meters distance are summarized for the following engines: the J57-59W, TF33-P3, TF30-P7, F100, TF41-A1, J85-5, F101-GE-102, and the F109-CF-100. GRA

N87-29311 Civil Aviation Authority, London (England). Chief Scientist's Div.
NOISE ATTENUATION PROPERTIES OF HEADSETS IN A HELICOPTER NOISE ENVIRONMENT
M. C. LOWER and P. D. WHEELER (Royal Aircraft Establishment, Farnborough, England) 1987 38 p Prepared in cooperation with Southampton Univ., England
(Contract RAE-7D/S/0416; MOD(PE)-A94B/3593)
(CAA-PAPER-87004; DRR-8607; ISBN-0-86039-299-6; ETN-87-90255) Avail: Issuing Activity

Ten subjects wearing each of four headset types were exposed to two helicopter noise environments and the noise received at the ear was measured. The evaluation shows the relative attenuation performance between the headset types; it also shows the effect of live-microphone communication systems on the noise levels being presented to helicopter pilots. Results are compared with a UK noise environment standard. Flight simulation shows that a lightweight headset causes the sound levels required for auditory warnings to be excessive below 1 kHz. Aircrew wearing this headset in this envionment are exposed to hazardous noise levels even with exposures as short as a few minutes. Repeated exposure is likely to damage their hearing. Earmuff or helmet based headsets are likely to be satisfactory since they do not require auditory warnings to be presented at excessive levels and noise levels at the ear are likely to be within acceptable limits. ESA

N87-29315*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
FREE-JET INVESTIGATION OF MECHANICALLY SUPPRESSED, HIGH RADIUS RATIO COANNULAR PLUG MODEL NOZZLES Final Report
B. A. JANARDAN, R. K. MAJJIGI, J. F. BRAUSCH, and P. R. KNOTT May 1985 250 p
(Contract NAS3-21608)
(NASA-CR-3596; E-2472; NAS 1.26:3596; R81AEG484) Avail: NTIS HC A11/MF A01 CSCL 20A

The experimental and analytical acoustic results of a scale-model investigation or unsuppressed and mechanically suppressed high-radius ratio coannular plug nozzles with inverted velocity and temperature profiles are summarized. Nine coannular nozzle configurations along with a reference conical nozzle were evaluated in the Anechoic Free-Jet Facility for a total of 212 acoustic test points. Most of the tests were conducted at variable cycle engine conditions applicable to advanced high speed aircraft. The tested nozzles included coannular plug nozzles with both convergent and convergent-divergent (C-D) terminations in order to evaluate C-D effectiveness in the reduction of shock-cell noise and 20 and 40 shallow-chute mechanical suppressors in the outer stream in order to evaluate their effectiveness in the reduction of jet noise. In addition to the acoustic tests, mean and turbulent velocity measurements were made on selected plumes of the 20 shallow-chute configuration using a laser velocimeter. At a mixed jet velocity of 700 m/sec, the 20 shallow-chute suppressor configuration yielded peak aft quadrant suppression of 11.5 and 9 PNdB and forward quadrant suppression of 7 and 6 PNdB relative to a baseline conical nozzles during static and simulated flight, respectively. The C-D terminations were observed to reduce shock-cell noise. An engineering spectral prediction method was formulated for mechanically suppressed coannular plug nozzles. Author

N87-30150# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
CALCULATION OF NOISE AROUND AIRPORTS FOR POWERED GLIDERS [BEREKENING VAN DE GELUIDSBELASTING RONDOM VLIEGVELDEN GEBRUIKT DOOR MOTORZWEEF-VLIEGTUIGEN]
G. J. J. RUIJGROK and D. M. VANPAASSEN Nov. 1985 45 p In DUTCH
(VTH-LR-475; B8707449; ETN-87-90215) Avail: NTIS HC A03/MF A01

The noise in the neighborhood of airports, used only by powered gliders, was estimated using a calculation model. The motor glider GROB-G 109B, which was taken as a characteristic aircraft type, is described with emphasis on its acoustic properties. The noise emission standards, and the equivalent noise level are presented. The calculated noise is presented by means of contours of constant equivalent noise level. The effects of a number of aircraft motions, of flight procedures, and of the strength of the noise source are calculated. ESA

N87-30155*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ACOUSTIC EFFECTS ON PROFILE DRAG OF A LAMINAR FLOW AIRFOIL
JOHN G. SHEARIN, MICHAEL G. JONES (PRC Kentron, Inc., Hampton, Va.), and ROBERT A. BAALS Sep. 1987 18 p
(NASA-TM-100505; NAS 1.15:100505) Avail: NTIS HC A02/MF A01 CSCL 20A

A two-dimensional laminar flow airfoil (NLF-0414) was subjected to high-intensity sound (pure tones and white noise) over a

frequency range of 2 to 5 kHz, while immersed in a flow of 240 ft/sec (Rn of 3 million) in a quiet flow facility. Using a wake-rake, wake dynamic pressures were determined and the deficit in momentum was used to calculate a two dimensional drag coefficient. Significant increases in drag were observed when the airfoil was subjected to the high intensity sound at critical sound frequencies. However, the increased drag was not accompanied by movement of the transition location. Author

17

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A87-51477
SPACE COMMUNICATIONS TO AIRCRAFT: A NEW DEVELOPMENT IN INTERNATIONAL SPACE LAW. I
WOLF D. VON NOORDEN (International Maritime Satellite Organization, London, England) Journal of Space Law, vol. 15, no. 1, 1987, p. 25-34. refs

The establishment of an international institutional framework for aeronautical satellite telecommunications is examined. The structure and current objectives of Inmarsat are reviewed. Various applications for aeronautical satellite telecommunications in the areas of air traffic services, aeronautical operational control, and aircraft passenger communications are described. The development of an aeronautical satellite system, and the role of Inmarsat in creating the communication system are discussed. I.F.

A87-52171
AVIATION TORT LITIGATION AGAINST THE UNITED STATES - JUDICIAL INROADS ON THE PILOT-IN-COMMAND CONCEPT
ANDREW J. DILK (FAA, Office of the Chief Counsel, Washington, DC) Journal of Air Law and Commerce (ISSN 0021-8642), vol. 52, Summer 1987, p. 797-867. refs

This article discusses the weakening of the pilot-in-command (PIC) concept in aviation law, which places primary responsibility for the successful operation of the aircraft on the pilot in charge of the flight. The historical development of the PIC concept is reviewed, and the dilution of the concept by the judiciary in major cases, with increasing liability being placed on air traffic controllers, is described in detail. A new routing for aviation tort litigation under the Federal Tort Claims Act is proposed. C.D.

A87-52172
AIRLINE MANAGEMENT PREROGATIVE IN THE DEREGULATION ERA
JAMES J. MCDONALD, JR. (Fisher and Phillips, Atlanta, GA) Journal of Air Law and Commerce (ISSN 0021-8642), vol. 52, Summer 1987, p. 869-939. refs

The application of the management prerogative concept, which holds that an employer may make decisions relating to the basic scope and direction of the enterprise without first bargaining with, or obtaining the consent of, the unions representing its employees, to the airline industry is discussed. The genesis of the concept of management prerogative is reviewed, and the scope of collective bargaining and management prerogative under the Railway Labor Act is examined. It is shown that no justification exists for construing the scope of an airline's management prerogative in most instances to be any narrower than that of nonairline employers. The applicability of the doctrine of airline management prerogative under deregulation is discussed, and procedural considerations are addressed. C.D.

A87-52900
CIVIL LIABILITY CONCERNING UNLAWFUL INTERFERENCE WITH CIVIL AVIATION
IAN AWFORD (Barlow Lyde and Gilbert, London, England) (Netherlands' Red Cross and Rijksuniversiteit te Leiden, International Conference on Aviation Security: How to Safeguard International Air Transport, The Hague, Netherlands, Jan. 22, 23, 1987) Air Law (ISSN 0165-2079), vol. 12, June 1987, p. 120-142.

Unlawful interference with civil aviation may take the form of hijacking, shooting down and sabotage of aircraft, bombings, and bomb threats. Attention is presently given to how the victims of such unlawful acts are to obtain compensation. There is noted to be a dearth of case law establishing the liability of airport operators and other aviation entities apart from the carrier in question. Article 17 of the 1929 Warsaw convention states that 'The carrier shall be liable for damage sustained in the event of the death or wounding of a passenger or any other bodily injury suffered by a passenger, if the accident which caused the damage so sustained took place on board the aircraft or in the course of any of the operations embarking or disembarking.' It remains possible for the carrier, however, to invoke Article 20, which provides for exoneration where the carrier can prove that it and its agents took all necessary measures to avoid the damage. O.C.

A87-53417
REDUCING TOTAL COST OF OWNERSHIP - A CHALLENGE TO HELICOPTER PROPULSION SPECIALISTS
DAVID FORD (Bell Helicopter Textron, Inc., Fort Worth, TX) IN: Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers . Alexandria, VA, American Helicopter Society, 1987, 9 p. refs

The cost of ownership of helicopter power plants is considered from the helicopter manufacturers' perspective, as influenced by the ultimate end user. The elements of cost of ownership are identified and analyzed, and specific areas of mutual interest to manufacturers of rotorcraft and of rotorcraft power plants are discussed. It is argued that, if the cost of ownership for helicopter propulsion systems is to remain competitive, then new technology must be included in next generation propulsion systems, current technology must be refined, and new technology spinoffs must be selectively introduced in a cost-effective manner. Technical, operational, financial, and general challenges for propulsion specialists are outlined. K.K.

N87-29364# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
FISCAL YEAR 1988 TECHNICAL OBJECTIVE DOCUMENT
Annual Report
Mar. 1987 76 p Supersedes AFWAL-TR-86-2000 (AD-A180311; AFWAL-TR-87-2000; AFWAL-TR-86-2000) Avail: NTIS HC A05/MF A01 CSCL 21H

This technical objective document (TOD) has been prepared by the Aero Propulsion Laboratory to provide science and industry with specific technical objectives which the Air Force feels are critical to maintain aerospace superiority in the future. The TOD contains three functional areas (Aircraft, Missile, and Space) which provide planning objectives covering the technical discipline of airbreathing propulsion, aerospace vehicle power, fire protection, and aircraft and missile fuels and lubrication. GRA

N87-29512# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio. Human Engineering Div.
AN ASSESSMENT OF VARIABLE FORMAT INFORMATION PRESENTATION
J. A. FORESTER *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 13 p Feb. 1987
Avail: NTIS HC A14/MF A01

Three experiments testing the feasibility of varying information display formats as task demands change in complex multitask environments were conducted. A multiple resource model of human information processing was used as a guide for determining how best to represent task relevant information under changing

conditions and the general validity of certain aspects of the model was assessed. Experiment 1 investigated the usefulness of a basic dual task environment for testing the variable format approach and Experiment 2 demonstrated that the technique was successful under simple task conditions. Experiment 3 increased the complexity of the base dual task by including a third task in an adaptive system context. The results from Experiment 3 supported the use of variable formats in complex adaptive systems and were consistent with the tenets of multiple resource theory. Experiment 3 also indicated the importance of considering individual differences in the design of adaptive systems. The overall approach attempts to improve human processing efficiency by capitalizing on current knowledge of human information processing characteristics and capabilities. Author

N87-30224# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

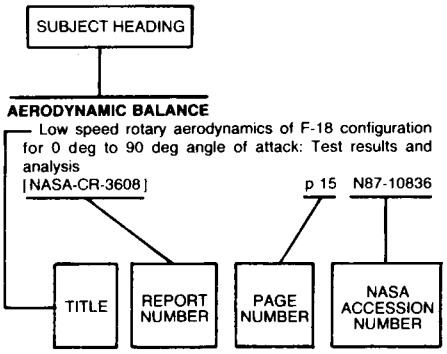
AIR FORCE TECHNICAL OBJECTIVE DOCUMENT FISCAL YEAR 1988

ALAN M. SALUS and ROBERT L. DENISON Dec. 1986 81 p Supersedes AFWAL-TR-85-4000, AD-A167324

(AD-A183017; AFWAL-TR-86-4000; AFWAL-TR-85-4000) Avail: NTIS HC A05/MF A01 CSCL 11D

This Technical Objective Document was prepared by the A.F. Materials Laboratory and describes the technical program in materials to meet future Air Force operational needs. The technology program is divided into ten Focal Areas which encompass the full spectrum of materials capabilities required for future aircraft, missile, space and electronic systems. These ten areas are: Thermal Protection Materials and Structures; Metallic Structural Materials; Nonmetallic Structural Materials; Nondestructive Evaluation; Aerospace Propulsion Materials; Nonstructural Materials: Electromagnetic Windows and Electronic Materials; Laser Hardened Materials; Computer Aided Manufacturing/Manufacturing R and D; and Systems Support. GRA

Typical Subject Index Listing



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A

A-7 AIRCRAFT
Corsair with more - A-7 plus p 824 A87-53744
ABLATION
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
ABNORMALITIES
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
ABORTED MISSIONS
Analysis of Convair 990 rejected-takeoff accident with emphasis on decision making, training and procedures
[NASA-TM-100189] p 819 N87-29471
ABRASION RESISTANCE
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
ACCELERATION TOLERANCE
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072
ACCELEROMETERS
Accelerometer placement in active flutter suppression systems p 828 A87-52963
ACEE PROGRAM
ACEE composite structures technology
[NASA-CR-172359] p 844 N87-28613
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
ACEE composite structures technology
[NASA-CR-172360] p 845 N87-28615
The ACEE program and basic composites research at Langley Research Center (1975 to 1986): Summary and bibliography
[NASA-RP-1177] p 846 N87-29612
ACOUSTIC ATTENUATION
Laboratory study of sidewall noise transmission and treatment for a light aircraft fuselage
p 824 A87-52887
ACOUSTIC EXCITATION
Self-excited oscillations in jet engine test cells
p 859 A87-51215
Enhanced mixing of an axisymmetric jet by aerodynamic excitation
[NASA-CR-175059] p 815 N87-29418
Control of shear flows by artificial excitation
[NASA-TM-100201] p 815 N87-29420
ACOUSTIC MEASUREMENT
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
ACOUSTIC PROPAGATION
Acoustic mode measurements in the inlet of a turbofan engine p 859 A87-52877
ACEE composite structures technology
[NASA-CR-172360] p 845 N87-28615
ACOUSTIC SCATTERING
Scattering of sound by a semi-infinite elastic plate with a soft backing - A matrix Wiener-Hopf problem
p 859 A87-52846
ACOUSTICS
Propfan test assessment propfan propulsion system static test report
[NASA-CR-179613] p 834 N87-29536
Acoustic effects on profile drag of a laminar flow airfoil
[NASA-TM-100505] p 860 N87-30155
ACTIVE CONTROL
On design of restructurable control systems for aircraft with some failures p 835 A87-51981
Accelerometer placement in active flutter suppression systems p 828 A87-52963
Interactions between an aircraft structure and active control systems p 835 A87-52964
An active control landing gear for the alleviation of aircraft taxi ground loads p 824 A87-53573
Simultaneous active controls on wind tunnel model
p 836 A87-54190
Integrated Application of Active Controls (IAAC) technology to an advanced subsonic transport project: Test act system validation
[NASA-CR-172525] p 836 N87-28563
ACTUATORS
Acta aeronautica et astronautica sinica (selected articles)
[AD-A182447] p 802 N87-28500
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495
ADAPTIVE CONTROL
Interactions between an aircraft structure and active control systems p 835 A87-52964
ADHESIVES
High-temperature polymers for adhesive and composite applications p 843 A87-53888
AERIAL RECONNAISSANCE
Aircraft microwave radiometry of land
p 853 A87-53269
AEROACOUSTICS
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
AERODYNAMIC BALANCE
Effect of dynamic stall on helicopter trim and flap-lag response p 835 A87-54139
Experimental techniques for three-axes load cells used at the National Full-Scale Aerodynamics Complex
[NASA-TM-86693] p 826 N87-28546
Trimming an aircraft model for flight simulation
[NASA-TM-89466] p 828 N87-29502
AERODYNAMIC CHARACTERISTICS
The application of the method of streams to the numerical modeling of unsteady aerohydrodynamics problems p 804 A87-51654
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
Leading- and trailing-edge flaps on a low Reynolds number airfoil p 808 A87-52886
A contribution to the aerodynamics of unsymmetrical aircraft configurations
[ETN-87-90030] p 810 N87-28504
Some numerical calculations by using linear classical sonic theories approached from sub- or supersonic speeds
[NASA-TT-20112] p 813 N87-28527
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
AERODYNAMIC COEFFICIENTS
Calculation of the aerodynamic coefficients of aircraft on a computer with allowance for physicochemical reactions p 803 A87-50876
Lift and pitching moment coefficient changes from low-level freestream turbulence p 808 A87-52888
An analysis of the approximation of the aerodynamic coefficients of thin bodies in a rarefied gas
p 808 A87-53526
On the feasibility of low-speed aircraft maneuvers involving extreme angles of attack p 835 A87-54140
Theoretical evaluation of the aerodynamic performance of a transonic wing
[ONERA-20/3423-AY] p 810 N87-28507
AERODYNAMIC CONFIGURATIONS
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
A technique of holographic visualization to flow fields of a model with variable angles of attack
p 806 A87-52306
Influence of forebody cross-sectional shape on wing vortex-burst location p 808 A87-52885
Solution of aerodynamic integral equations without matrix inversion p 808 A87-52889
Program LRCDM2: Improved aerodynamic prediction program for supersonic canard-tail missiles with axisymmetric bodies
[NASA-CR-3883] p 813 N87-28525
Propfan test assessment testbed aircraft flutter model test report
[NASA-CR-179458] p 814 N87-29413
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422
Parachute recovery systems design manual, chapter 5
[AD-A183191] p 816 N87-29426
Transonic rotor tip design using numerical optimization
[NASA-TM-86771] p 816 N87-29431
Trimming an aircraft model for flight simulation
[NASA-TM-89466] p 828 N87-29502
AERODYNAMIC DRAG
Wave drag analysis of realistic fighter aircraft using a full-potential method p 807 A87-52882
Supersonic and transonic supersonic flow
[MPIS-16/1986] p 811 N87-28508
AERODYNAMIC INTERFERENCE
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521
Transonic interference reduction by limited ventilation wall panels
[NASA-CR-175039] p 815 N87-29419
AERODYNAMIC LOADS
The prediction of the vibratory airloads of helicopter rotors in forward flight p 823 A87-51214
An active control landing gear for the alleviation of aircraft taxi ground loads p 824 A87-53573
Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513
Comparison between 2D transonic flutter calculations in the time and frequency domain p 812 N87-28520
Experimental techniques for three-axes load cells used at the National Full-Scale Aerodynamics Complex
[NASA-TM-86693] p 826 N87-28546

Estimation of blade airloads from rotor blade bending moments
[NASA-TM-100020] p 815 N87-29421
Application of a panel method to wake-vortex/wing interaction and comparison with experimental data
[NASA-TM-88337] p 817 N87-29461

AERODYNAMIC NOISE
Calculation of noise caused by interaction of supersonic cascade and varied oncoming gust p 859 A87-51812
Supersonic rotor noise calculation with sonic boom prediction methods p 860 A87-53903
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308

AERODYNAMIC STABILITY
Jet spoiler as a yaw control device
p 835 A87-52880
Pitot and static errors due to non-steady flight
[ESDU-85011] p 813 N87-29410

AERODYNAMIC STALLING
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
Effect of dynamic stall on helicopter trim and flap-lag response p 835 A87-54139
Toward comparing experiment and theory for corroborative research on hingeless rotor stability in forward flight
[NASA-CR-181354] p 836 N87-28562

AERODYNAMICS
Numerical modeling in aerohydrodynamics
p 804 A87-51651
Aerogasdynamics and its development at the Institute of Theoretical and Applied Mechanics of the Siberian Section of the Academy of Sciences of the USSR
p 809 A87-53544
Numerical aerodynamics using large computers
p 809 A87-53562
Calculation of frictionless flow about airfoil wings and propellers by numerical solution of the Euler equations
p 809 A87-53563
Aerodynamics of 3-dimensional bodies in transitional flow
[NASA-CR-181395] p 816 N87-29429

AEROELASTICITY
A new model of a self-controlled system --- cross-flow excited elastically suspended body vibration
p 847 A87-51158
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777
Experimental aeroelastic behavior of forward-swept graphite/epoxy wings with rigid-body freedom
p 824 A87-53781
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782
Unsteady test method applied to wind tunnel studies of flutter p 838 A87-54189
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893

AERONAUTICAL SATELLITES
Space communications to aircraft: A new development in international space law. I p 861 A87-51477
Satellites for air navigation - An airline view
p 820 A87-53580

AERONAUTICS
Acta aeronautica et astronautica sinica (selected articles)
[AD-A182447] p 802 N87-28500

AEROSPACE ENGINEERING
Application of artificial intelligence (AI) to aerospace manufacturing - A user perspective p 857 A87-53075

AEROSPACE SYSTEMS
Fiscal year 1988 technical objective document
[AD-A180311] p 861 N87-29364
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224

AEROSPACE VEHICLES
Fiscal year 1988 technical objective document
[AD-A180311] p 861 N87-29364

AEROTHERMODYNAMICS
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483
Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies
p 807 A87-52371
Aerothermodynamics of transatmospheric vehicles
p 807 A87-52878
The aerothermodynamic environment for holes in hypersonic configurations
[DE87-003790] p 814 N87-29414

AGING (METALLURGY)
Age forming aluminum in an autoclave
p 848 A87-52678
The effect of prestrain and of ageing at room temperature on the mechanical properties of an Al-Li-Cu-Mg alloy
p 842 A87-52683

AILERONS
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956

AIR DATA SYSTEMS
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497

AIR FILTERS
Hot corrosion site environment in gas turbines
p 830 A87-51353

AIR FLOW
User's manual for ADAM (Advanced Dynamic Airfoil Model)
[DE87-012342] p 813 N87-28524
Airflow calibration and exhaust pressure/temperature survey of an F404, S/N 215-109, turbofan engine
[NASA-TM-100159] p 834 N87-29537

AIR LAW
Aviation tort litigation against the United States - Judicial inroads on the pilot-in-command concept
p 861 A87-52171
Airline management prerogative in the deregulation era p 861 A87-52172
Civil liability concerning unlawful interference with civil aviation p 861 A87-52900

AIR NAVIGATION
Space-age navigation p 820 A87-51325
A comparison between integrated and separated navigation and flight control motion sensing equipment and a concept for aircraft motion sensing and attitude/heading determination p 828 A87-51941
Inertial-GPS - A marriage of convenience under test
p 820 A87-53578
Airborne navigation plots its future
p 821 A87-53800

AIR TRAFFIC
FAA (Federal Aviation Administration) air traffic activity FY 1986
[AD-A183624] p 802 N87-29407

AIR TRAFFIC CONTROL
Aviation tort litigation against the United States - Judicial inroads on the pilot-in-command concept
p 861 A87-52171
Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation --- conference
[DFVLR-MITT-86-24] p 821 N87-28530
Models for the description of holding procedures in air traffic as an aid for optimization with respect to safety and efficiency p 822 N87-28536
Models of the description of air traffic control scenarios, for the evaluation of future air traffic control systems
p 822 N87-28538
Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539
Systems evaluation procedure using simulation illustrated by the Computer Oriented Metering Planning and Advisory System (COMPAS) project
p 822 N87-28540
FAA (Federal Aviation Administration) air traffic activity FY 1986
[AD-A183624] p 802 N87-29407
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469

AIRBORNE EQUIPMENT
Experimental comparison of radiometric scales from laboratory standards and solar radiation
p 849 A87-53576

AIRBORNE SURVEILLANCE RADAR
Approach to study of PRF sensitivity in airborne pulse-Doppler radar p 829 A87-53802

AIRCRAFT ACCIDENT INVESTIGATION
Aircraft fires - Living through the smoke
p 818 A87-54315
Aircraft accident reports. Brief format, US civil and foreign aviation, issue number 2, 1986 accidents
[PB87-916904] p 818 N87-28528
Aircraft accident reports. Brief format, US civil and foreign aviation, issue number 3, 1986 accidents
[PB87-916905] p 819 N87-28529
Analysis of Convair 990 rejected-takeoff accident with emphasis on decision making, training and procedures
[NASA-TM-100189] p 819 N87-29471

AIRCRAFT ACCIDENTS
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060

AIRCRAFT ANTENNAS
Radiation resistance of thin antennas of arbitrary elevation and configuration over perfectly conducting ground p 848 A87-52189

AIRCRAFT COMMUNICATION
Aviation satcoms p 820 A87-51322
Space communications to aircraft: A new development in international space law. I p 861 A87-51477
Ground testing of an operational fighter aircraft for p-static discharge effects p 824 A87-52522

AIRCRAFT COMPARTMENTS
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949
Detection of in-flight propeller-induced structure-borne noise p 838 A87-53779
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783

AIRCRAFT CONFIGURATIONS
A contribution to the aerodynamics of unsymmetrical aircraft configurations
[ETN-87-90030] p 810 N87-28504
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-1] p 833 N87-28552
Advances in Guidance and Control Systems and Technology
[AGARD-CP-411] p 822 N87-29474

AIRCRAFT CONSTRUCTION MATERIALS
Design of high-temperature, ordered intermetallic alloys p 840 A87-51177
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft
p 841 A87-51792
Mechanical properties of rapidly solidified Al-4Be
p 842 A87-52658
Development of fine-grained 7075-O sheet for aircraft taper-rolled stringer p 842 A87-52661
The effect of prestrain and of ageing at room temperature on the mechanical properties of an Al-Li-Cu-Mg alloy
p 842 A87-52683
Practical application to composite materials of a portable digital ultrasound device controlled by a microprocessor
p 849 A87-53585
Advanced composite vertical fin for L-1011 aircraft
[NASA-CR-3816] p 845 N87-28617
Standard test evaluation of graphite fiber/resin matrix composite materials for improved toughness
[NASA-TM-86298] p 845 N87-28618
Study of utilization of advanced composites in fuselage structures of large transports
[NASA-CR-172404] p 845 N87-28619
Diffusion bonding of metals p 852 N87-29646

AIRCRAFT CONTROL
On design of restructurable control systems for aircraft with some failures p 835 A87-51981
Accelerometer placement in active flutter suppression systems p 828 A87-52963
An active control landing gear for the alleviation of aircraft taxi ground loads p 824 A87-53573
Head-up flying p 835 A87-53583
On the feasibility of low-speed aircraft maneuvers involving extreme angles of attack p 835 A87-54140
Simultaneous active controls on wind tunnel model
p 836 A87-54190
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367
A multichannel model for the description of the pilot in the closed control system, for the evaluation of future aircraft guidance systems p 822 N87-28537
Advances in Guidance and Control Systems and Technology
[AGARD-CP-411] p 822 N87-29474
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
Application of parameter estimation to aircraft stability and control: The output-error approach
[NASA-RP-1168] p 827 N87-29499
Automation at the man-machine interface
p 855 N87-29504
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099

AIRCRAFT DESIGN
Piaggio's Avanti combines jet-like handling with turboprop efficiency p 823 A87-51347

Around-the-world flight p 801 A87-53553
Multimission STOVL application of a hybrid powered-lift system p 824 A87-53776
Principles of the computer-aided design of aircraft --- Russian book p 858 A87-53957
Integrated Application of Active Controls (IAAC) technology to an advanced subsonic transport project: Test act system validation
[NASA-CR-172525] p 836 N87-28563
ACEE composite structures technology
[NASA-CR-172359] p 844 N87-28613
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
ACEE composite structures technology
[NASA-CR-172360] p 845 N87-28615
Study of utilization of advanced composites in fuselage structures of large transports
[NASA-CR-172404] p 845 N87-28619
An investigation of the flow characteristics in the blade endwall corner region
[NASA-CR-4076] p 814 N87-29412
Propfan test assessment testbed aircraft flutter model test report
[NASA-CR-179458] p 814 N87-29413
Bibliography for aircraft parameter estimation
[NASA-TM-86804] p 827 N87-29498

AIRCRAFT ENGINES
Static tests of the propulsion system --- Propfan Test Assessment program
[AIAA PAPER 87-1728] p 830 A87-52245
UHB demonstrator flight test program
[AIAA PAPER 87-1732] p 824 A87-52844
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962
Structural ceramics in heat engines - The NASA viewpoint p 842 A87-53352
Engine Structural Integrity Program (ENSIP) - A viewpoint based on experience p 831 A87-53424
Measurement of spectral emissivity of technical surfaces in high-performance engines p 832 A87-53575
Corsair with more - A-7 plus p 824 A87-53744
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823
Development and testing of highly loaded engine components made of carbon fiber reinforced plastics
[ETN-87-90036] p 832 N87-28550
High accuracy thrust measurement of aeronautical propulsion systems with particular consideration to a hydraulic force measuring device, part 1
[NASA-TT-20080] p 834 N87-28558
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842

AIRCRAFT EQUIPMENT
Satellites for air navigation - An airline view p 820 A87-53580
Lightweight 2 fiber aviation cable featuring low fiber stress levels
[AD-P005282] p 826 N87-29297
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 1
[AD-A183690] p 826 N87-29493
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 2
[AD-A183781] p 826 N87-29494

AIRCRAFT FUELS
A variable geometry combustor for broadened properties fuels
[AIAA PAPER 87-1832] p 830 A87-52246
Evaluation of naphthene rich turbine fuels as heat sinks for hypersonic aircraft
[AD-A182118] p 845 N87-28658

AIRCRAFT GUIDANCE
Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation --- conference
[DFVLR-MITT-86-24] p 821 N87-28530
A multichannel model for the description of the pilot in the closed control system, for the evaluation of future aircraft guidance systems p 822 N87-28537

AIRCRAFT HAZARDS
Prospects for destructive self-induced interactions in a vortex pair --- due to sinusoidal disturbances from large transport aircraft wakes p 809 A87-53778
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783
Aircraft fires - Living through the smoke p 818 A87-54315

AIRCRAFT INSTRUMENTS
Wind shear p 853 A87-51232
A comparison between integrated and separated navigation and flight control motion sensing equipment and a concept for aircraft motion sensing and attitude/heading determination p 828 A87-51941
Head-up flying p 835 A87-53583

AIRCRAFT LANDING
The problem of the aviation-meteorological prediction of strong surface winds in eastern Bulgaria p 853 A87-51195
Acta aeronautica et astronautica sinica (selected articles)
[AD-A182447] p 802 N87-28500
Anticipation of the landing shock phenomenon in flight simulation
[NASA-TM-89465] p 826 N87-29491
Langley Aircraft Landing Dynamics Facility
[NASA-RP-1189] p 839 N87-29544

AIRCRAFT MAINTENANCE
The 214ST drive system Lead-the-Fleet program --- inspections of component durability in helicopter engines p 801 A87-53414
Supportability model - Quantifies reliability and maintainability influence on cost --- of military aircraft p 801 A87-53415
Engine Structural Integrity Program (ENSIP) - A viewpoint based on experience p 831 A87-53424
Improved reliability and maintainability (RAM) in advanced technology engines p 831 A87-53426
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823
Prototype aircraft sustainability model
[AD-A183183] p 802 N87-29405

AIRCRAFT MANEUVERS
On the feasibility of low-speed aircraft maneuvers involving extreme angles of attack p 835 A87-54140
Singular trajectories in airplane cruise-dash optimization p 825 N87-28544

AIRCRAFT MODELS
Simulation and characteristic value determination in helicopters p 824 A87-53564
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system p 825 A87-53901
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191
An improved design technique for model following control systems in in-flight simulation
[DFVLR-FB-87-09] p 836 N87-28561
Trimming an aircraft model for flight simulation
[NASA-TM-89466] p 828 N87-29502

AIRCRAFT NOISE
Community reactions to helicopter noise - Results from an experimental study p 853 A87-52064
Scattering of sound by a semi-infinite elastic plate with a soft backing - A matrix Wiener-Hopf problem p 859 A87-52846
Doppler frequency shift in a refractive atmosphere p 859 A87-52876
Laboratory study of sidewall noise transmission and treatment for a light aircraft fuselage p 824 A87-52887
Detection of in-flight propeller-induced structure-borne noise p 838 A87-53779
Noise attenuation properties of headsets in a helicopter noise environment
[CAA-PAPER-87004] p 860 N87-29311
An experimental investigation of wing-tip turbulence and sound radiated from the tip region of a blunt-tipped airfoil p 818 N87-29466
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
Propfan test assessment propfan propulsion system static test report
[NASA-CR-179613] p 834 N87-29536

AIRCRAFT PARTS
Fatigue strength of 30KhGSN2A steel lugs under programmed loading p 843 A87-53441

AIRCRAFT PERFORMANCE
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962
Voyager crew faces turbulence, fatigue on world flight attempt p 801 A87-53552
Corsair with more - A-7 plus p 824 A87-53744
Canadair's CL-227 Sentinel gains credibility p 824 A87-53798
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545

AIRCRAFT PILOTS
In real time with a pilot in the loop p 857 A87-53066

AIRCRAFT PRODUCTION
Application of artificial intelligence (AI) to aerospace manufacturing - A user perspective p 857 A87-53075
Future impact of manufacturing technology and automation in Pratt & Whitney Canada p 849 A87-53416

AIRCRAFT RELIABILITY
The 214ST drive system Lead-the-Fleet program --- inspections of component durability in helicopter engines p 801 A87-53414
Supportability model - Quantifies reliability and maintainability influence on cost --- of military aircraft p 801 A87-53415
Improved reliability and maintainability (RAM) in advanced technology engines p 831 A87-53426
Preliminary airworthiness evaluation of the UH-1H helicopter with the T53-L-703 engine installed
[AD-A182369] p 825 N87-28541

AIRCRAFT SAFETY
Head-up flying p 835 A87-53583
Helicopter certification - New test techniques p 825 A87-54201
New methods and materials for molding and casting ice formations
[NASA-TM-100126] p 819 N87-29470

AIRCRAFT STABILITY
Investigation of F-16 control surface failures and optimal setting of functional controls
[AD-A182667] p 825 N87-28542
Application of parameter estimation to aircraft stability and control: The output-error approach
[NASA-RP-1168] p 827 N87-29499

AIRCRAFT STRUCTURES
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft p 841 A87-51792
Interactions between an aircraft structure and active control systems p 835 A87-52964
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives
[NASA-CASE-ARC-11425-2] p 844 N87-28605
A designers' guide to the achievement of electrical continuity in carbon fibre composite structures --- aircraft
[CD6500551] p 844 N87-28607
The ACEE program and basic composites research at Langley Research Center (1975 to 1986): Summary and bibliography
[NASA-RP-1177] p 846 N87-29612
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650

AIRCRAFT TIRES
Analysis of Convair 990 rejected-takeoff accident with emphasis on decision making, training and procedures
[NASA-TM-100189] p 819 N87-29471

AIRCRAFT WAKES
Prospects for destructive self-induced interactions in a vortex pair --- due to sinusoidal disturbances from large transport aircraft wakes p 809 A87-53778
Acta aeronautica et astronautica sinica (selected articles)
[AD-A182447] p 802 N87-28500

AIRDROPS
Parachute recovery systems design manual, chapter 5
[AD-A183191] p 816 N87-29426

AIRFOIL OSCILLATIONS
Near wake of an unsteady symmetric airfoil p 803 A87-51221
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777

AIRFOIL PROFILES
Profiling of a lifting convex wing by a hodograph method p 805 A87-51672
Manipulated turbulence structure in flight p 806 A87-52056
Applications of the titanium tetrachloride method for flow visualization in aerodynamic testing p 806 A87-52324
Analysis and design of airfoils and axisymmetric bodies in transonic nonuniform flow p 811 N87-28509
Acoustic effects on profile drag of a laminar flow airfoil
[NASA-TM-100505] p 860 N87-30155

AIRFOILS
Visualization of the laminar separation bubble on airfoils at low Reynolds numbers p 806 A87-52348
Leading- and trailing-edge flaps on a low Reynolds number airfoil p 808 A87-52886
Lift and pitching moment coefficient changes from low-level freestream turbulence p 808 A87-52888
Calculation of frictionless flow about airfoil wings and propellers by numerical solution of the Euler equations p 809 A87-53563
Effect of a round airfoil nose on leading-edge suction p 809 A87-53784
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations p 811 N87-28510

Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513
User's manual for ADAM (Advanced Dynamic Airfoil Model)
[DE87-012342] p 813 N87-28524
Experimental evaluation of corner turning vanes
[NASA-TM-100143] p 839 N87-28571
A numerical model for unsteady two-dimensional flow calculations with flow separation
[DE87-012316] p 850 N87-28866
An analysis of the crossover between local and massive separation on airfoils
[NASA-CR-4096] p 814 N87-29411
Transonic interference reduction by limited ventilation wall panels
[NASA-CR-175039] p 815 N87-29419

AIRFRAME MATERIALS
Aluminium-lithium alloys for helicopter structures
p 843 A87-53892
Dispersion strengthened alloys for aerospace
p 844 A87-53894
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224

AIRFRAMES
Piaggio's Avanti combines jet-like handling with turboprop efficiency p 823 A87-51347
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521

AIRLINE OPERATIONS
Aviation satcoms p 820 A87-51322
Aviation safety: Procedures for registering and certifying air carriers
[PB87-193249] p 819 N87-29468

AIRPORT PLANNING
The problems of the calculation of the capacity of flight operation surfaces of airports
[ILR-MITT-170] p 838 N87-28566

AIRPORTS
Pilot evaluation of population-minimal ground tracks in the airport community p 838 A87-52879
Modeling of radio navigation systems in the neighborhood of airports p 821 N87-28533
Pressuremeter moduli for airport pavement design and evaluation
[DOT/FAA/PM-87/10] p 839 N87-28572
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545
Calculation of noise around airports for powered gliders
[VTH-LR-475] p 860 N87-30150

AIRSPACE
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487

AIRSPEED
Singular trajectories in airplane cruise-dash optimization p 825 N87-28544

ALGORITHMS
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962
Full-potential modeling of blade-vortex interactions
p 817 N87-29465
Advances in Guidance and Control Systems and Technology
[AGARD-CP-411] p 822 N87-29474
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893
Small-scale rotor test rig capabilities for testing vibration alleviation algorithms
[NASA-TM-100002] p 858 N87-30102

ALLOYS
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869

ALTIMETRY
Airborne multibeam radar altimetry --- of oceans
p 853 A87-53115

ALUMINUM
Age forming aluminum in an autoclave
p 848 A87-52678

ALUMINUM ALLOYS
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
Mechanical properties of rapidly solidified Al-4Be
p 842 A87-52658
Development of fine-grained 7075-O sheet for aircraft taper-rolled stringer p 842 A87-52661
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
The effect of prestrain and of ageing at room temperature on the mechanical properties of an Al-Li-Cu-Mg alloy
p 842 A87-52683
Residual stresses in 2024-T81 aluminum using caustics and moire interferometry p 843 A87-53785
Aluminium-lithium alloys for helicopter structures
p 843 A87-53892
Development of aluminium-lithium alloys in the UK
p 843 A87-53893
Dispersion strengthened alloys for aerospace
p 844 A87-53894
Diffusion bonding of metals p 852 N87-29646
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650

ANGLE OF ATTACK
A three-dimensional boundary layer on blunt bodies with a porous surface at angles of attack and sideslip
p 803 A87-51007
A technique of holographic visualization to flow fields of a model with variable angles of attack
p 806 A87-52306
Rain effects at low Reynolds number
p 808 A87-52884
On the feasibility of low-speed aircraft maneuvers involving extreme angles of attack p 835 A87-54140
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497

ANGULAR DISTRIBUTION
The MLS angle receiver p 820 A87-51231

ANNULAR DUCTS
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539

ANNULAR NOZZLES
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315

ANTENNA DESIGN
Radiation resistance of thin antennas of arbitrary elevation and configuration over perfectly conducting ground p 848 A87-52189

ANTENNA RADIATION PATTERNS
Radiation resistance of thin antennas of arbitrary elevation and configuration over perfectly conducting ground p 848 A87-52189

ANTENNAS
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488

APPLICATIONS PROGRAMS (COMPUTERS)
Parachute systems technology: Fundamentals, concepts, and applications. Advanced parachute design
[DE87-011634] p 814 N87-29415
Application of a panel method to wake-vortex/wing interaction and comparison with experimental data
[NASA-TM-88337] p 817 N87-29461
Cost characteristics of tilt-rotor, conventional air and high speed rail short-haul intercity passenger service
[NASA-CR-181421] p 828 N87-29501
Some proposed enhancements to the NASA Langley 13-inch magnetic suspension and balance system
[NASA-CR-181152] p 839 N87-29543

APPROACH CONTROL
Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539

APPROACH INDICATORS
A simulator evaluation of alternative heliport approach lighting systems
[AIAA PAPER 87-2635] p 838 A87-52290

APPROXIMATION
An analysis of the approximation of the aerodynamic coefficients of thin bodies in a rarefied gas
p 808 A87-53526

ARCHITECTURE (COMPUTERS)
Integrated Application of Active Controls (IAAC) technology to an advanced subsonic transport project: Test act system validation
[NASA-CR-172525] p 836 N87-28563
The SIFT hardware/software systems. Volume 1: A detailed description
[NASA-TM-87574] p 858 N87-29186

ARMED FORCES (UNITED STATES)
Prototype aircraft sustainability model
[AD-A183183] p 802 N87-29405

ARTIFICIAL INTELLIGENCE
Problems associated with the integration of artificial intelligence into crew systems p 857 A87-53062
Application of artificial intelligence (AI) to aerospace manufacturing - A user perspective p 857 A87-53075
AI at Ames: Artificial Intelligence research and application at NASA Ames Research Center, Moffett Field, California, February 1985 p 858 N87-29140

ASPECT RATIO
Rain effects at low Reynolds number
p 808 A87-52884

ASTRONAUT TRAINING
Simulating Hermes p 840 A87-54195

ASTRONAUTICS
Acta aeronautica et astronautica sinica (selected articles)
[AD-A182447] p 802 N87-28500

ASYMMETRY
A contribution to the aerodynamics of unsymmetrical aircraft configurations
[ETN-87-90030] p 810 N87-28504

ASYMPTOTIC METHODS
Scattering of sound by a semi-infinite elastic plate with a soft backing - A matrix Wiener-Hopf problem
p 859 A87-52846

ATMOSPHERIC BOUNDARY LAYER
Determination of wind velocity and direction in the lower part of the atmospheric boundary layer on the basis of ground data p 854 A87-53969

ATMOSPHERIC REFRACTION
Doppler frequency shift in a refractive atmosphere
p 859 A87-52876

ATTITUDE (INCLINATION)
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532

ATTITUDE CONTROL
Jet spoiler as a yaw control device
p 835 A87-52880
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425

ATTITUDE INDICATORS
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051

AUTOCLAVES
Age forming aluminum in an autoclave
p 848 A87-52678

AUTOMATIC CONTROL
Automation at the man-machine interface
p 855 N87-29504

AUTOMATIC LANDING CONTROL
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079

AUTOMATIC PILOTS
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495

AUTOMATION
Future impact of manufacturing technology and automation in Pratt & Whitney Canada
p 849 A87-53416
Principles of the computer-aided design of aircraft --- Russian book p 858 A87-53957

AVIONICS
Wind shear p 853 A87-51232
A flight evaluation of voice interaction as a component of an integrated helicopter avionics system
[RAE-TM-FS(B)-637] p 829 N87-28547
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data
[RAE-TM-FS(B)-638] p 829 N87-28548
Advances in Guidance and Control Systems and Technology
[AGARD-CP-411] p 822 N87-29474
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
Configuration design of a helicopter integrated navigation system p 823 N87-29480
Navigation systems for the new generation of combat and transport helicopters and associated flight tests
p 823 N87-29481

AXISYMMETRIC BODIES
Analysis and design of airfoils and axisymmetric bodies in transonic nonuniform flow p 811 N87-28509
Program LRCDM2: Improved aerodynamic prediction program for supersonic canard-tail missiles with axisymmetric bodies
[NASA-CR-3883] p 813 N87-28525

AXISYMMETRIC FLOW
Enhanced mixing of an axisymmetric jet by aerodynamic excitation
[NASA-CR-175059] p 815 N87-29418

B

BACKWARD FACING STEPS
Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies p 807 A87-52371

BASE PRESSURE
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution [AD-A183531] p 816 N87-29428

BEARING (DIRECTION)
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes [AD-A183303] p 829 N87-29532

BEARINGS
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471
Advances and applications of Pyrowear 53 in helicopter transmission systems p 849 A87-53419

BENDING
Supersonic flow over elastic bodies in oscillation p 817 N87-29464

BENDING FATIGUE
Non-isothermal fatigue crack growth in Hastelloy-X p 840 A87-51400

BENDING MOMENTS
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782
Estimation of blade airloads from rotor blade bending moments [NASA-TM-100020] p 815 N87-29421

BERYLLIUM ALLOYS
Mechanical properties of rapidly solidified Al-4Be p 842 A87-52658

BIBLIOGRAPHIES
Bibliography for aircraft parameter estimation [NASA-TM-86804] p 827 N87-29498

BLACK BODY RADIATION
Measurement of spectral emissivity of technical surfaces in high-performance engines p 832 A87-53575

BLADE TIPS
Supersonic rotor noise calculation with sonic boom prediction methods p 860 A87-53903
Transonic rotor tip design using numerical optimization [NASA-TM-86771] p 816 N87-29431
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine [NASA-TM-100136] p 855 N87-29956

BLOWOUTS
Analysis of Convair 990 rejected-takeoff accident with emphasis on decision making, training and procedures [NASA-TM-100189] p 819 N87-29471

BLUFF BODIES
A new model of a self-controlled system --- cross-flow excited elastically suspended body vibration p 847 A87-51158

BLUNT BODIES
A three-dimensional boundary layer on blunt bodies with a porous surface at angles of attack and sideslip p 803 A87-51007
Three-dimensional flow around and radiative heating of blunt bodies p 804 A87-51653
Aerodynamics of 3-dimensional bodies in transitional flow [NASA-CR-181395] p 816 N87-29429

BODY-WING CONFIGURATIONS
Influence of forebody cross-sectional shape on wing vortex-burst location p 808 A87-52885

BOLTZMANN TRANSPORT EQUATION
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483

BORON FIBERS
Composites - What next p 841 A87-51807

BOUNDARY LAYER COMBUSTION
Status of holographic interferometry at Wright Patterson Air Force Base p 851 N87-29436

BOUNDARY LAYER CONTROL
Development of laminar flow control wing surface porous structure [NASA-CR-172424] p 802 N87-28502
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement [DFVLR-FB-86-59] p 810 N87-28506
An analysis of the crossover between local and massive separation on airfoils [NASA-CR-4096] p 814 N87-29411

BOUNDARY LAYER FLOW
Forced oscillations in a boundary layer at frequencies close to the upper branch of the neutral curve p 803 A87-50890
Status of holographic interferometry at Wright Patterson Air Force Base p 851 N87-29436

BOUNDARY LAYER SEPARATION
Visualization of the laminar separation bubble on airfoils at low Reynolds numbers p 806 A87-52348
Visualization of vortex breakdown on a delta wing p 807 A87-52357
A numerical model for unsteady two-dimensional flow calculations with flow separation [DE87-012316] p 850 N87-28866

BOUNDARY LAYER TRANSITION
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782

BOUNDARY VALUE PROBLEMS
Direct variational method in flight dynamics boundary value problems --- Russian book p 856 A87-52233
Development of supersonic computational aerodynamic program using panel method [NASA-TT-20113] p 813 N87-28526

BOW WAVES
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel p 837 A87-51968

BREATHING APPARATUS
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems [AD-A183731] p 856 N87-30072

BRITTLE MATERIALS
Composites - What next p 841 A87-51807

BURN-IN
Processor tradeoffs in distributed real-time systems p 857 A87-52796

BYPASS RATIO
UHB demonstrator flight test program [AIAA PAPER 87-1732] p 824 A87-52844

C

CABINS
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783

CALIBRATING
Airflow calibration and exhaust pressure/temperature survey of an F404, S/N 215-109, turbofan engine [NASA-TM-100159] p 834 N87-29537

CANARD CONFIGURATIONS
Piaggio's Avanti combines jet-like handling with turboprop efficiency p 823 A87-51347

CANCER
Combustion by-products on F-4 drogue parachutes [AD-A182929] p 819 N87-29472

CANOPIES
Parachute recovery systems design manual, chapter 5 [AD-A183191] p 816 N87-29426

CARBON FIBER REINFORCED PLASTICS
Development and testing of highly loaded engine components made of carbon fiber reinforced plastics [ETN-87-90036] p 832 N87-28550
The effect of load dwells on the fatigue of carbon fiber composites [BAE-MSM-R-GEN-0547] p 844 N87-28606
Nondestructive tests of Carbon Fiber Reinforced Plastics (CFRP) in the framework of damage mechanics investigations [DFVLR-MITT-86-09] p 851 N87-28923

CARBON FIBERS
Composites - What next p 841 A87-51807
A designers' guide to the achievement of electrical continuity in carbon fibre composite structures --- aircraft [CD6500551] p 844 N87-28607

CARBURIZING
Advances and applications of Pyrowear 53 in helicopter transmission systems p 849 A87-53419

CARRIER FREQUENCIES
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367

CASCADE FLOW
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
Calculation of noise caused by interaction of supersonic cascade and varied oncoming gust p 859 A87-51812
Processes in turbomachinery: Applications and exercises --- Romanian book p 808 A87-53412

CASE HISTORIES
Aviation tort litigation against the United States - Judicial inroads on the pilot-in-command concept p 861 A87-52171

CASTING
New methods and materials for molding and casting ice formations [NASA-TM-100126] p 819 N87-29470

CAUSES
Aircraft accident reports. Brief format, US civil and foreign aviation, issue number 3, 1986 accidents [PB87-916905] p 819 N87-28529

CAUSTICS (OPTICS)
Residual stresses in 2024-T81 aluminum using caustics and moire interferometry p 843 A87-53785

CAVITIES
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement [DFVLR-FB-86-59] p 810 N87-28506
The aerothermodynamic environment for holes in hypersonic configurations [DE87-003790] p 814 N87-29414

CENSUS
Census of US civil aircraft, calendar year 1986 [AD-A183423] p 802 N87-29406

CENTRIFUGES
A method for controlling a centrifuge cabin p 857 A87-52823

CERAMIC COATINGS
New ZrO2-Yb2O3 plasma-sprayed coatings for thermal barrier applications p 843 A87-53623

CERAMICS
Structural ceramics in heat engines - The NASA viewpoint p 842 A87-53352
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
Application of modern materials technologies in small gas turbine engines p 831 A87-53429

CERMETS
Dispersion strengthened alloys for aerospace p 844 A87-53894

CERTIFICATION
Helicopter certification - New test techniques p 825 A87-54201

CHEMICAL COMPOSITION
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
Development of aluminium-lithium alloys in the UK p 843 A87-53893

CHEMICAL LASERS
An approach to the numerical modeling of the dynamics of reacting gases in nozzles --- gasdynamic and chemical lasers p 847 A87-50872

CHEMICAL REACTIONS
Calculation of the aerodynamic coefficients of aircraft on a computer with allowance for physicochemical reactions p 803 A87-50876
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives [NASA-CASE-ARC-11425-2] p 844 N87-28605

CHROMIUM ALLOYS
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634

CHROMIUM STEELS
Fatigue strength of 30KhGSN2A steel lugs under programmed loading p 843 A87-53441

CIRCULAR CYLINDERS
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution [AD-A183531] p 816 N87-29428

CIVIL AVIATION
Aviation satcoms p 820 A87-51322
Airline management prerogative in the deregulation era p 861 A87-52172
Civil liability concerning unlawful interference with civil aviation p 861 A87-52900
The role of Navstar/GPS in civil aviation p 820 A87-53582
Aircraft accident reports. Brief format, US civil and foreign aviation, issue number 2, 1986 accidents [PB87-916904] p 818 N87-28528
General aviation aircraft utilization in the construction industry [AD-A183155] p 802 N87-29404
Census of US civil aircraft, calendar year 1986 [AD-A183423] p 802 N87-29406

CLOSE PACKED LATTICES
Alpha silicon carbide components for heat engine applications p 842 A87-53354

CLOUD PHYSICS
SPACE/COHMEX data inventory document [NASA-TM-4006] p 854 N87-29068

COAL
Combustion by-products on F-4 drogue parachutes [AD-A182929] p 819 N87-29472

COCKPIT SIMULATORS
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation [NASA-TP-2567] p 819 N87-29469

COCKPITS
Organization of displays in the visual space of the combat aircraft pilot p 856 N87-29516
Voice control of cockpit systems p 837 N87-29526

The flight evaluation of a speech recognition and a speech output system in an advanced cockpit display and flight management system for helicopters
p 829 N87-29527
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532

CODING
User's manual for ADAM (Advanced Dynamic Airfoil Model)
[DE87-012342] p 813 N87-28524

COGNITION
Sophisticated integral control methods for use in flight
p 856 N87-29510

COLOR
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data
[RAE-TM-FS(B)-638] p 829 N87-28548

COMBUSTIBLE FLOW
Holographic interferometry at Wright Aeronautical Laboratories p 851 N87-29435
Status of holographic interferometry at Wright Patterson Air Force Base p 851 N87-29436

COMBUSTION
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629

COMBUSTION CHAMBERS
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475
A variable geometry combustor for broadened properties fuels
[AIAA PAPER 87-1832] p 830 A87-52246
Flow visualization studies of transverse fuel injection patterns in a nonreacting Mach 2 combustor
p 807 A87-52386
A numerical study of flow in gas-turbine combustor
[AIAA PAPER 87-2132] p 832 A87-53986
Toward improved durability in advanced combustors and turbines: Progress in the prediction of thermomechanical loads
[NASA-TM-88932] p 832 N87-28551
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629

COMBUSTION CHEMISTRY
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483

COMBUSTION EFFICIENCY
Fuel effects on gas turbine combustion
p 830 A87-51474

COMMERCIAL AIRCRAFT
Piaggio's Avanti combines jet-like handling with turboprop efficiency p 823 A87-51347
Pilot evaluation of population-minimal ground tracks in the airport community p 838 A87-52879
Satellites for air navigation - An airline view
p 820 A87-53580
General aviation aircraft utilization in the construction industry
[AD-A183155] p 802 N87-29404
Aviation safety: Procedures for registering and certifying air carriers
[PB87-193249] p 819 N87-29468
A strategy for advancing tilt-rotor technology
[NASA-CR-181420] p 827 N87-29500

COMMUNICATION SATELLITES
Aviation satcoms p 820 A87-51322

COMPARISON
Advanced Propfan Engine Technology (APET) and single-rotation gearbox/pitch change mechanism
[NASA-CR-168113] p 833 N87-28553

COMPLEX SYSTEMS
Investigation of the life cycles of complex engineering systems using Petri nets p 857 A87-52832

COMPOSITE MATERIALS
Structural changes occurring in composite ring-disk flywheels under high speed rotation p 841 A87-51757
Composites - What next p 841 A87-51807
Application of modern materials technologies in small gas turbine engines p 831 A87-53429
Practical application to composite materials of a portable digital ultrasound device controlled by a microprocessor
p 849 A87-53585
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
Advanced composite vertical fin for L-1011 aircraft
[NASA-CR-3816] p 845 N87-28617
Study of utilization of advanced composites in fuselage structures of large transports
[NASA-CR-172404] p 845 N87-28619
The 737 graphite composite flight spoiler flight service evaluation
[NASA-CR-178322] p 846 N87-29609

COMPOSITE STRUCTURES
Around-the-world flight p 801 A87-53553
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543
A designers' guide to the achievement of electrical continuity in carbon fibre composite structures --- aircraft
[CD6500551] p 844 N87-28607
ACEE composite structures technology
[NASA-CR-172359] p 844 N87-28613
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604
The ACEE program and basic composites research at Langley Research Center (1975 to 1986): Summary and bibliography
[NASA-RP-1177] p 846 N87-29612
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224

COMPRESSIBLE FLOW
Numerical simulation of compressible homogeneous flows in the turbulent regime p 809 A87-54363
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile
[ETN-87-90038] p 810 N87-28505
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629

COMPRESSIBLE FLUIDS
Stochastic model theory of broadband shock associated noise from supersonic jets p 859 A87-52069

COMPRESSION LOADS
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604

COMPRESSOR BLADES
Thin film strain gage development program
[NASA-CR-174707] p 850 N87-28883

COMPRESSOR ROTORS
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809

COMPRESSORS
Compressors for advanced turboshaft engines
p 831 A87-53427

COMPUTATION
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893

COMPUTATIONAL FLUID DYNAMICS
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
Modified characteristic method for calculation of supersonic S2 flow field in compressor
p 804 A87-51473
Numerical modeling in aerohydrodynamics
p 804 A87-51651
The application of the method of streams to the numerical modeling of unsteady aerohydrodynamics problems p 804 A87-51654
Numerical modeling of supersonic muliphase flows
p 804 A87-51659
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
Calculation of three-dimensional supersonic flow past cone-like bodies with a separated shock wave
p 805 A87-51671
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
Finite element methods for incompressible viscous flow p 848 A87-52393
Processes in turbomachinery: Applications and exercises --- Romanian book p 808 A87-53412
A supersonic jet in a chamber with a diaphragm
p 808 A87-53520
Numerical aerodynamics using large computers
p 809 A87-53562
Calculation of frictionless flow about airfoil wings and propellers by numerical solution of the Euler equations
p 809 A87-53563
A numerical study of flow in gas-turbine combustor
[AIAA PAPER 87-2132] p 832 A87-53986
On the computation of transonic leading-edge vortices using the Euler equations p 809 A87-54361
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile
[ETN-87-90038] p 810 N87-28505
Theoretical evaluation of the aerodynamic performance of a transonic wing
[ONERA-20/3423-AY] p 810 N87-28507
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations
p 811 N87-28510
Implementation and validation of a wake model for low-speed forward flight
[NASA-CR-181341] p 811 N87-28514
Future Research on Transonic Unsteady Aerodynamics and Its Aeroelastic Applications
[AGARD-R-749] p 812 N87-28518
Development of supersonic computational aerodynamic program using panel method
[NASA-TT-20113] p 813 N87-28526
Some numerical calculations by using linear classical sonic theories approached from sub- or supersonic speeds
[NASA-TT-20112] p 813 N87-28527
Contribution to the description of rotating flow instabilities and inlet perturbations in axial flow compressors
[ETN-87-90040] p 850 N87-28845

COMPUTATIONAL GRIDS
Interaction of bodies with a nonuniform supersonic flow p 804 A87-51663
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835

COMPUTER AIDED DESIGN
Mathematical model partitioning and packing for parallel computer calculation p 856 A87-52534
Principles of the computer-aided design of aircraft --- Russian book p 858 A87-53957
NYANS: A package for time varying control systems --- computer aided design
[FOA-C-20642-2.1] p 858 N87-29174

COMPUTER AIDED MANUFACTURING
Future impact of manufacturing technology and automation in Pratt & Whitney Canada
p 849 A87-53416
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224

COMPUTER AIDED TOMOGRAPHY
Reconstruction of a three-dimensional, transonic rotor flow field from holographic interferogram data
p 817 N87-29445

COMPUTER GRAPHICS
Practical application to composite materials of a portable digital ultrasound device controlled by a microprocessor
p 849 A87-53585
Implementation and validation of a wake model for low-speed forward flight
[NASA-CR-181341] p 811 N87-28514

COMPUTER PROGRAMS
JPL multipolarization workstation - Hardware, software and examples of data analysis p 858 A87-53231
The design and analysis of simple low speed flap systems with the aid of linearized theory computer programs
[NASA-CR-3913] p 812 N87-28522
Program LRCDM2: Improved aerodynamic prediction program for supersonic canard-tail missiles with axisymmetric bodies
[NASA-CR-3883] p 813 N87-28525
Experimental techniques for three-axes load cells used at the National Full-Scale Aerodynamics Complex
[NASA-TM-86693] p 826 N87-28546
The SIFT hardware/software systems. Volume 1: A detailed description
[NASA-TM-87574] p 858 N87-29186

COMPUTER SYSTEMS PERFORMANCE
AI at Ames: Artificial Intelligence research and application at NASA Ames Research Center, Moffett Field, California, February 1985 p 858 N87-29140

COMPUTER SYSTEMS PROGRAMS
Infrared simulation model SENSAT-2
[DFVLR-FB-87-10] p 854 N87-28950

COMPUTER TECHNIQUES
Closing the man-machine loop: On the use of physiological measures to affect computer-controlled devices p 855 N87-29507
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842

COMPUTERIZED SIMULATION
An approach to the numerical modeling of the dynamics of reacting gases in nozzles --- gasdynamic and chemical lasers p 847 A87-50872
Calculation of the aerodynamic coefficients of aircraft on a computer with allowance for physicochemical reactions p 803 A87-50876
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962
Aerogasdynamics and its development at the Institute of Theoretical and Applied Mechanics of the Siberian Section of the Academy of Sciences of the USSR p 809 A87-53544
Simulation and characteristic value determination in helicopters p 824 A87-53564
Approach to study of PRF sensitivity in airborne pulse-Doppler radar p 829 A87-53802
COMPUTERS
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099
CONFERENCES
Conference on High-Temperature Corrosion of Superalloys, London, England, Feb 11, 12, 1986, Proceedings p 840 A87-51351
1986 IEEE International Symposium on Electromagnetic Compatibility, San Diego, CA, Sept. 16-18, 1986, Symposium Record p 848 A87-52517
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Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation --- conference
[DFVLR-MITT-86-24] p 821 N87-28530
ACEE composite structures technology
[NASA-CR-172359] p 844 N87-28613
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
ACEE composite structures technology
[NASA-CR-172360] p 845 N87-28615
Advances in Guidance and Control Systems and Technology
[AGARD-CP-411] p 822 N87-29474
CONFIGURATION MANAGEMENT
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099
CONICAL BODIES
Calculation of three-dimensional supersonic flow past cone-like bodies with a separated shock wave p 805 A87-51671
Development of supersonic computational aerodynamic program using panel method
[NASA-TT-20113] p 813 N87-28526
CONICAL NOZZLES
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
CONSTRUCTION INDUSTRY
General aviation aircraft utilization in the construction industry
[AD-A183155] p 802 N87-29404
CONTINUITY EQUATION
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
CONTROL CONFIGURED VEHICLES
Interactions between an aircraft structure and active control systems p 835 A87-52964
CONTROL STABILITY
On design of restructurable control systems for aircraft with some failures p 835 A87-51981
CONTROL SURFACES
Investigation of F-16 control surface failures and optimal setting of functional controls
[AD-A182667] p 825 N87-28542
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956
CONTROL SYSTEMS DESIGN
On design of restructurable control systems for aircraft with some failures p 835 A87-51981
Accelerometer placement in active flutter suppression systems p 828 A87-52963
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
Multi-variable control concepts for turboshaft engines p 832 A87-53431
An improved design technique for model following control systems in in-flight simulation
[DFVLR-FB-87-09] p 836 N87-28561
NYANS: A package for time varying control systems --- computer aided design
[FOA-C-20642-2.1] p 858 N87-29174
Control of shear flows by artificial excitation
[NASA-TM-100201] p 815 N87-29420
CONTROL THEORY
Integrated Application of Active Controls (IAAC) technology to an advanced subsonic transport project: Test act system validation
[NASA-CR-172525] p 836 N87-28563
NYANS: A package for time varying control systems --- computer aided design
[FOA-C-20642-2.1] p 858 N87-29174
Small-scale rotor test rig capabilities for testing vibration alleviation algorithms
[NASA-TM-100002] p 858 N87-30102
CONTROLLABILITY
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559
CONVECTION
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
CONVECTIVE HEAT TRANSFER
Control of the intensity of convective heat transfer in a Laval nozzle under conditions of turbulent flow and in the presence of local separation zones p 803 A87-50972
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
CONVEXITY
Profiling of a lifting convex wing by a hodograph method p 805 A87-51672
COOLING
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475
COPPER ALLOYS
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
CORNER FLOW
Experimental evaluation of corner turning vanes
[NASA-TM-100143] p 839 N87-28571
CORROSION RESISTANCE
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
Alpha silicon carbide components for heat engine applications p 842 A87-53354
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869
COST ANALYSIS
High accuracy thrust measurement of aeronautical propulsion systems with particular consideration to a hydraulic force measuring device, part 1
[NASA-TT-20080] p 834 N87-28558
Cost characteristics of tilt-rotor, conventional air and high speed rail short-haul intercity passenger service
[NASA-CR-181421] p 828 N87-29501
COST ESTIMATES
A strategy for advancing tilt-rotor technology
[NASA-CR-181420] p 827 N87-29500
COST REDUCTION
Reducing total cost of ownership - A challenge to helicopter propulsion specialists p 861 A87-53417
Application of modern materials technologies in small gas turbine engines p 831 A87-53429
COSTS
Supportability model - Quantifies reliability and maintainability influence on cost --- of military aircraft p 801 A87-53415
COUNTER-ROTATING WHEELS
Advanced Propfan Engine Technology (APET) definition study, single and counter-rotation gearbox/pitch change mechanism design
[NASA-CR-168115] p 833 N87-28554
CRACK PROPAGATION
Non-isothermal fatigue crack growth in Hastelloy-X p 840 A87-51400
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604
CRACKING (FRACTURING)
PTFE (polytetrafluoroethylene) resin selection for high performance wire and cable
[AD-P005211] p 846 N87-29227
CRASH LANDING
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783
CREEP RUPTURE STRENGTH
Mechanical properties of thick section AF2-1DA-6 powder metal turbine rotors p 841 A87-51648
CRITICAL TEMPERATURE
Computation of optimum turbofan mixing with a subaccurate varying specific heat solution p 830 A87-51808
CROSS FLOW
A new model of a self-controlled system --- cross-flow excited elastically suspended body vibration p 847 A87-51158
The problem of the aviation-meteorological prediction of strong surface winds in eastern Bulgaria p 853 A87-51195
CRUISING FLIGHT
Reducing fuel consumption of subsonic aircraft by optimal cyclic cruise p 824 A87-52881
Singular trajectories in airplane cruise-dash optimization p 825 N87-28544
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
CRYOGENIC WIND TUNNELS
Evolution, calibration, and operational characteristics of the two-dimensional test section of the Langley 0.3-meter transonic cryogenic tunnel
[NASA-TP-2749] p 839 N87-28570
CRYSTAL STRUCTURE
High-strength, high-temperature intermetallic compounds p 840 A87-51301
CURRENT DENSITY
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
CYLINDRICAL CHAMBERS
A supersonic jet in a chamber with a diaphragm p 808 A87-53520

D

DAMAGE
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
Nondestructive tests of Carbon Fiber Reinforced Plastics (CFRP) in the framework of damage mechanics investigations
[DFVLR-MITT-86-09] p 851 N87-28923
DAMAGE ASSESSMENT
ACEE composite structures technology
[NASA-CR-172359] p 844 N87-28613
DAMPERS
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471
DATA ACQUISITION
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
DATA MANAGEMENT
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
DATA PROCESSING
Some principles of parallel programming p 857 A87-53069
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367
DATA REDUCTION
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545
DECELERATION
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559
DECISION MAKING
Closing the man-machine loop: On the use of physiological measures to affect computer-controlled devices p 855 N87-29507
DEFENSE PROGRAM
Fiscal year 1988 technical objective document
[AD-A180311] p 861 N87-29364
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224
DEGREES OF FREEDOM
Experimental aeroelastic behavior of forward-swept graphite/epoxy wings with rigid-body freedom p 824 A87-53781
DEICERS
Electro-expulsive separation system
[NASA-CASE-ARC-11613-1] p 849 N87-28833
DEICING
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191

DELTA WINGS
Characteristics of separated flow past a delta wing p 805 A87-51669
Visualization of vortex breakdown on a delta wing p 807 A87-52357
Influence of forebody cross-sectional shape on wing vortex-burst location p 808 A87-52885
On the computation of transonic leading-edge vortices using the Euler equations p 809 A87-54361
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
Calculation of pressure distributions on supersonic delta wings using stagnation solutions
[VTH-LR-484] p 815 N87-29417
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425
The structure of leading edge vortex flows including vortex breakdown p 818 N87-29467
DESIGN ANALYSIS
Principles of the computer-aided design of aircraft --- Russian book p 858 A87-53957
Analysis and design of airfoils and axisymmetric bodies in transonic nonuniform flow p 811 N87-28509
The design and analysis of simple low speed flap systems with the aid of linearized theory computer programs
[NASA-CR-3913] p 812 N87-28522
Advanced composite vertical fin for L-1011 aircraft
[NASA-CR-3816] p 845 N87-28617
Parachute systems technology: Fundamentals, concepts, and applications. Advanced parachute design
[DE87-011634] p 814 N87-29415
DESIGN TO COST
LHTEC - Meeting the LHX cost challence p 801 A87-53425
DETECTION
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531
DIAPHRAGMS (MECHANICS)
A supersonic jet in a chamber with a diaphragm p 808 A87-53520
DIESEL ENGINES
Compound cycle engine program p 831 A87-53428
DIFFUSION FLAMES
Vortex-scalar element calculations of a diffusion flame stabilized on a plane mixing layer
[NASA-TM-100133] p 802 N87-28501
DIFFUSION WELDING
Diffusion bonding of metals p 852 N87-29646
DIGITAL COMMAND SYSTEMS
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
DIGITAL SIMULATION
Numerical simulation of compressible homogeneous flows in the turbulent regime p 809 A87-54363
DIGITAL SYSTEMS
Application of a sensitivity analysis technique to high-order digital flight control systems
[NASA-CR-179429] p 837 N87-28565
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
DIGITAL TECHNIQUES
Application of digital interferogram evaluation techniques to the measurement of 3-D flow fields p 851 N87-29451
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452
DIPOLE MOMENTS
Radiation resistance of thin antennas of arbitrary elevation and configuration over perfectly conducting ground p 848 A87-52189
DISKS (SHAPES)
Structural changes occurring in composite ring-disk flywheels under high speed rotation p 841 A87-51757
DISPLAY DEVICES
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data
[RAE-TM-FS(B)-638] p 829 N87-28548
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469
An assessment of variable format information presentation p 861 N87-29512
Organization of displays in the visual space of the combat aircraft pilot p 856 N87-29516
The flight evaluation of a speech recognition and a speech output system in an advanced cockpit display and flight management system for helicopters p 829 N87-29527
DISTRIBUTED PROCESSING
Processor tradeoffs in distributed real-time systems p 857 A87-52796
DOPPLER EFFECT
Doppler frequency shift in a refractive atmosphere p 859 A87-52876
DOPPLER NAVIGATION
Modeling of the fault situation in navigation systems p 821 N87-28534
DOPPLER RADAR
Approach to study of PRF sensitivity in airborne pulse-Doppler radar p 829 A87-53802
Preliminary Memphis FAA (Federal Aviation Administration)/Lincoln Laboratory operational weather studies results
[AD-A182730] p 854 N87-29057
DOWNWASH
Implementation and validation of a wake model for low-speed forward flight
[NASA-CR-181341] p 811 N87-28514
DRAG
Acoustic effects on profile drag of a laminar flow airfoil
[NASA-TM-100505] p 860 N87-30155
DRAG CHUTES
Combustion by-products on F-4 drogue parachutes
[AD-A182929] p 819 N87-29472
DRAG COEFFICIENTS
Wave drag analysis of realistic fighter aircraft using a full-potential method p 807 A87-52882
DRAG REDUCTION
Manipulated turbulence structure in flight p 806 A87-52056
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement
[DFVLR-FB-86-59] p 810 N87-28506
Analysis and design of airfoils and axisymmetric bodies in transonic nonuniform flow p 811 N87-28509
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422
DROP SIZE
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
DURABILITY
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
DWELL
The effect of load dwells on the fatigue of carbon fiber composites
[BAE-MSM-R-GEN-0547] p 844 N87-28606
DYNAMIC CHARACTERISTICS
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
DYNAMIC CONTROL
Optimization of the controlled rotations of a rigid body with an elastic rod using first integrals of a free system p 859 A87-50915
DYNAMIC LOADS
Langley Aircraft Landing Dynamics Facility
[NASA-RP-1189] p 839 N87-29544
DYNAMIC MODELS
Dynamics of a high-speed rotor touching a boundary p 848 A87-51614
Dynamic positioning using GPS carrier phase measurements p 820 A87-52765
User's manual for ADAM (Advanced Dynamic Airfoil Model)
[DE87-012342] p 813 N87-28524
DYNAMIC RESPONSE
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555
DYNAMIC STABILITY
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543
Rotor dynamics test facility
[ONERA-RT-20/3239-RY-054R-0] p 839 N87-28567
DYNAMIC STRUCTURAL ANALYSIS
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780
DYNAMIC TESTS
The measurement of oscillatory pressures with discrete and sweep excitation p 837 A87-51213

E

EAR PROTECTORS
Noise attenuation properties of headsets in a helicopter noise environment
[CAA-PAPER-87004] p 860 N87-29311
ELASTIC BARS
Optimization of the controlled rotations of a rigid body with an elastic rod using first integrals of a free system p 859 A87-50915
ELASTIC PLATES
Scattering of sound by a semi-infinite elastic plate with a soft backing - A matrix Wiener-Hopf problem p 859 A87-52846
ELASTOMERS
Electro-expulsive separation system
[NASA-CASE-ARC-11613-1] p 849 N87-28833
ELECTRIC CURRENT
Electro-expulsive separation system
[NASA-CASE-ARC-11613-1] p 849 N87-28833
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
ELECTRIC DISCHARGES
Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge p 806 A87-52322
Ground testing of an operational fighter aircraft for p-static discharge effects p 824 A87-52522
ELECTRIC WIRE
PTFE (polytetrafluoroethylene) resin selection for high performance wire and cable
[AD-P005211] p 846 N87-29227
ELECTRICAL MEASUREMENT
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
ELECTRICAL PROPERTIES
A designers' guide to the achievement of electrical continuity in carbon fibre composite structures --- aircraft
[CD6500551] p 844 N87-28607
ELECTROMAGNETIC COMPATIBILITY
1986 IEEE International Symposium on Electromagnetic Compatibility, San Diego, CA, Sept. 16-18, 1986, Symposium Record p 848 A87-52517
ELECTROMECHANICAL DEVICES
Electro-expulsive separation system
[NASA-CASE-ARC-11613-1] p 849 N87-28833
ENGINE CONTROL
Multi-variable control concepts for turboshaft engines p 832 A87-53431
ENGINE DESIGN
Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers p 801 A87-53413
Design and development of a high contact ratio helicopter transmission utilizing self-aligning bearingless planetary (SABP) p 849 A87-53418
T406-AD-400 full-scale development p 831 A87-53423
Engine Structural Integrity Program (ENSIP) - A viewpoint based on experience p 831 A87-53424
LHTEC - Meeting the LHX cost challence p 801 A87-53425
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
ENGINE INLETS
Acoustic mode measurements in the inlet of a turbofan engine p 859 A87-52877
ENGINE NOISE
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539
ENGINE PARTS
Structural ceramics in heat engines - The NASA viewpoint p 842 A87-53352
Alpha silicon carbide components for heat engine applications p 842 A87-53354
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823
Development and testing of highly loaded engine components made of carbon fiber reinforced plastics
[ETN-87-90036] p 832 N87-28550
ENGINE TESTS
Self-excited oscillations in jet engine test cells p 859 A87-51215

Static tests of the propulsion system --- Propfan Test Assessment program
[AIAA PAPER 87-1728] p 830 A87-52245
The 214ST drive system Lead-the-Fleet program --- inspections of component durability in helicopter engines
p 801 A87-53414
Smoke emission tests on series 2 and series 3 Allison T56 turboprop engines
[AD-A182385] p 832 N87-28549
Measurement uncertainty for the Uniform Engine Testing Program conducted at NASA Lewis Research Center
[NASA-TM-88943] p 833 N87-28557

ENTHALPY
Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies
p 807 A87-52371

ENVIRONMENTAL TESTS
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616

ENVIRONMENTS
The 737 graphite composite flight spoiler flight service evaluation
[NASA-CR-178322] p 846 N87-29609

EQUATIONS OF MOTION
Stochastic model theory of broadband shock associated noise from supersonic jets p 859 A87-52069

EROSION
A design system for erosion tolerant helicopter engines p 831 A87-53430

ERROR ANALYSIS
Simulation of strapdown systems for error analysis, and modeling for navigation with other sensor systems
p 821 N87-28535
Measurement uncertainty for the Uniform Engine Testing Program conducted at NASA Lewis Research Center
[NASA-TM-88943] p 833 N87-28557
Velocity accuracy measurement of GPS user equipment p 822 N87-29477

ESTIMATES
Estimation of blade airloads from rotor blade bending moments
[NASA-TM-100020] p 815 N87-29421
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893

EULER EQUATIONS OF MOTION
The application of the method of streams to the numerical modeling of unsteady aerohydrodynamics problems p 804 A87-51654
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890
Calculation of frictionless flow about airfoil wings and propellers by numerical solution of the Euler equations
p 809 A87-53563
On the computation of transonic leading-edge vortices using the Euler equations p 809 A87-54361
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations
p 811 N87-28510

EVALUATION
Systems evaluation procedure using simulation illustrated by the Computer Oriented Metering Planning and Advisory System (COMPAS) project
p 822 N87-28540
The 737 graphite composite flight spoiler flight service evaluation
[NASA-CR-178322] p 846 N87-29609
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956

EVOLUTION (DEVELOPMENT)
Evolution, calibration, and operational characteristics of the two-dimensional test section of the Langley 0.3-meter transonic cryogenic tunnel
[NASA-TP-2749] p 839 N87-28570

EXHAUST EMISSION
Smoke emission tests on series 2 and series 3 Allison T56 turboprop engines
[AD-A182385] p 832 N87-28549

EXHAUST GASES
Airflow calibration and exhaust pressure/temperature survey of an F404, S/N 215-109, turbofan engine
[NASA-TM-100159] p 834 N87-29537

EXPERT SYSTEMS
Problems associated with the integration of artificial intelligence into crew systems p 857 A87-53062
In real time with a pilot in the loop
p 857 A87-53066
Application of artificial intelligence (AI) to aerospace manufacturing - A user perspective p 857 A87-53075

EXPULSION
Electro-expulsive separation system
[NASA-CASE-ARC-11613-1] p 849 N87-28833

EYE MOVEMENTS
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115

F

F-16 AIRCRAFT
Investigation of F-16 control surface failures and optimal setting of functional controls
[AD-A182667] p 825 N87-28542

FABRICATION
Advanced composite vertical fin for L-1011 aircraft
[NASA-CR-3816] p 845 N87-28617

FAILURE ANALYSIS
On design of restructurable control systems for aircraft with some failures p 835 A87-51981
Integrated Application of Active Controls (IAAC) technology to an advanced subsonic transport project: Test act system validation
[NASA-CR-172525] p 836 N87-28563
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604

FAILURE MODES
Structural changes occurring in composite ring-disk flywheels under high speed rotation p 841 A87-51757
Advances and applications of Pyrowear 53 in helicopter transmission systems p 849 A87-53419

FAIRINGS
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422

FAR FIELDS
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308

FATIGUE (MATERIALS)
The effect of load dwells on the fatigue of carbon fiber composites
[BAE-MSM-R-GEN-0547] p 844 N87-28606

FATIGUE TESTS
Non-isothermal fatigue crack growth in Hastelloy-X
p 840 A87-51400
Fatigue strength of 30KhGSN2A steel lugs under programmed loading p 843 A87-53441
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316

FAULT TOLERANCE
A design system for erosion tolerant helicopter engines p 831 A87-53430
The SIFT hardware/software systems. Volume 1: A detailed description
[NASA-TM-87574] p 858 N87-29186
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099

FEASIBILITY ANALYSIS
Development of a reduced area horizontal tail for a wide body jet aircraft
[NASA-CR-172278] p 837 N87-28564

FEEDBACK CONTROL
Processor tradeoffs in distributed real-time systems
p 857 A87-52796
Time-scale synthesis of a closed-loop discrete optimal control system p 857 A87-52960
Multi-variable control concepts for turboshaft engines
p 832 A87-53431
Application of a sensitivity analysis technique to high-order digital flight control systems
[NASA-CR-179429] p 837 N87-28565

FIBER OPTICS
Lightweight 2 fiber aviation cable featuring low fiber stress levels
[AD-P005282] p 826 N87-29297

FICKS EQUATION
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483

FIGHTER AIRCRAFT
Ground testing of an operational fighter aircraft for p-static discharge effects p 824 A87-52522
Wave drag analysis of realistic fighter aircraft using a full-potential method p 807 A87-52882
Interactions between an aircraft structure and active control systems p 835 A87-52964
In real time with a pilot in the loop
p 857 A87-53066
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 1
[AD-A183690] p 826 N87-29493

FILAMENT WINDING
Structural changes occurring in composite ring-disk flywheels under high speed rotation p 841 A87-51757

FILM COOLING
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475

FINITE ELEMENT METHOD
A two-dimensional finite element stress analysis of radial impellers p 847 A87-51472
Finite element methods for incompressible viscous flow p 848 A87-52393

FINS
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft
p 841 A87-51792
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
Advanced composite vertical fin for L-1011 aircraft
[NASA-CR-3816] p 845 N87-28617

FIRES
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783
Aircraft fires - Living through the smoke
p 818 A87-54315

FLAME PROPAGATION
Vortex-scalar element calculations of a diffusion flame stabilized on a plane mixing layer
[NASA-TM-100133] p 802 N87-28501

FLAME RETARDANTS
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives
[NASA-CASE-ARC-11425-2] p 844 N87-28605

FLAPS (CONTROL SURFACES)
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
Effect of dynamic stall on helicopter trim and flap-lag response p 835 A87-54139

FLAT PLATES
An investigation of the flow characteristics in the blade endwall corner region
[NASA-CR-4076] p 814 N87-29412

FLAT SURFACES
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503

FLEXIBILITY
Supersonic flow over elastic bodies in oscillation
p 817 N87-29464

FLEXIBLE BODIES
Interactions between an aircraft structure and active control systems p 835 A87-52964
Acta aeronautica et astronautica sinica (selected articles)
[AD-A182447] p 802 N87-28500
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893

FLIGHT CHARACTERISTICS
Pitot and static errors due to non-steady flight
[ESDU-85011] p 813 N87-29410

FLIGHT CONDITIONS
Voyager crew faces turbulence, fatigue on world flight attempt p 801 A87-53552

FLIGHT CONTROL
Piaggio's Avanti combines jet-like handling with turboprop efficiency p 823 A87-51347
A comparison between integrated and separated navigation and flight control motion sensing equipment and a concept for aircraft motion sensing and attitude/heading determination p 828 A87-51941
Time-scale synthesis of a closed-loop discrete optimal control system p 857 A87-52960
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559
Application of a sensitivity analysis technique to high-order digital flight control systems
[NASA-CR-179429] p 837 N87-28565

The SIFT hardware/software systems. Volume 1: A detailed description
[NASA-TM-87574] p 858 N87-29186
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495
Sophisticated integral control methods for use in flight
p 856 N87-29510

FLIGHT CREWS
Problems associated with the integration of artificial intelligence into crew systems p 857 A87-53062
Noise attenuation properties of headsets in a helicopter noise environment
[CAA-PAPER-87004] p 860 N87-29311

FLIGHT FATIGUE
Voyager crew faces turbulence, fatigue on world flight attempt p 801 A87-53552

FLIGHT HAZARDS
Wind shear p 853 A87-51232
Prospects for destructive self-induced interactions in a vortex pair --- due to sinusoidal disturbances from large transport aircraft wakes p 809 A87-53778
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060

FLIGHT MANAGEMENT SYSTEMS
A flight evaluation of voice interaction as a component of an integrated helicopter avionics system
[RAE-TM-FS(B)-637] p 829 N87-28547
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data
[RAE-TM-FS(B)-638] p 829 N87-28548
The flight evaluation of a speech recognition and a speech output system in an advanced cockpit display and flight management system for helicopters
p 829 N87-29527

FLIGHT MECHANICS
Direct variational method in flight dynamics boundary value problems --- Russian book p 856 A87-52233

FLIGHT OPERATIONS
The problems of the calculation of the capacity of flight operation surfaces of airports
[ILR-MITT-170] p 838 N87-28566
Sophisticated integral control methods for use in flight
p 856 N87-29510

FLIGHT OPTIMIZATION
Reducing fuel consumption of subsonic aircraft by optimal cyclic cruise p 824 A87-52881
Singular trajectories in airplane cruise-dash optimization p 825 N87-28544

FLIGHT PATHS
Pilot evaluation of population-minimal ground tracks in the airport community p 838 A87-52879

FLIGHT PLANS
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488

FLIGHT SAFETY
Models for the description of holding procedures in air traffic as an aid for optimization with respect to safety and efficiency p 822 N87-28536
Aviation safety: Procedures for registering and certifying air carriers
[PB87-193249] p 819 N87-29468

FLIGHT SIMULATION
A simulator evaluation of alternative heliport approach lighting systems
[AIAA PAPER 87-2635] p 838 A87-52290
A method for controlling a centrifuge cabin
p 857 A87-52823
Simulating Hermes p 840 A87-54195
An improved design technique for model following control systems in in-flight simulation
[DFVLR-FB-87-09] p 836 N87-28561
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
Anticipation of the landing shock phenomenon in flight simulation
[NASA-TM-89465] p 826 N87-29491

FLIGHT SIMULATORS
Pilot evaluation of population-minimal ground tracks in the airport community p 838 A87-52879
Trimming an aircraft model for flight simulation
[NASA-TM-89466] p 828 N87-29502

FLIGHT TEST INSTRUMENTS
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495

FLIGHT TESTS
Manipulated turbulence structure in flight
p 806 A87-52056
UHB demonstrator flight test program
[AIAA PAPER 87-1732] p 824 A87-52844
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
Helicopter certification - New test techniques
p 825 A87-54201
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367
Preliminary airworthiness evaluation of the UH-1H helicopter with the T53-L-703 engine installed
[AD-A182369] p 825 N87-28541
A flight evaluation of voice interaction as a component of an integrated helicopter avionics system
[RAE-TM-FS(B)-637] p 829 N87-28547
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data
[RAE-TM-FS(B)-638] p 829 N87-28548
Parachute systems technology: Fundamentals, concepts, and applications. Advanced parachute design
[DE87-011634] p 814 N87-29415
Parachute systems technology: Fundamentals, concepts, and applications
[DE87-011722] p 815 N87-29416
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495
Bibliography for aircraft parameter estimation
[NASA-TM-86804] p 827 N87-29498
Application of parameter estimation to aircraft stability and control: The output-error approach
[NASA-RP-1168] p 827 N87-29499
Trimming an aircraft model for flight simulation
[NASA-TM-89466] p 828 N87-29502
The 737 graphite composite flight spoiler flight service evaluation
[NASA-CR-178322] p 846 N87-29609

FLOW CHARACTERISTICS
Characteristics of separated flow past a delta wing
p 805 A87-51669
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370
An investigation of the flow characteristics in the blade endwall corner region
[NASA-CR-4076] p 814 N87-29412

FLOW COEFFICIENTS
Investigation of F-16 control surface failures and optimal setting of functional controls
[AD-A182667] p 825 N87-28542

FLOW DEFLECTION
A three-dimensional boundary layer on blunt bodies with a porous surface at angles of attack and sideslip
p 803 A87-51007
Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge
p 806 A87-52322
Applications of the titanium tetrachloride method for flow visualization in aerodynamic testing p 806 A87-52324
Investigation of F-16 control surface failures and optimal setting of functional controls
[AD-A182667] p 825 N87-28542
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425

FLOW DISTORTION
An experimental investigation of the effect of inlet flow distortion on compressor performance
p 805 A87-51813
Contribution to the description of rotating flow instabilities and inlet perturbations in axial flow compressors
[ETN-87-90040] p 850 N87-28845

FLOW DISTRIBUTION
Moving shock waves in transonic flows
p 806 A87-52304
A technique of holographic visualization to flow fields of a model with variable angles of attack
p 806 A87-52306
Visualization of vortex breakdown on a delta wing
p 807 A87-52357
The flow field in the second throat region of a wind tunnel, computed by an Euler method
p 809 A87-53574
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
Control of shear flows by artificial excitation
[NASA-TM-100201] p 815 N87-29420
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
Reconstruction of a three-dimensional, transonic rotor flow field from holographic interferogram data
p 817 N87-29445
Application of digital interferogram evaluation techniques to the measurement of 3-D flow fields
p 851 N87-29451
KC-135 aero-optical turbulent boundary layer/shear layer experiment revisited p 852 N87-29454
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497

FLOW EQUATIONS
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile
[ETN-87-90038] p 810 N87-28505
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations
p 811 N87-28510
Comparison between 2D transonic flutter calculations in the time and frequency domain p 812 N87-28520

FLOW GEOMETRY
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
Flow visualization studies of transverse fuel injection patterns in a nonreacting Mach 2 combustor
p 807 A87-52386
A reconsideration of the three-shock theory for a pseudo-steady Mach reflection p 810 A87-54364

FLOW MEASUREMENT
Measurement of swirling flow field using the single slanted hot-wire technique p 847 A87-51469
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement
[DFVLR-FB-86-59] p 810 N87-28506
Transonic rotor flow-measurement technique using holographic interferometry p 851 N87-29434
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452

FLOW STABILITY
Forced oscillations in a boundary layer at frequencies close to the upper branch of the neutral curve
p 803 A87-50890
Contribution to the description of rotating flow instabilities and inlet perturbations in axial flow compressors
[ETN-87-90040] p 850 N87-28845

FLOW THEORY
Supersonic and transonic supersonic flow
[MPIS-16/1986] p 811 N87-28508

FLOW VELOCITY
Application of particle imaging velocimetry in windtunnels p 848 A87-52314
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution
[AD-A183531] p 816 N87-29428

FLOW VISUALIZATION
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
A technique of holographic visualization to flow fields of a model with variable angles of attack
p 806 A87-52306
Application of particle imaging velocimetry in windtunnels p 848 A87-52314
Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge
p 806 A87-52322
Applications of the titanium tetrachloride method for flow visualization in aerodynamic testing p 806 A87-52324
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
Visualization of the laminar separation bubble on airfoils at low Reynolds numbers p 806 A87-52348
Visualization of vortex breakdown on a delta wing
p 807 A87-52357
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
Supersonic vortex rings - Visualization techniques
p 807 A87-52360
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370

Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies
p 807 A87-52371
Flow visualization studies of transverse fuel injection patterns in a nonreacting Mach 2 combustor
p 807 A87-52386
Holographic interferometry at Wright Aeronautical Laboratories p 851 N87-29435
Optical interferometry in fluid dynamics research
p 851 N87-29447
The structure of leading edge vortex flows including vortex breakdown p 818 N87-29467
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629

FLUID DYNAMICS
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629

FLUTTER
Accelerometer placement in active flutter suppression systems p 828 A87-52963
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543

FLUTTER ANALYSIS
Unsteady test method applied to wind tunnel studies of flutter p 838 A87-54189
Future Research on Transonic Unsteady Aerodynamics and Its Aeroelastic Applications
[AGARD-R-749] p 812 N87-28518
Comparison between 2D transonic flutter calculations in the time and frequency domain p 812 N87-28520

FLY BY WIRE CONTROL
The model inverse as an element of a predetermined control system for helicopters p 836 N87-28532

FLYWHEELS
Structural changes occurring in composite ring-disk flywheels under high speed rotation p 841 A87-51757

FORCED VIBRATION
Forced oscillations in a boundary layer at frequencies close to the upper branch of the neutral curve
p 803 A87-50890

FOREBODIES
Influence of forebody cross-sectional shape on wing vortex-burst location p 808 A87-52885

FORMAT
An assessment of variable format information presentation p 861 N87-29512

FRACTURE MECHANICS
Nondestructive tests of Carbon Fiber Reinforced Plastics (CFRP) in the framework of damage mechanics investigations
[DFVLR-MITT-86-09] p 851 N87-28923

FREQUENCY SHIFT
Doppler frequency shift in a refractive atmosphere
p 859 A87-52876

FUEL CONSUMPTION
Reducing fuel consumption of subsonic aircraft by optimal cyclic cruise p 824 A87-52881
Singular trajectories in airplane cruise-dash optimization p 825 N87-28544
Development of a reduced area horizontal tail for a wide body jet aircraft
[NASA-CR-172278] p 837 N87-28564

FUEL INJECTION
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
Flow visualization studies of transverse fuel injection patterns in a nonreacting Mach 2 combustor
p 807 A87-52386

FUEL SPRAYS
Fuel effects on gas turbine combustion
p 830 A87-51474

FUEL SYSTEMS
Hot corrosion site environment in gas turbines
p 830 A87-51353

FUEL TANKS
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 1
[AD-A183690] p 826 N87-29493

FUEL TESTS
Fuel effects on gas turbine combustion
p 830 A87-51474

FULL SCALE TESTS
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780

FUSELAGES
Development of fine-grained 7075-O sheet for aircraft taper-rolled stringer p 842 A87-52661
Laboratory study of sidewall noise transmission and treatment for a light aircraft fuselage
p 824 A87-52887
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system
p 825 A87-53901
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555
ACEE composite structures technology
[NASA-CR-172359] p 844 N87-28613
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
Standard test evaluation of graphite fiber/resin matrix composite materials for improved toughness
[NASA-TM-86298] p 845 N87-28618
Study of utilization of advanced composites in fuselage structures of large transports
[NASA-CR-172404] p 845 N87-28619

G

GAS DENSITY
Pulsation structure of the mixing layer of underexpanded jets p 847 A87-50974

GAS DYNAMICS
Aerogasdynamics and its development at the Institute of Theoretical and Applied Mechanics of the Siberian Section of the Academy of Sciences of the USSR
p 809 A87-53544

GAS GENERATORS
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 1
[AD-A183690] p 826 N87-29493
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 2
[AD-A183781] p 826 N87-29494

GAS TURBINE ENGINES
Measurement of swirling flow field using the single slanted hot-wire technique p 847 A87-51469
Fuel effects on gas turbine combustion
p 830 A87-51474
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475
Military aircraft 4-cSt gas turbine engine oil development p 841 A87-52403
Improved reliability and maintainability (RAM) in advanced technology engines p 831 A87-53426
Application of modern materials technologies in small gas turbine engines p 831 A87-53429
A numerical study of flow in gas-turbine combustor
[AIAA PAPER 87-2132] p 832 A87-53986

GAS TURBINES
Conference on High-Temperature Corrosion of Superalloys, London, England, Feb 11, 12, 1986, Proceedings p 840 A87-51351
Hot corrosion site environment in gas turbines
p 830 A87-51353
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842

GASDYNAMIC LASERS
An approach to the numerical modeling of the dynamics of reacting gases in nozzles --- gasdynamic and chemical lasers p 847 A87-50872

GASEOUS DIFFUSION
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483

GEAR TEETH
Design and development of a high contact ratio helicopter transmission utilizing self-aligning bearingless planetary (SABP) p 849 A87-53418
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420

GEARS
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-1] p 833 N87-28552
Advanced Propfan Engine Technology (APET) and single-rotation gearbox/pitch change mechanism
[NASA-CR-168113] p 833 N87-28553
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-2] p 833 N87-28556

GENERAL AVIATION AIRCRAFT
General aviation aircraft utilization in the construction industry
[AD-A183155] p 802 N87-29404
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462

GEODETIC ACCURACY
Dynamic positioning using GPS carrier phase measurements p 820 A87-52765

GLIDERS
Calculation of noise around airports for powered gliders
[VTH-LR-475] p 860 N87-30150

GLOBAL POSITIONING SYSTEM
Space-age navigation p 820 A87-51325
Dynamic positioning using GPS carrier phase measurements p 820 A87-52765
Inertial-GPS - A marriage of convenience under test
p 820 A87-53578
The Navstar/GPS program - An evolution or a revolution in the world of navigation p 840 A87-53581
The role of Navstar/GPS in civil aviation
p 820 A87-53582
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367
Velocity accuracy measurement of GPS user equipment p 822 N87-29477
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488

GOVERNMENT PROCUREMENT
LHTEC - Meeting the LHX cost challenge
p 801 A87-53425

GRAPHITE-EPOXY COMPOSITES
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft
p 841 A87-51792
Experimental aeroelastic behavior of forward-swept graphite/epoxy wings with rigid-body freedom
p 824 A87-53781
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316
The 737 graphite composite flight spoiler flight service evaluation
[NASA-CR-178322] p 846 N87-29609

GRASSLANDS
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985
p 853 A87-53206

GROUND BASED CONTROL
Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539

GROUND STATIONS
The MLS angle receiver p 820 A87-51231

GROUND TESTS
Ground testing of an operational fighter aircraft for p-static discharge effects p 824 A87-52522
Experimental techniques for three-axes load cells used at the National Full-Scale Aerodynamics Complex
[NASA-TM-86693] p 826 N87-28546

GROUND TRACKS
Pilot evaluation of population-minimal ground tracks in the airport community p 838 A87-52879

GROUND TRUTH
Aircraft microwave radiometry of land
p 853 A87-53269
Determination of wind velocity and direction in the lower part of the atmospheric boundary layer on the basis of ground data p 854 A87-53969

GROUND WIND
Wind shear p 853 A87-51232

GUIDANCE SENSORS
Advances in Guidance and Control Systems and Technology
[AGARD-CP-411] p 822 N87-29474

GUSTS
Calculation of noise caused by interaction of supersonic cascade and varied oncoming gust p 859 A87-51812
Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513
Preliminary Memphis FAA (Federal Aviation Administration)/Lincoln Laboratory operational weather studies results
[AD-A182730] p 854 N87-29057

GYROSCOPIC PENDULUMS
Dynamics of a high-speed rotor touching a boundary
p 848 A87-51614

GYROSTABILIZERS
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051

H

HANDBOOKS
A designers' guide to the achievement of electrical continuity in carbon fibre composite structures --- aircraft
[CD6500551] p 844 N87-28607

HARDWARE
The SIFT hardware/software systems. Volume 1: A detailed description
[NASA-TM-87574] p 858 N87-29186

HARMONIC CONTROL
Small-scale rotor test rig capabilities for testing vibration alleviation algorithms
[NASA-TM-100002] p 858 N87-30102

HARMONICS
Supersonic flow over elastic bodies in oscillation
p 817 N87-29464
HASTELLOY (TRADEMARK)
Non-isothermal fatigue crack growth in Hastelloy-X
p 840 A87-51400
HEAD-UP DISPLAYS
Head-up flying p 835 A87-53583
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532
HEAT RESISTANT ALLOYS
Design of high-temperature, ordered intermetallic alloys p 840 A87-51177
Conference on High-Temperature Corrosion of Superalloys, London, England, Feb 11, 12, 1986, Proceedings p 840 A87-51351
Dispersion strengthened alloys for aerospace
p 844 A87-53894
Toward improved durability in advanced combustors and turbines: Progress in the prediction of thermomechanical loads
[NASA-TM-88932] p 832 N87-28551
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650
HEAT SHIELDING
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
HEAT SINKS
Evaluation of naphthene rich turbine fuels as heat sinks for hypersonic aircraft
[AD-A182118] p 845 N87-28658
HEAT TRANSFER
Toward improved durability in advanced combustors and turbines: Progress in the prediction of thermomechanical loads
[NASA-TM-88932] p 832 N87-28551
HEAT TRANSFER COEFFICIENTS
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
HEAT TREATMENT
Mechanical properties of thick section AF2-1DA-6 powder metal turbine rotors p 841 A87-51648
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
HELICOPTER CONTROL
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
The model inverse as an element of a predetermined control system for helicopters p 836 N87-28532
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559
The flight evaluation of a speech recognition and a speech output system in an advanced cockpit display and flight management system for helicopters
p 829 N87-29527
HELICOPTER DESIGN
Simulation and characteristic value determination in helicopters p 824 A87-53564
Aluminium-lithium alloys for helicopter structures
p 843 A87-53892
Configuration design of a helicopter integrated navigation system p 823 N87-29480
Navigation systems for the new generation of combat and transport helicopters and associated flight tests
p 823 N87-29481
HELICOPTER ENGINES
Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers p 801 A87-53413
The 214ST drive system Lead-the-Fleet program --- inspections of component durability in helicopter engines
p 801 A87-53414
Reducing total cost of ownership - A challenge to helicopter propulsion specialists p 861 A87-53417
Design and development of a high contact ratio helicopter transmission utilizing self-aligning bearingless planetary (SABP) p 849 A87-53418
Advances and applications of Pyrowear 53 in helicopter transmission systems p 849 A87-53419
LHTEC - Meeting the LHX cost challenge
p 801 A87-53425
Compressors for advanced turboshaft engines
p 831 A87-53427
Compound cycle engine program p 831 A87-53428
A design system for erosion tolerant helicopter engines p 831 A87-53430
Preliminary airworthiness evaluation of the UH-1H helicopter with the T53-L-703 engine installed
[AD-A182369] p 825 N87-28541
HELICOPTER PERFORMANCE
Helicopter certification - New test techniques
p 825 A87-54201
HELICOPTER WAKES
The prediction of the vibratory airloads of helicopter rotors in forward flight p 823 A87-51214
HELICOPTERS
Community reactions to helicopter noise - Results from an experimental study p 853 A87-52064
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
Compound cycle engine program p 831 A87-53428
Preliminary airworthiness evaluation of the UH-1H helicopter with the T53-L-703 engine installed
[AD-A182369] p 825 N87-28541
A flight evaluation of voice interaction as a component of an integrated helicopter avionics system
[RAE-TM-FS(B)-637] p 829 N87-28547
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data
[RAE-TM-FS(B)-638] p 829 N87-28548
Rotor dynamics test facility
[ONERA-RT-20/3239-RY-054R-0] p 839 N87-28567
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115
Noise attenuation properties of headsets in a helicopter noise environment
[CAA-PAPER-87004] p 860 N87-29311
General aviation aircraft utilization in the construction industry
[AD-A183155] p 802 N87-29404
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488
Trimming an aircraft model for flight simulation
[NASA-TM-89466] p 828 N87-29502
HELIPORTS
A simulator evaluation of alternative heliport approach lighting systems
[AIAA PAPER 87-2635] p 838 A87-52290
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
HERMES MANNED SPACEPLANE
Simulating Hermes p 840 A87-54195
HEXAGONAL CELLS
Alpha silicon carbide components for heat engine applications p 842 A87-53354
HIGH FREQUENCIES
Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513
HIGH REYNOLDS NUMBER
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution
[AD-A183531] p 816 N87-29428
HIGH STRENGTH ALLOYS
Dispersion strengthened alloys for aerospace
p 844 A87-53894
HINGES
The results of a wind tunnel investigation of a model rotor with a free tip
[NASA-TM-86758] p 827 N87-29496
HISTORIES
Evolution, calibration, and operational characteristics of the two-dimensional test section of the Langley 0.3-meter transonic cryogenic tunnel
[NASA-TP-2749] p 839 N87-28570
HODOGRAPHS
Profiling of a lifting convex wing by a hodograph method p 805 A87-51672
HOLDING
Models for the description of holding procedures in air traffic as an aid for optimization with respect to safety and efficiency p 822 N87-28536
HOLE GEOMETRY (MECHANICS)
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604
HOLOGRAPHIC INTERFEROMETRY
A technique of holographic visualization to flow fields of a model with variable angles of attack
p 806 A87-52306
Transonic rotor flow-measurement technique using holographic interferometry p 851 N87-29434
Holographic interferometry at Wright Aeronautical Laboratories p 851 N87-29435
Status of holographic interferometry at Wright Patterson Air Force Base p 851 N87-29436
Reconstruction of a three-dimensional, transonic rotor flow field from holographic interferogram data
p 817 N87-29445
Optical interferometry in fluid dynamics research
p 851 N87-29447
Application of digital interferogram evaluation techniques to the measurement of 3-D flow fields
p 851 N87-29451
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452
HORIZON
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051
HORIZONTAL FLIGHT
The prediction of the vibratory airloads of helicopter rotors in forward flight p 823 A87-51214
HORIZONTAL ORIENTATION
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051
HOT CORROSION
Conference on High-Temperature Corrosion of Superalloys, London, England, Feb 11, 12, 1986, Proceedings p 840 A87-51351
Hot corrosion site environment in gas turbines
p 830 A87-51353
HOT ISOSTATIC PRESSING
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
HOT-WIRE ANEMOMETERS
Measurement of swirling flow field using the single slanted hot-wire technique p 847 A87-51469
HOVERING
Transonic rotor flow-measurement technique using holographic interferometry p 851 N87-29434
HOVERING STABILITY
Toward comparing experiment and theory for corroborative research on hingeless rotor stability in forward flight
[NASA-CR-181354] p 836 N87-28562
HUBS
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422
HUMAN FACTORS ENGINEERING
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532
HUMAN PERFORMANCE
Sophisticated integral control methods for use in flight
p 856 N87-29510
An assessment of variable format information presentation p 861 N87-29512
HUMAN REACTIONS
Community reactions to helicopter noise - Results from an experimental study p 853 A87-52064
HYDROCARBON FUEL PRODUCTION
Evaluation of naphthene rich turbine fuels as heat sinks for hypersonic aircraft
[AD-A182118] p 845 N87-28658
HYDRODYNAMICS
Numerical modeling in aerohydrodynamics
p 804 A87-51651
HYPERSONIC AIRCRAFT
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
Evaluation of naphthene rich turbine fuels as heat sinks for hypersonic aircraft
[AD-A182118] p 845 N87-28658
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
HYPERSONIC BOUNDARY LAYER
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
HYPERSONIC FLIGHT
Evaluation of naphthene rich turbine fuels as heat sinks for hypersonic aircraft
[AD-A182118] p 845 N87-28658
HYPERSONIC FLOW
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies
p 807 A87-52371
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
The aerothermodynamic environment for holes in hypersonic configurations
[DE87-003790] p 814 N87-29414
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427

HYPERSONIC REENTRY
Three-dimensional flow around and radiative heating of blunt bodies p 804 A87-51653
HYPERSONIC VEHICLES
Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge p 806 A87-52322
Aerothermodynamics of transatmospheric vehicles p 807 A87-52878

I

ICE FORMATION
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191
New methods and materials for molding and casting ice formations
[NASA-TM-100126] p 819 N87-29470
IDEAL GAS
A reconsideration of the three-shock theory for a pseudo-steady Mach reflection p 810 A87-54364
IMAGE PROCESSING
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
JPL multipolarization workstation - Hardware, software and examples of data analysis p 858 A87-53231
Application of digital interferogram evaluation techniques to the measurement of 3-D flow fields p 851 N87-29451
IMPACT
Dynamics of a high-speed rotor touching a boundary p 848 A87-51614
IMPACT DAMAGE
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316
IMPACT TESTS
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780
IMPELLERS
A two-dimensional finite element stress analysis of radial impellers p 847 A87-51472
IN-FLIGHT MONITORING
Detection of in-flight propeller-induced structure-borne noise p 838 A87-53779
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115
INCOMPATIBILITY
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072
INCOMPRESSIBLE FLOW
Finite element methods for incompressible viscous flow p 848 A87-52393
Solution of the Volterra integral equation in the problem of the unsteady motion of a thin wing p 808 A87-53522
INCOMPRESSIBLE FLUIDS
Forced oscillations in a boundary layer at frequencies close to the upper branch of the neutral curve p 803 A87-50890
INERTIAL GUIDANCE
Navigation systems for the new generation of combat and transport helicopters and associated flight tests p 823 N87-29481
INERTIAL NAVIGATION
Inertial-GPS - A marriage of convenience under test p 820 A87-53578
Airborne navigation plots its future p 821 A87-53800
Modeling of the fault situation in navigation systems p 821 N87-28534
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
INERTIAL PLATFORMS
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531
INFORMATION DISSEMINATION
A strategy for advancing tilt-rotor technology
[NASA-CR-181420] p 827 N87-29500
INFORMATION PROCESSING (BIOLOGY)
Sophisticated integral control methods for use in flight p 856 N87-29510
An assessment of variable format information presentation p 861 N87-29512
INFRARED INSTRUMENTS
Infrared simulation model SENSAT-2
[DFVLR-FB-87-10] p 854 N87-28950
INFRARED RADAR
Aircraft microwave radiometry of land p 853 A87-53269
INLET FLOW
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
An experimental investigation of the effect of inlet flow distortion on compressor performance p 805 A87-51813
The flow field in the second throat region of a wind tunnel, computed by an Euler method p 809 A87-53574
Contribution to the description of rotating flow instabilities and inlet perturbations in axial flow compressors
[ETN-87-90040] p 850 N87-28845
INLET PRESSURE
An experimental investigation of the effect of inlet flow distortion on compressor performance p 805 A87-51813
INSPECTION
Aviation safety: Procedures for registering and certifying air carriers
[PB87-193249] p 819 N87-29468
INSTRUMENT APPROACH
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
INSTRUMENT ORIENTATION
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051
INSTRUMENTS
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
INTERACTIONAL AERODYNAMICS
Calculation of noise caused by interaction of supersonic cascade and varied oncoming gust p 859 A87-51812
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777
Prospects for destructive self-induced interactions in a vortex pair --- due to sinusoidal disturbances from large transport aircraft wakes p 809 A87-53778
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
INTERMETALLICS
Design of high-temperature, ordered intermetallic alloys p 840 A87-51177
High-strength, high-temperature intermetallic compounds p 840 A87-51301
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224
INTERNATIONAL RELATIONS
Civil liability concerning unlawful interference with civil aviation p 861 A87-52900
INVENTORIES
Prototype aircraft sustainability model
[AD-A183183] p 802 N87-29405
INVISCID FLOW
Computation of optimum turbofan mixing with a subaccurate varying specific heat solution p 830 A87-51808
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile
[ETN-87-90038] p 810 N87-28505
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations p 811 N87-28510
An analysis of the crossover between local and massive separation on airfoils
[NASA-CR-4096] p 814 N87-29411
IRON ALLOYS
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
ISOLATION
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531
ITERATIVE SOLUTION
A numerical study of flow in gas-turbine combustor
[AIAA PAPER 87-2132] p 832 A87-53986

J

JET AIRCRAFT
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469
JET AIRCRAFT NOISE
Acoustic mode measurements in the inlet of a turbofan engine p 859 A87-52877
JET ENGINES
Self-excited oscillations in jet engine test cells p 859 A87-51215
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471
Measurement of spectral emissivity of technical surfaces in high-performance engines p 832 A87-53575
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224
JET FLOW
Jet spoiler as a yaw control device p 835 A87-52880
JET IMPINGEMENT
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
JET MIXING FLOW
Pulsation structure of the mixing layer of underexpanded jets p 847 A87-50974
Flow visualization studies of transverse fuel injection patterns in a nonreacting Mach 2 combustor p 807 A87-52386

K

KNUDSEN FLOW
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880

L

L-1011 AIRCRAFT
Development of a reduced area horizontal tail for a wide body jet aircraft
[NASA-CR-172278] p 837 N87-28564
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
Advanced composite vertical fin for L-1011 aircraft
[NASA-CR-3816] p 845 N87-28617
LABOR
Airline management prerogative in the deregulation era p 861 A87-52172
LAMINAR BOUNDARY LAYER
Flow energizers. Task A
[NASA-CR-176202] p 812 N87-28523
LAMINAR FLOW
Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge p 806 A87-52322
Visualization of the laminar separation bubble on airfoils at low Reynolds numbers p 806 A87-52348
Acoustic effects on profile drag of a laminar flow airfoil
[NASA-TM-100505] p 860 N87-30155
LAMINATES
Structural changes occurring in composite ring-disk flywheels under high speed rotation p 841 A87-51757
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316
LANDING GEAR
An active control landing gear for the alleviation of aircraft taxi ground loads p 824 A87-53573
Analysis of Convair 990 rejected-takeoff accident with emphasis on decision making, training and procedures
[NASA-TM-100189] p 819 N87-29471
Langley Aircraft Landing Dynamics Facility
[NASA-RP-1189] p 839 N87-29544
LANDING LOADS
Anticipation of the landing shock phenomenon in flight simulation
[NASA-TM-89465] p 826 N87-29491
LANDING SIMULATION
Modeling of radio navigation systems in the neighborhood of airports p 821 N87-28533

LANDING SITES
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545
LASER ANEMOMETERS
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
LASER APPLICATIONS
Holographic interferometry at Wright Aeronautical Laboratories p 851 N87-29435
Advances in Guidance and Control Systems and Technology
[AGARD-CP-411] p 822 N87-29474
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051
LASER DOPPLER VELOCIMETERS
Optical interferometry in fluid dynamics research p 851 N87-29447
LASER PROPULSION
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224
LEADING EDGE FLAPS
Leading- and trailing-edge flaps on a low Reynolds number airfoil p 808 A87-52886
LEADING EDGES
Effect of a round airfoil nose on leading-edge suction p 809 A87-53784
On the computation of transonic leading-edge vortices using the Euler equations p 809 A87-54361
Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425
The structure of leading edge vortex flows including vortex breakdown p 818 N87-29467
LEGAL LIABILITY
Aviation tort litigation against the United States - Judicial inroads on the pilot-in-command concept p 861 A87-52171
Civil liability concerning unlawful interference with civil aviation p 861 A87-52900
LICENSING
Aviation safety: Procedures for registering and certifying air carriers
[PB87-193249] p 819 N87-29468
LIFE (DURABILITY)
Toward improved durability in advanced combustors and turbines: Progress in the prediction of thermomechanical loads
[NASA-TM-88932] p 832 N87-28551
LIFE CYCLE COSTS
Processor tradeoffs in distributed real-time systems p 857 A87-52796
Investigation of the life cycles of complex engineering systems using Petri nets p 857 A87-52832
LIFT
Lift and pitching moment coefficient changes from low-level freestream turbulence p 808 A87-52888
LIFTING BODIES
Profiling of a lifting convex wing by a hodograph method p 805 A87-51672
Aerodynamics of 3-dimensional bodies in transitional flow
[NASA-CR-181395] p 816 N87-29429
LIGHT AIRCRAFT
Laboratory study of sidewall noise transmission and treatment for a light aircraft fuselage p 824 A87-52887
Voyager crew faces turbulence, fatigue on world flight attempt p 801 A87-53552
Around-the-world flight p 801 A87-53553
Once around the earth without refueling p 801 A87-54252
LIGHTNING
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
LINEAR QUADRATIC GAUSSIAN CONTROL
Multi-variable control concepts for turboshaft engines p 832 A87-53431
NYANS: A package for time varying control systems --- computer aided design
[FOA-C-20642-2.1] p 858 N87-29174
LINEAR SYSTEMS
The design and analysis of simple low speed flap systems with the aid of linearized theory computer programs
[NASA-CR-3913] p 812 N87-28522
LITHIUM ALLOYS
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
Aluminium-lithium alloys for helicopter structures p 843 A87-53892
Development of aluminium-lithium alloys in the UK p 843 A87-53893
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650
LOAD TESTS
The effect of load dwells on the fatigue of carbon fiber composites
[BAE-MSM-R-GEN-0547] p 844 N87-28606
LOW ASPECT RATIO
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
LOW DENSITY MATERIALS
Aluminium-lithium alloys for helicopter structures p 843 A87-53892
Dispersion strengthened alloys for aerospace p 844 A87-53894
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650
LOW FREQUENCIES
Radiation resistance of thin antennas of arbitrary elevation and configuration over perfectly conducting ground p 848 A87-52189
LOW REYNOLDS NUMBER
Visualization of the laminar separation bubble on airfoils at low Reynolds numbers p 806 A87-52348
Rain effects at low Reynolds number p 808 A87-52884
Leading- and trailing-edge flaps on a low Reynolds number airfoil p 808 A87-52886
LOW SPEED
On the feasibility of low-speed aircraft maneuvers involving extreme angles of attack p 835 A87-54140
The design and analysis of simple low speed flap systems with the aid of linearized theory computer programs
[NASA-CR-3913] p 812 N87-28522
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
LOW SPEED STABILITY
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543
LOW SPEED WIND TUNNELS
PSI multitransducer in low-velocity wind tunnel in Braunschweig p 838 A87-53569
LOW TURBULENCE
Lift and pitching moment coefficient changes from low-level freestream turbulence p 808 A87-52888
LUBRICATING OILS
Military aircraft 4-cSt gas turbine engine oil development p 841 A87-52403
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
LUGS
Fatigue strength of 30KhGSN2A steel lugs under programmed loading p 843 A87-53441

M

MACH REFLECTION
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370
A reconsideration of the three-shock theory for a pseudo-steady Mach reflection p 810 A87-54364
MACH-ZEHNDER INTERFEROMETERS
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452
MAGNESIUM ALLOYS
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
MAGNETIC FIELDS
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
MAGNETIC SUSPENSION
Some proposed enhancements to the NASA Langley 13-inch magnetic suspension and balance system
[NASA-CR-181152] p 839 N87-29543
MAGNUS EFFECT
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880
MAINTAINABILITY
Supportability model - Quantifies reliability and maintainability influence on cost --- of military aircraft p 801 A87-53415
MAN ENVIRONMENT INTERACTIONS
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949
MAN MACHINE SYSTEMS
Problems associated with the integration of artificial intelligence into crew systems p 857 A87-53062
In real time with a pilot in the loop p 857 A87-53066
Application of artificial intelligence (AI) to aerospace manufacturing - A user perspective p 857 A87-53075
A multichannel model for the description of the pilot in the closed control system, for the evaluation of future aircraft guidance systems p 822 N87-28537
A flight evaluation of voice interaction as a component of an integrated helicopter avionics system
[RAE-TM-FS(B)-637] p 829 N87-28547
Automation at the man-machine interface p 855 N87-29504
Closing the man-machine loop: On the use of physiological measures to affect computer-controlled devices p 855 N87-29507
Sophisticated integral control methods for use in flight p 856 N87-29510
MANAGEMENT PLANNING
Airline management prerogative in the deregulation era p 861 A87-52172
MANEUVERABILITY
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495
MANEUVERS
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072
MANUFACTURING
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives
[NASA-CASE-ARC-11425-2] p 844 N87-28605
MARINE ENVIRONMENTS
Hot corrosion site environment in gas turbines p 830 A87-51353
MASS FLOW
A supersonic jet in a chamber with a diaphragm p 808 A87-53520
MATHEMATICAL MODELS
An approach to the numerical modeling of the dynamics of reacting gases in nozzles --- gasdynamic and chemical lasers p 847 A87-50872
Implementation and validation of a wake model for low-speed forward flight
[NASA-CR-181341] p 811 N87-28514
Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation --- conference
[DFVLR-MITT-86-24] p 821 N87-28530
Role and task of models as tools for research and development p 821 N87-28531
The model inverse as an element of a predetermined control system for helicopters p 836 N87-28532
Modeling of radio navigation systems in the neighborhood of airports p 821 N87-28533
Modeling of the fault situation in navigation systems p 821 N87-28534
Simulation of strapdown systems for error analysis, and modeling for navigation with other sensor systems p 821 N87-28535
Models for the description of holding procedures in air traffic as an aid for optimization with respect to safety and efficiency p 822 N87-28536
A multichannel model for the description of the pilot in the closed control system, for the evaluation of future aircraft guidance systems p 822 N87-28537
Models of the description of air traffic control scenarios, for the evaluation of future air traffic control systems p 822 N87-28538
Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
Full-potential modeling of blade-vortex interactions p 817 N87-29465
An experimental investigation of wing-tip turbulence and sound radiated from the tip region of a blunt-tipped airfoil p 818 N87-29466
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604
MATRICES (MATHEMATICS)
Solution of aerodynamic integral equations without matrix inversion p 808 A87-52889
MAXIMUM LIKELIHOOD ESTIMATES
Bibliography for aircraft parameter estimation
[NASA-TM-86804] p 827 N87-29498
MEASURING INSTRUMENTS
Measurement uncertainty for the Uniform Engine Testing Program conducted at NASA Lewis Research Center
[NASA-TM-88943] p 833 N87-28557
MECHANICAL DRIVES
The 214ST drive system Lead-the-Fleet program --- inspections of component durability in helicopter engines p 801 A87-53414
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420

MECHANICAL ENGINEERING
Some proposed enhancements to the NASA Langley 13-inch magnetic suspension and balance system
[NASA-CR-181152] p 839 N87-29543
MECHANICAL PROPERTIES
High-strength, high-temperature intermetallic compounds p 840 A87-51301
Mechanical properties of thick section AF2-1DA-6 powder metal turbine rotors p 841 A87-51648
Mechanical properties of rapidly solidified Al-4Be p 842 A87-52658
The effect of prestrain and of ageing at room temperature on the mechanical properties of an Al-Li-Cu-Mg alloy p 842 A87-52683
MELTING POINTS
High-strength, high-temperature intermetallic compounds p 840 A87-51301
MESOSCALE PHENOMENA
Weather Research Program
[PB87-196390] p 854 N87-29065
METAL FATIGUE
Fatigue of gas turbine blades under random vibrations p 832 A87-53442
METAL MATRIX COMPOSITES
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224
METAL POWDER
Mechanical properties of thick section AF2-1DA-6 powder metal turbine rotors p 841 A87-51648
METAL SHEETS
Development of fine-grained 7075-O sheet for aircraft taper-rolled stringer p 842 A87-52661
METAL-METAL BONDING
Diffusion bonding of metals p 852 N87-29646
METEOROLOGICAL RADAR
Preliminary Memphis FAA (Federal Aviation Administration)/Lincoln Laboratory operational weather studies results
[AD-A182730] p 854 N87-29057
METEOROLOGICAL SATELLITES
SPACE/COHMEX data inventory document
[NASA-TM-4006] p 854 N87-29068
METHOD OF CHARACTERISTICS
Modified characteristic method for calculation of supersonic S2 flow field in compressor p 804 A87-51473
MICROBURSTS
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060
MICROCLIMATOLOGY
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949
MICROPROCESSORS
Practical application to composite materials of a portable digital ultrasound device controlled by a microprocessor p 849 A87-53585
MICROSTRUCTURE
Design of high-temperature, ordered intermetallic alloys p 840 A87-51177
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
MICROWAVE LANDING SYSTEMS
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
MICROWAVE RADIOMETERS
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985 p 853 A87-53206
Aircraft microwave radiometry of land p 853 A87-53269
MICROWAVE SOUNDING
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985 p 853 A87-53206
MILITARY AIRCRAFT
Military aircraft 4-cSt gas turbine engine oil development p 841 A87-52403
Problems associated with the integration of artificial intelligence into crew systems p 857 A87-53062
Supportability model - Quantifies reliability and maintainability influence on cost — of military aircraft p 801 A87-53415
Improved reliability and maintainability (RAM) in advanced technology engines p 831 A87-53426
Multimission STOVL application of a hybrid powered-lift system p 824 A87-53776
Canadair's CL-227 Sentinel gains credibility p 824 A87-53798
MILITARY HELICOPTERS
LHTEC - Meeting the LHX cost challenge p 801 A87-53425
Compressors for advanced turboshaft engines p 831 A87-53427
MILITARY OPERATIONS
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224
MILITARY TECHNOLOGY
Configuration design of a helicopter integrated navigation system p 823 N87-29480
MISALIGNMENT
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
MISSILE CONTROL
Simultaneous active controls on wind tunnel model p 836 A87-54190
MISSILES
Program LRCDM2: Improved aerodynamic prediction program for supersonic canard-tail missiles with axisymmetric bodies
[NASA-CR-3883] p 813 N87-28525
MISSION PLANNING
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 2
[AD-A183781] p 826 N87-29494
MIXING
Computation of optimum turbofan mixing with a subaccurate varying specific heat solution p 830 A87-51808
Enhanced mixing of an axisymmetric jet by aerodynamic excitation
[NASA-CR-175059] p 815 N87-29418
MODAL RESPONSE
Near wake of an unsteady symmetric airfoil p 803 A87-51221
MODELS
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893
MODULUS OF ELASTICITY
Aluminium-lithium alloys for helicopter structures p 843 A87-53892
Pressuremeter moduli for airport pavement design and evaluation
[DOT/FAA/PM-87/10] p 839 N87-28572
MOIRE INTERFEROMETRY
Residual stresses in 2024-T81 aluminum using caustics and moire interferometry p 843 A87-53785
MOLDS
New methods and materials for molding and casting ice formations
[NASA-TM-100126] p 819 N87-29470
MONATOMIC GASES
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880
MONITORS
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962

N

NAPHTHALENE
Evaluation of naphthene rich turbine fuels as heat sinks for hypersonic aircraft
[AD-A182118] p 845 N87-28658
NASA PROGRAMS
The NASA strain gage laboratory p 838 A87-52494
NAVIER-STOKES EQUATION
Numerical modeling in aerohydrodynamics p 804 A87-51651
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
NAVIGATION AIDS
Inertial-GPS - A marriage of convenience under test p 820 A87-53578
Configuration design of a helicopter integrated navigation system p 823 N87-29480
Navigation systems for the new generation of combat and transport helicopters and associated flight tests p 823 N87-29481
NAVIGATION INSTRUMENTS
A comparison between integrated and separated navigation and flight control motion sensing equipment and a concept for aircraft motion sensing and attitude/heading determination p 828 A87-51941
Airborne navigation plots its future p 821 A87-53800
NAVSTAR SATELLITES
Space-age navigation p 820 A87-51325
The Navstar/GPS program - An evolution or a revolution in the world of navigation p 840 A87-53581
The role of Navstar/GPS in civil aviation p 820 A87-53582
NEAR WAKES
Near wake of an unsteady symmetric airfoil p 803 A87-51221
NICKEL ALLOYS
Fatigue of gas turbine blades under random vibrations p 832 A87-53442
NOISE MEASUREMENT
Community reactions to helicopter noise - Results from an experimental study p 853 A87-52064
Acoustic mode measurements in the inlet of a turbofan engine p 859 A87-52877
Detection of in-flight propeller-induced structure-borne noise p 838 A87-53779
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
NOISE POLLUTION
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
NOISE PREDICTION (AIRCRAFT)
Supersonic rotor noise calculation with sonic boom prediction methods p 860 A87-53903
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539
Calculation of noise around airports for powered gliders
[VTH-LR-475] p 860 N87-30150
NOISE PROPAGATION
Stochastic model theory of broadband shock associated noise from supersonic jets p 859 A87-52069
Detection of in-flight propeller-induced structure-borne noise p 838 A87-53779
NOISE REDUCTION
Laboratory study of sidewall noise transmission and treatment for a light aircraft fuselage p 824 A87-52887
Noise attenuation properties of headsets in a helicopter noise environment
[CAA-PAPER-87004] p 860 N87-29311
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539
NONDESTRUCTIVE TESTS
Nondestructive tests of Carbon Fiber Reinforced Plastics (CFRP) in the framework of damage mechanics investigations
[DFVLR-MITT-86-09] p 851 N87-28923
NONEQUILIBRIUM FLOW
An approach to the numerical modeling of the dynamics of reacting gases in nozzles --- gasdynamic and chemical lasers p 847 A87-50872
NONLINEAR SYSTEMS
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
NONUNIFORM FLOW
Interaction of bodies with a nonuniform supersonic flow p 804 A87-51663
Analysis and design of airfoils and axisymmetric bodies in transonic nonuniform flow p 811 N87-28509
NOTCH TESTS
Non-isothermal fatigue crack growth in Hastelloy-X p 840 A87-51400
NOZZLE DESIGN
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
NOZZLE FLOW
Control of the intensity of convective heat transfer in a Laval nozzle under conditions of turbulent flow and in the presence of local separation zones p 803 A87-50972

Pulsation structure of the mixing layer of underexpanded jets p 847 A87-50974
NUMERICAL ANALYSIS
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
An analysis of the crossover between local and massive separation on airfoils
[NASA-CR-4096] p 814 N87-29411
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
NUMERICAL FLOW VISUALIZATION
Numerical aerodynamics using large computers
p 809 A87-53562
A numerical study of flow in gas-turbine combustor
[AIAA PAPER 87-2132] p 832 A87-53986
NUMERICAL WEATHER FORECASTING
Determination of wind velocity and direction in the lower part of the atmospheric boundary layer on the basis of ground data p 854 A87-53969

O

OBLIQUE SHOCK WAVES
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel
p 837 A87-51968
Supersonic vortex rings - Visualization techniques
p 807 A87-52360
OCEAN DYNAMICS
Airborne multibeam radar altimetry --- of oceans
p 853 A87-53115
OCEAN SURFACE
Airborne multibeam radar altimetry --- of oceans
p 853 A87-53115
ONBOARD DATA PROCESSING
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
OPERATING COSTS
Reducing total cost of ownership - A challenge to helicopter propulsion specialists p 861 A87-53417
OPERATOR PERFORMANCE
Closing the man-machine loop: On the use of physiological measures to affect computer-controlled devices p 855 N87-29507
OPTIMAL CONTROL
Optimization of the controlled rotations of a rigid body with an elastic rod using first integrals of a free system
p 859 A87-50915
A method for controlling a centrifuge cabin
p 857 A87-52823
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
Simultaneous active controls on wind tunnel model
p 836 A87-54190
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893
OPTIMIZATION
Models for the description of holding procedures in air traffic as an aid for optimization with respect to safety and efficiency p 822 N87-28536
Transonic rotor tip design using numerical optimization
[NASA-TM-86771] p 816 N87-29431
ORGANIC COMPOUNDS
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives
[NASA-CASE-ARC-11425-2] p 844 N87-28605
ORIFICE FLOW
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
OSCILLATING FLOW
Forced oscillations in a boundary layer at frequencies close to the upper branch of the neutral curve
p 803 A87-50890
OSCILLATIONS
Supersonic flow over elastic bodies in oscillation
p 817 N87-29464
OXIDATION RESISTANCE
Military aircraft 4-cSt gas turbine engine oil development p 841 A87-52403
Alpha silicon carbide components for heat engine applications p 842 A87-53354
OXYGEN SUPPLY EQUIPMENT
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072

P

PANEL METHOD (FLUID DYNAMICS)
Development of supersonic computational aerodynamic program using panel method
[NASA-TT-20113] p 813 N87-28526
Application of a panel method to wake-vortex/wing interaction and comparison with experimental data
[NASA-TM-88337] p 817 N87-29461
Supersonic flow over elastic bodies in oscillation
p 817 N87-29464
PANELS
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
PARACHUTES
Parachute systems technology: Fundamentals, concepts, and applications. Advanced parachute design
[DE87-011634] p 814 N87-29415
Parachute systems technology: Fundamentals, concepts, and applications
[DE87-011722] p 815 N87-29416
Parachute recovery systems design manual, chapter 5
[AD-A183191] p 816 N87-29426
PARALLEL PROGRAMMING
Mathematical model partitioning and packing for parallel computer calculation p 856 A87-52534
Some principles of parallel programming
p 857 A87-53069
PARAMETER IDENTIFICATION
Parametric exploration of unsteady wing tip vortices
p 807 A87-52355
Bibliography for aircraft parameter estimation
[NASA-TM-86804] p 827 N87-29498
Application of parameter estimation to aircraft stability and control: The output-error approach
[NASA-RP-1168] p 827 N87-29499
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893
PARTICLE DENSITY (CONCENTRATION)
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
PARTICLE SIZE DISTRIBUTION
Application of particle imaging velocimetry in windtunnels p 848 A87-52314
PARTITIONS (MATHEMATICS)
Mathematical model partitioning and packing for parallel computer calculation p 856 A87-52534
PASSENGERS
Cost characteristics of tilt-rotor, conventional air and high speed rail short-haul intercity passenger service
[NASA-CR-181421] p 828 N87-29501
PAVEMENTS
Pressuremeter moduli for airport pavement design and evaluation
[DOT/FAA/PM-87/10] p 839 N87-28572
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545
PERFORATED PLATES
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement
[DFVLR-FB-86-59] p 810 N87-28506
Transonic interference reduction by limited ventilation wall panels
[NASA-CR-175039] p 815 N87-29419
PERFORMANCE PREDICTION
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545
Parachute systems technology: Fundamentals, concepts, and applications. Advanced parachute design
[DE87-011634] p 814 N87-29415
PERFORMANCE TESTS
Development and testing of highly loaded engine components made of carbon fiber reinforced plastics
[ETN-87-90036] p 832 N87-28550
Measurement uncertainty for the Uniform Engine Testing Program conducted at NASA Lewis Research Center
[NASA-TM-88943] p 833 N87-28557
Advanced composite vertical fin for L-1011 aircraft
[NASA-CR-3816] p 845 N87-28617
Propfan test assessment propfan propulsion system static test report
[NASA-CR-179613] p 834 N87-29536
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956
PERSONNEL
Combustion by-products on F-4 drogue parachutes
[AD-A182929] p 819 N87-29472
PETRI NETS
Investigation of the life cycles of complex engineering systems using Petri nets p 857 A87-52832
PHASE SHIFT
Dynamic positioning using GPS carrier phase measurements p 820 A87-52765
PHOSPHORUS COMPOUNDS
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives
[NASA-CASE-ARC-11425-2] p 844 N87-28605
PHYSIOLOGICAL EFFECTS
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949
PHYSIOLOGICAL FACTORS
Closing the man-machine loop: On the use of physiological measures to affect computer-controlled devices p 855 N87-29507
PILOT PERFORMANCE
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949
Aviation tort litigation against the United States - Judicial inroads on the pilot-in-command concept
p 861 A87-52171
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115
Automation at the man-machine interface
p 855 N87-29504
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072
PITCH (INCLINATION)
Experimental aeroelastic behavior of forward-swept graphite/epoxy wings with rigid-body freedom
p 824 A87-53781
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-2] p 833 N87-28556
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956
PITCHING MOMENTS
Lift and pitching moment coefficient changes from low-level freestream turbulence p 808 A87-52888
Advanced Propfan Engine Technology (APET) definition study, single and counter-rotation gearbox/pitch change mechanism design
[NASA-CR-168115] p 833 N87-28554
PITOT TUBES
Pitot and static errors due to non-steady flight
[ESDU-85011] p 813 N87-29410
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
PLANFORMS
Development of a reduced area horizontal tail for a wide body jet aircraft
[NASA-CR-172278] p 837 N87-28564
PLANNING
Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539
Systems evaluation procedure using simulation illustrated by the Computer Oriented Metering Planning and Advisory System (COMPAS) project
p 822 N87-28540
PLASMA SPRAYING
New ZrO2-Yb2O3 plasma-sprayed coatings for thermal barrier applications p 843 A87-53623
PLASTIC AIRCRAFT STRUCTURES
Around-the-world flight p 801 A87-53553
PLASTIC DEFORMATION
Composites - What next p 841 A87-51807
PLASTIC PROPERTIES
High-strength, high-temperature intermetallic compounds p 840 A87-51301
POLARIZATION (WAVES)
JPL multipolarization workstation - Hardware, software and examples of data analysis p 858 A87-53231
POLYMER CHEMISTRY
High-temperature polymers for adhesive and composite applications p 843 A87-53888
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives
[NASA-CASE-ARC-11425-2] p 844 N87-28605
POLYMER MATRIX COMPOSITES
High-temperature polymers for adhesive and composite applications p 843 A87-53888
POLYMER PHYSICS
High-temperature polymers for adhesive and composite applications p 843 A87-53888
POLYTETRAFLUOROETHYLENE
PTFE (polytetrafluoroethylene) resin selection for high performance wire and cable
[AD-P005211] p 846 N87-29227

POROSITY
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
PORTABLE EQUIPMENT
Practical application to composite materials of a portable digital ultrasound device controlled by a microprocessor
p 849 A87-53585
POSITION (LOCATION)
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532
POSITION ERRORS
Modeling of the fault situation in navigation systems
p 821 N87-28534
POSITIONING
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051
POTENTIAL FLOW
Development of supersonic computational aerodynamic program using panel method
[NASA-TT-20113] p 813 N87-28526
POTENTIAL THEORY
Wave drag analysis of realistic fighter aircraft using a full-potential method p 807 A87-52882
POWERED LIFT AIRCRAFT
Multimission STOVL application of a hybrid powered-lift system p 824 A87-53776
PRECIPITATION (METEOROLOGY)
SPACE/COHMEX data inventory document
[NASA-TM-4006] p 854 N87-29068
PREDICTION ANALYSIS TECHNIQUES
Program LRCDM2: Improved aerodynamic prediction program for supersonic canard-tail missiles with axisymmetric bodies
[NASA-CR-3883] p 813 N87-28525
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
Estimation of sideforce, yawing moment and rolling moment derivatives due to rate of roll for complete aircraft at subsonic speeds
[ESDU-85010] p 826 N87-29490
Anticipation of the landing shock phenomenon in flight simulation
[NASA-TM-89465] p 826 N87-29491
PRESSURE
Airflow calibration and exhaust pressure/temperature survey of an F404, S/N 215-109, turbofan engine
[NASA-TM-100159] p 834 N87-29537
PRESSURE DEPENDENCE
A supersonic jet in a chamber with a diaphragm
p 808 A87-53520
PRESSURE DISTRIBUTION
Supersonic vortex rings - Visualization techniques
p 807 A87-52360
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement
[DFVLR-FB-86-59] p 810 N87-28506
Supersonic and transonic supersonic flow
[MPIS-16/1986] p 811 N87-28508
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545
Calculation of pressure distributions on supersonic delta wings using stagnation solutions
[VTH-LR-484] p 815 N87-29417
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution
[AD-A183531] p 816 N87-29428
PRESSURE DROP
The flow field in the second throat region of a wind tunnel, computed by an Euler method
p 809 A87-53574
PRESSURE EFFECTS
Pitot and static errors due to non-steady flight
[ESDU-85011] p 813 N87-29410
PRESSURE GRADIENTS
Calculation of noise caused by interaction of supersonic cascade and varied oncoming gust p 859 A87-51812
PRESSURE MEASUREMENT
The measurement of oscillatory pressures with discrete and sweep excitation p 837 A87-51213
PSI multitransducer in low-velocity wind tunnel in Braunschweig p 838 A87-53569
Pressuremeter moduli for airport pavement design and evaluation
[DOT/FAA/PM-87/10] p 839 N87-28572
Pitot and static errors due to non-steady flight
[ESDU-85011] p 813 N87-29410
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution
[AD-A183531] p 816 N87-29428
PRESSURE OSCILLATIONS
The measurement of oscillatory pressures with discrete and sweep excitation p 837 A87-51213
PRESSURE SUITS
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072
PRESTRESSING
The effect of prestrain and of ageing at room temperature on the mechanical properties of an Al-Li-Cu-Mg alloy
p 842 A87-52683
PRODUCT DEVELOPMENT
Development and testing of highly loaded engine components made of carbon fiber reinforced plastics
[ETN-87-90036] p 832 N87-28550
PRODUCTION ENGINEERING
High-temperature polymers for adhesive and composite applications p 843 A87-53888
PROGRAMMING LANGUAGES
Some principles of parallel programming
p 857 A87-53069
PROP-FAN TECHNOLOGY
Static tests of the propulsion system --- Propfan Test Assessment program
[AIAA PAPER 87-1728] p 830 A87-52245
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan
[AIAA PAPER 87-1893] p 806 A87-52251
UHB demonstrator flight test program
[AIAA PAPER 87-1732] p 824 A87-52844
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-1] p 833 N87-28552
Advanced Propfan Engine Technology (APET) definition study, single and counter-rotation gearbox/pitch change mechanism design
[NASA-CR-168115] p 833 N87-28554
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-2] p 833 N87-28556
Propfan test assessment testbed aircraft flutter model test report
[NASA-CR-179458] p 814 N87-29413
Propfan test assessment propfan propulsion system static test report
[NASA-CR-179613] p 834 N87-29536
PROPAGATION MODES
Acoustic mode measurements in the inlet of a turbofan engine p 859 A87-52877
PROPELLANT PROPERTIES
A variable geometry combustor for broadened properties fuels
[AIAA PAPER 87-1832] p 830 A87-52246
PROPELLER BLADES
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan
[AIAA PAPER 87-1893] p 806 A87-52251
Propfan test assessment propfan propulsion system static test report
[NASA-CR-179613] p 834 N87-29536
PROPELLER FANS
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan
[AIAA PAPER 87-1893] p 806 A87-52251
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545
PROPELLER SLIPSTREAMS
Detection of in-flight propeller-induced structure-borne noise p 838 A87-53779
Flow energizers. Task A
[NASA-CR-176202] p 812 N87-28523
PROPELLERS
Calculation of frictionless flow about airfoil wings and propellers by numerical solution of the Euler equations
p 809 A87-53563
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
PROPULSION SYSTEM CONFIGURATIONS
A variable geometry combustor for broadened properties fuels
[AIAA PAPER 87-1832] p 830 A87-52246
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521
Advanced Propfan Engine Technology (APET) and single-rotation gearbox/pitch change mechanism
[NASA-CR-168113] p 833 N87-28553
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
PROPULSION SYSTEM PERFORMANCE
Static tests of the propulsion system --- Propfan Test Assessment program
[AIAA PAPER 87-1728] p 830 A87-52245
Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers p 801 A87-53413
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-1] p 833 N87-28552
High accuracy thrust measurement of aeronautical propulsion systems with particular consideration to a hydraulic force measuring device, part 1
[NASA-TT-20080] p 834 N87-28558
Fiscal year 1988 technical objective document
[AD-A180311] p 861 N87-29364
Holographic interferometry at Wright Aeronautical Laboratories p 851 N87-29435
PROTECTIVE COATINGS
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823
PROTOTYPES
Prototype aircraft sustainability model
[AD-A183183] p 802 N87-29405
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 2
[AD-A183781] p 826 N87-29494
PROVING
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099
PULMONARY FUNCTIONS
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072
PULSE REPETITION RATE
Approach to study of PRF sensitivity in airborne pulse-Doppler radar p 829 A87-53802
PUSHBROOM SENSOR MODES
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985
p 853 A87-53206
PYLON MOUNTING
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
PYLONS
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422

Q

QUALITY
Preliminary airworthiness evaluation of the UH-1H helicopter with the T53-L-703 engine installed
[AD-A182369] p 825 N87-28541
QUATERNARY ALLOYS
The effect of prestrain and of ageing at room temperature on the mechanical properties of an Al-Li-Cu-Mg alloy
p 842 A87-52683

R

RADAR DATA
JPL multipolarization workstation - Hardware, software and examples of data analysis p 858 A87-53231
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060
RADAR GEOLOGY
Preliminary simultaneous L/C-band images from the JPL aircraft synthetic aperture radar p 853 A87-53159
RADAR IMAGERY
Preliminary simultaneous L/C-band images from the JPL aircraft synthetic aperture radar p 853 A87-53159
RADAR MEASUREMENT
Airborne multibeam radar altimetry --- of oceans
p 853 A87-53115
RADAR RECEIVERS
Approach to study of PRF sensitivity in airborne pulse-Doppler radar p 829 A87-53802
RADAR RESOLUTION
Preliminary simultaneous L/C-band images from the JPL aircraft synthetic aperture radar p 853 A87-53159
RADIAL FLOW
A two-dimensional finite element stress analysis of radial impellers p 847 A87-51472

RADIATIVE HEAT TRANSFER
Three-dimensional flow around and radiative heating of blunt bodies p 804 A87-51653
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
RADIO FREQUENCY INTERFERENCE
Ground testing of an operational fighter aircraft for p-static discharge effects p 824 A87-52522
RADIO NAVIGATION
Modeling of radio navigation systems in the neighborhood of airports p 821 N87-28533
Modeling of the fault situation in navigation systems p 821 N87-28534
RADIO RECEIVERS
The MLS angle receiver p 820 A87-51231
RADIOMETERS
Experimental comparison of radiometric scales from laboratory standards and solar radiation p 849 A87-53576
RAIL TRANSPORTATION
Cost characteristics of tilt-rotor, conventional air and high speed rail short-haul intercity passenger service
[NASA-CR-181421] p 828 N87-29501
RAIN
Rain effects at low Reynolds number p 808 A87-52884
RANDOM SAMPLING
Aircraft accident reports. Brief format, US civil and foreign aviation, issue number 2, 1986 accidents
[PB87-916904] p 818 N87-28528
Aircraft accident reports. Brief format, US civil and foreign aviation, issue number 3, 1986 accidents
[PB87-916905] p 819 N87-28529
RANDOM VIBRATION
Fatigue of gas turbine blades under random vibrations p 832 A87-53442
RANGE (EXTREMES)
Once around the earth without refueling p 801 A87-54252
RAPID QUENCHING (METALLURGY)
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
Mechanical properties of rapidly solidified Al-4Be p 842 A87-52658
RARE GASES
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 1
[AD-A183690] p 826 N87-29493
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 2
[AD-A183781] p 826 N87-29494
RAREFIED GAS DYNAMICS
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880
RAREFIED GASES
An analysis of the approximation of the aerodynamic coefficients of thin bodies in a rarefied gas p 808 A87-53526
REAL TIME OPERATION
Processor tradeoffs in distributed real-time systems p 857 A87-52796
In real time with a pilot in the loop p 857 A87-53066
Trimming an aircraft model for flight simulation
[NASA-TM-89466] p 828 N87-29502
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
RECORDING INSTRUMENTS
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115
RECORDS
Once around the earth without refueling p 801 A87-54252
RECOVERY PARACHUTES
Parachute recovery systems design manual, chapter 5
[AD-A183191] p 816 N87-29426
REGRESSION ANALYSIS
An analysis of the approximation of the aerodynamic coefficients of thin bodies in a rarefied gas p 808 A87-53526
REGULATIONS
Airline management prerogative in the deregulation era p 861 A87-52172
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
REINFORCED PLASTICS
Composites - What next p 841 A87-51807
RELIABILITY ANALYSIS
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099
REMOTE SENSING
Airborne multibeam radar altimetry --- of oceans p 853 A87-53115
Preliminary simultaneous L/C-band images from the JPL aircraft synthetic aperture radar p 853 A87-53159
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985 p 853 A87-53206
SPACE/COHMEX data inventory document
[NASA-TM-4006] p 854 N87-29068
REMOTE SENSORS
Infrared simulation model SENSAT-2
[DFVLR-FB-87-10] p 854 N87-28950
REMOTELY PILOTED VEHICLES
Canadair's CL-227 Sentinel gains credibility p 824 A87-53798
RESEARCH AND DEVELOPMENT
Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation --- conference
[DFVLR-MITT-86-24] p 821 N87-28530
Role and task of models as tools for research and development p 821 N87-28531
RESEARCH FACILITIES
AI at Ames: Artificial Intelligence research and application at NASA Ames Research Center, Moffett Field, California, February 1985 p 858 N87-29140
The ACEE program and basic composites research at Langley Research Center (1975 to 1986): Summary and bibliography
[NASA-RP-1177] p 846 N87-29612
RESEARCH MANAGEMENT
Weather Research Program
[PB87-196390] p 854 N87-29065
RESIDUAL STRESS
Residual stresses in 2024-T81 aluminum using caustics and moire interferometry p 843 A87-53785
RESONANT FREQUENCIES
A new model of a self-controlled system --- cross-flow excited elastically suspended body vibration p 847 A87-51158
Self-excited oscillations in jet engine test cells p 859 A87-51215
RESPIRATION
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072
RIGID ROTORS
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system p 825 A87-53901
Toward comparing experiment and theory for corroborative research on hingeless rotor stability in forward flight
[NASA-CR-181354] p 836 N87-28562
RIGID WINGS
Experimental aeroelastic behavior of forward-swept graphite/epoxy wings with rigid-body freedom p 824 A87-53781
ROADS
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545
ROBOTS
Future impact of manufacturing technology and automation in Pratt & Whitney Canada p 849 A87-53416
ROCKET ENGINES
High accuracy thrust measurement of aeronautical propulsion systems with particular consideration to a hydraulic force measuring device, part 1
[NASA-TT-20080] p 834 N87-28558
ROLLING MOMENTS
Contribution of wing dihedral to sideforce, yawing moment and rolling moment derivatives due to rate of roll at subsonic speeds, (Y sub p)sub gamma, (N sub p)sub gamma and (L sub p)sub gamma
[ESDU-85006] p 813 N87-29409
Estimation of sideforce, yawing moment and rolling moment derivatives due to rate of roll for complete aircraft at subsonic speeds
[ESDU-85010] p 826 N87-29490
ROTARY STABILITY
Toward comparing experiment and theory for corroborative research on hingeless rotor stability in forward flight
[NASA-CR-181354] p 836 N87-28562
ROTARY WING AIRCRAFT
Specialists' Meeting on Rotary Wing Propulsion Systems, Williamsburg, VA, Nov. 12-14, 1986, Technical Papers p 801 A87-53413
Compound cycle engine program p 831 A87-53428
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system p 825 A87-53901
ROTARY WINGS
The prediction of the vibratory airloads of helicopter rotors in forward flight p 823 A87-51214
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
Multi-variable control concepts for turboshaft engines p 832 A87-53431
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777
Effect of dynamic stall on helicopter trim and flap-lag response p 835 A87-54139
Rotor dynamics test facility
[ONERA-RT-20/3239-RY-054R-0] p 839 N87-28567
Transonic rotor tip design using numerical optimization
[NASA-TM-86771] p 816 N87-29431
Application of digital interferogram evaluation techniques to the measurement of 3-D flow fields p 851 N87-29451
Small-scale rotor test rig capabilities for testing vibration alleviation algorithms
[NASA-TM-100002] p 858 N87-30102
ROTATING BODIES
Optimization of the controlled rotations of a rigid body with an elastic rod using first integrals of a free system p 859 A87-50915
ROTATING CYLINDERS
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880
ROTATING STALLS
Contribution to the description of rotating flow instabilities and inlet perturbations in axial flow compressors
[ETN-87-90040] p 850 N87-28845
ROTOR BLADES
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system p 825 A87-53901
Supersonic rotor noise calculation with sonic boom prediction methods p 860 A87-53903
Transonic rotor flow-measurement technique using holographic interferometry p 851 N87-29434
ROTOR BLADES (TURBOMACHINERY)
Implementation and validation of a wake model for low-speed forward flight
[NASA-CR-181341] p 811 N87-28514
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869
An investigation of the flow characteristics in the blade endwall corner region
[NASA-CR-4076] p 814 N87-29412
Estimation of blade airloads from rotor blade bending moments
[NASA-TM-100020] p 815 N87-29421
Reconstruction of a three-dimensional, transonic rotor flow field from holographic interferogram data p 817 N87-29445
Full-potential modeling of blade-vortex interactions p 817 N87-29465
ROTOR BODY INTERACTIONS
Toward comparing experiment and theory for corroborative research on hingeless rotor stability in forward flight
[NASA-CR-181354] p 836 N87-28562
ROTORS
Dynamics of a high-speed rotor touching a boundary p 848 A87-51614
The results of a wind tunnel investigation of a model rotor with a free tip
[NASA-TM-86758] p 827 N87-29496
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956
RUNWAY CONDITIONS
An active control landing gear for the alleviation of aircraft taxi ground loads p 824 A87-53573
RUNWAY LIGHTS
A simulator evaluation of alternative heliport approach lighting systems
[AIAA PAPER 87-2635] p 838 A87-52290
RUNWAYS
The problems of the calculation of the capacity of flight operation surfaces of airports
[ILR-MITT-170] p 838 N87-28566
Pressuremeter moduli for airport pavement design and evaluation
[DOT/FAA/PM-87/10] p 839 N87-28572
Langley Aircraft Landing Dynamics Facility
[NASA-RP-1189] p 839 N87-29544
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545

S

S-N DIAGRAMS
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316
SATELLITE COMMUNICATION
Space communications to aircraft: A new development in international space law. I p 861 A87-51477
SATELLITE GUIDANCE
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488
SATELLITE NAVIGATION SYSTEMS
Space-age navigation p 820 A87-51325
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488
SATELLITE NETWORKS
The Navstar/GPS program - An evolution or a revolution in the world of navigation p 840 A87-53581
SCALARS
Vortex-scalar element calculations of a diffusion flame stabilized on a plane mixing layer
[NASA-TM-100133] p 802 N87-28501
SCALE (RATIO)
Experimental comparison of radiometric scales from laboratory standards and solar radiation
p 849 A87-53576
SCALE MODELS
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191
SELF EXCITATION
Self-excited oscillations in jet engine test cells
p 859 A87-51215
Dynamics of a high-speed rotor touching a boundary
p 848 A87-51614
SELF OSCILLATION
Self-excited oscillations in jet engine test cells
p 859 A87-51215
SEPARATED FLOW
Control of the intensity of convective heat transfer in a Laval nozzle under conditions of turbulent flow and in the presence of local separation zones p 803 A87-50972
Characteristics of separated flow past a delta wing
p 805 A87-51669
Calculation of three-dimensional supersonic flow past cone-like bodies with a separated shock wave
p 805 A87-51671
Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies
p 807 A87-52371
An analysis of the crossover between local and massive separation on airfoils
[NASA-CR-4096] p 814 N87-29411
SERVICE LIFE
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
SHADOWGRAPH PHOTOGRAPHY
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370
SHAPES
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422
New methods and materials for molding and casting ice formations
[NASA-TM-100126] p 819 N87-29470
SHEAR FLOW
Lift and pitching moment coefficient changes from low-level freestream turbulence p 808 A87-52888
Control of shear flows by artificial excitation
[NASA-TM-100201] p 815 N87-29420
KC-135 aero-optical turbulent boundary layer/shear layer experiment revisited p 852 N87-29454
SHEAR LAYERS
Enhanced mixing of an axisymmetric jet by aerodynamic excitation
[NASA-CR-175059] p 815 N87-29418
KC-135 aero-optical turbulent boundary layer/shear layer experiment revisited p 852 N87-29454
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629
SHEAR PROPERTIES
The aerothermodynamic environment for holes in hypersonic configurations
[DE87-003790] p 814 N87-29414
SHEAR STRESS
An investigation of the flow characteristics in the blade endwall corner region
[NASA-CR-4076] p 814 N87-29412
SHEATHS
Lightweight 2 fiber aviation cable featuring low fiber stress levels
[AD-P005282] p 826 N87-29297
SHOCK LAYERS
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
SHOCK LOADS
Anticipation of the landing shock phenomenon in flight simulation
[NASA-TM-89465] p 826 N87-29491
SHOCK TUNNELS
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel
p 837 A87-51968
SHOCK WAVE INTERACTION
Interaction of bodies with a nonuniform supersonic flow p 804 A87-51663
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel
p 837 A87-51968
Stochastic model theory of broadband shock associated noise from supersonic jets p 859 A87-52069
A reconsideration of the three-shock theory for a pseudo-steady Mach reflection p 810 A87-54364
SHOCK WAVE PROPAGATION
Moving shock waves in transonic flows
p 806 A87-52304
SHOCK WAVES
Calculation of three-dimensional supersonic flow past cone-like bodies with a separated shock wave
p 805 A87-51671
Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge
p 806 A87-52322
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370
SHORT TAKEOFF AIRCRAFT
Multimission STOVL application of a hybrid powered-lift system p 824 A87-53776
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521
SHROUDS
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
SIDESLIP
Contribution of wing dihedral to sideforce, yawing moment and rolling moment derivatives due to rate of roll at subsonic speeds, (Y sub p)sub gamma, (N sub p)sub gamma and (L sub p)sub gamma
[ESDU-85006] p 813 N87-29409
Estimation of sideforce, yawing moment and rolling moment derivatives due to rate of roll for complete aircraft at subsonic speeds
[ESDU-85010] p 826 N87-29490
SIGNAL PROCESSING
The MLS angle receiver p 820 A87-51231
SILICON CARBIDES
Alpha silicon carbide components for heat engine applications p 842 A87-53354
SILICON NITRIDES
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
SIMULATION
Role and task of models as tools for research and development p 821 N87-28531
Experimental evaluation of corner turning vanes
[NASA-TM-100143] p 839 N87-28571
SINGULAR INTEGRAL EQUATIONS
Solution of aerodynamic integral equations without matrix inversion p 808 A87-52889
SINGULARITY (MATHEMATICS)
Application of a sensitivity analysis technique to high-order digital flight control systems
[NASA-CR-179429] p 837 N87-28565
SIZE (DIMENSIONS)
Development of a reduced area horizontal tail for a wide body jet aircraft
[NASA-CR-172278] p 837 N87-28564
SKIN (ANATOMY)
Combustion by-products on F-4 drogue parachutes
[AD-A182929] p 819 N87-29472
SLENDER BODIES
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
SLENDER WINGS
Effect of a round airfoil nose on leading-edge suction
p 809 A87-53784
SLIPSTREAMS
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370
SMALL PERTURBATION FLOW
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890
SMOKE
Aircraft fires - Living through the smoke
p 818 A87-54315
Smoke emission tests on series 2 and series 3 Allison T56 turboprop engines
[AD-A182385] p 832 N87-28549
SOFTWARE ENGINEERING
Integrated Application of Active Controls (IAAC) technology to an advanced subsonic transport project: Test act system validation
[NASA-CR-172525] p 836 N87-28563
Configuration design of a helicopter integrated navigation system p 823 N87-29480
Some proposed enhancements to the NASA Langley 13-inch magnetic suspension and balance system
[NASA-CR-181152] p 839 N87-29543
SOIL MECHANICS
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545
SOIL MOISTURE
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985
p 853 A87-53206
SOLAR RADIATION
Experimental comparison of radiometric scales from laboratory standards and solar radiation
p 849 A87-53576
SONIC BOOMS
Supersonic rotor noise calculation with sonic boom prediction methods p 860 A87-53903
SOUND GENERATORS
Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513
SOUND PROPAGATION
Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539
SOUND TRANSMISSION
Laboratory study of sidewall noise transmission and treatment for a light aircraft fuselage
p 824 A87-52887
ACEE composite structures technology
[NASA-CR-172360] p 845 N87-28615
SOUND WAVES
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
SPACE LAW
Space communications to aircraft: A new development in international space law. I p 861 A87-51477
SPARE PARTS
Prototype aircraft sustainability model
[AD-A183183] p 802 N87-29405
SPATIAL DISTRIBUTION
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532
SPECIFIC HEAT
Computation of optimum turbofan mixing with a subaccurate varying specific heat solution
p 830 A87-51808
SPECTRAL EMISSION
Measurement of spectral emissivity of technical surfaces in high-performance engines p 832 A87-53575
SPEECH RECOGNITION
Voice control of cockpit systems p 837 N87-29526
The flight evaluation of a speech recognition and a speech output system in an advanced cockpit display and flight management system for helicopters
p 829 N87-29527
SPOILERS
Jet spoiler as a yaw control device
p 835 A87-52880
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
Simultaneous active controls on wind tunnel model
p 836 A87-54190
The 737 graphite composite flight spoiler flight service evaluation
[NASA-CR-178322] p 846 N87-29609
SPRAY CHARACTERISTICS
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
SPRAYED COATINGS
New ZrO2-Yb2O3 plasma-sprayed coatings for thermal barrier applications p 843 A87-53623
SQUEEZE FILMS
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471

STABILITY
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555
STABILITY AUGMENTATION
Small-scale rotor test rig capabilities for testing vibration alleviation algorithms
[NASA-TM-100002] p 858 N87-30102
STABILIZATION
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545
STAGNATION FLOW
Calculation of pressure distributions on supersonic delta wings using stagnation solutions
[VTH-LR-484] p 815 N87-29417
STAGNATION PRESSURE
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
STATIC ELECTRICITY
Ground testing of an operational fighter aircraft for p-static discharge effects p 824 A87-52522
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
STATIC PRESSURE
Pitot and static errors due to non-steady flight
[ESDU-85011] p 813 N87-29410
STATIC TESTS
Static tests of the propulsion system --- Propfan Test Assessment program
[AIAA PAPER 87-1728] p 830 A87-52245
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
STATISTICAL ANALYSIS
Census of US civil aircraft, calendar year 1986
[AD-A183423] p 802 N87-29406
STEEL STRUCTURES
Fatigue strength of 30KhGSN2A steel lugs under programmed loading p 843 A87-53441
STOCHASTIC PROCESSES
Stochastic model theory of broadband shock associated noise from supersonic jets p 859 A87-52069
STRAIN GAGES
The NASA strain gage laboratory p 838 A87-52494
Experimental techniques for three-axes load cells used at the National Full-Scale Aerodynamics Complex
[NASA-TM-86693] p 826 N87-28546
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869
Thin film strain gage development program
[NASA-CR-174707] p 850 N87-28883
STRAPDOWN INERTIAL GUIDANCE
A comparison between integrated and separated navigation and flight control motion sensing equipment and a concept for aircraft motion sensing and attitude/heading determination p 828 A87-51941
Simulation of strapdown systems for error analysis, and modeling for navigation with other sensor systems
p 821 N87-28535
STRATIFIED FLOW
Pulsation structure of the mixing layer of underexpanded jets p 847 A87-50974
The application of the method of streams to the numerical modeling of unsteady aerohydrodynamics problems p 804 A87-51654
STREAM FUNCTIONS (FLUIDS)
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
STRESS ANALYSIS
A two-dimensional finite element stress analysis of radial impellers p 847 A87-51472
Residual stresses in 2024-T81 aluminum using caustics and moire interferometry p 843 A87-53785
PTFE (polytetrafluoroethylene) resin selection for high performance wire and cable
[AD-P005211] p 846 N87-29227
Lightweight 2 fiber aviation cable featuring low fiber stress levels
[AD-P005282] p 826 N87-29297
Propfan test assessment propfan propulsion system static test report
[NASA-CR-179613] p 834 N87-29536
STRESSED-SKIN STRUCTURES
Age forming aluminum in an autoclave
p 848 A87-52678
STRINGERS
Development of fine-grained 7075-O sheet for aircraft taper-rolled stringer p 842 A87-52661
STRUCTURAL ANALYSIS
Preliminary airworthiness evaluation of the UH-1H helicopter with the T53-L-703 engine installed
[AD-A182369] p 825 N87-28541
Propfan test assessment testbed aircraft flutter model test report
[NASA-CR-179458] p 814 N87-29413
STRUCTURAL DESIGN
A designers' guide to the achievement of electrical continuity in carbon fibre composite structures --- aircraft
[CD6500551] p 844 N87-28607
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
STRUCTURAL DESIGN CRITERIA
ACEE composite structures technology
[NASA-CR-172360] p 845 N87-28615
Parachute systems technology: Fundamentals, concepts, and applications. Advanced parachute design
[DE87-011634] p 814 N87-29415
Parachute systems technology: Fundamentals, concepts, and applications
[DE87-011722] p 815 N87-29416
Some proposed enhancements to the NASA Langley 13-inch magnetic suspension and balance system
[NASA-CR-181152] p 839 N87-29543
STRUCTURAL RELIABILITY
Engine Structural Integrity Program (ENSIP) - A viewpoint based on experience p 831 A87-53424
STRUCTURAL VIBRATION
The prediction of the vibratory airloads of helicopter rotors in forward flight p 823 A87-51214
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
SUBROUTINES
Application of a sensitivity analysis technique to high-order digital flight control systems
[NASA-CR-179429] p 837 N87-28565
SUBSONIC AIRCRAFT
Reducing fuel consumption of subsonic aircraft by optimal cyclic cruise p 824 A87-52881
SUBSONIC FLOW
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
Solution of the Volterra integral equation in the problem of the unsteady motion of a thin wing
p 808 A87-53522
SUBSONIC SPEED
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
Some numerical calculations by using linear classical sonic theories approached from sub- or supersonic speeds
[NASA-TT-20112] p 813 N87-28527
Contribution of wing dihedral to sideforce, yawing moment and rolling moment derivatives due to rate of roll at subsonic speeds, (Y sub p)sub gamma, (N sub p)sub gamma and (L sub p)sub gamma
[ESDU-85006] p 813 N87-29409
Estimation of sideforce, yawing moment and rolling moment derivatives due to rate of roll for complete aircraft at subsonic speeds
[ESDU-85010] p 826 N87-29490
SUCTION
Effect of a round airfoil nose on leading-edge suction
p 809 A87-53784
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
SUPERCOMPUTERS
Numerical aerodynamics using large computers
p 809 A87-53562
SUPERCRITICAL AIRFOILS
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
Optical interferometry in fluid dynamics research
p 851 N87-29447
SUPERCRITICAL WINGS
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement
[DFVLR-FB-86-59] p 810 N87-28506
SUPERSONIC AIRCRAFT
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521
SUPERSONIC COMBUSTION
Flow visualization studies of transverse fuel injection patterns in a nonreacting Mach 2 combustor
p 807 A87-52386
SUPERSONIC COMBUSTION RAMJET ENGINES
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629
SUPERSONIC COMPRESSORS
Modified characteristic method for calculation of supersonic S2 flow field in compressor
p 804 A87-51473
An experimental investigation of the effect of inlet flow distortion on compressor performance
p 805 A87-51813
SUPERSONIC FLIGHT
Supersonic rotor noise calculation with sonic boom prediction methods p 860 A87-53903
SUPERSONIC FLOW
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880
Forced oscillations in a boundary layer at frequencies close to the upper branch of the neutral curve
p 803 A87-50890
Modified characteristic method for calculation of supersonic S2 flow field in compressor
p 804 A87-51473
Numerical modeling in aerohydrodynamics
p 804 A87-51651
Numerical modeling of supersonic muliphase flows
p 804 A87-51659
Interaction of bodies with a nonuniform supersonic flow p 804 A87-51663
Calculation of three-dimensional supersonic flow past cone-like bodies with a separated shock wave
p 805 A87-51671
Calculation of noise caused by interaction of supersonic cascade and varied oncoming gust p 859 A87-51812
Supersonic and transonic supersonic flow
[MPIS-16/1986] p 811 N87-28508
Calculation of pressure distributions on supersonic delta wings using stagnation solutions
[VTH-LR-484] p 815 N87-29417
Supersonic flow over elastic bodies in oscillation
p 817 N87-29464
SUPERSONIC JET FLOW
Pulsation structure of the mixing layer of underexpanded jets p 847 A87-50974
Stochastic model theory of broadband shock associated noise from supersonic jets p 859 A87-52069
Supersonic vortex rings - Visualization techniques
p 807 A87-52360
A supersonic jet in a chamber with a diaphragm
p 808 A87-53520
SUPERSONIC NOZZLES
An approach to the numerical modeling of the dynamics of reacting gases in nozzles --- gasdynamic and chemical lasers p 847 A87-50872
SUPERSONIC SPEED
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
Some numerical calculations by using linear classical sonic theories approached from sub- or supersonic speeds
[NASA-TT-20112] p 813 N87-28527
SURFACE NOISE INTERACTIONS
Enhanced mixing of an axisymmetric jet by aerodynamic excitation
[NASA-CR-175059] p 815 N87-29418
SURFACE PROPERTIES
A three-dimensional boundary layer on blunt bodies with a porous surface at angles of attack and sideslip
p 803 A87-51007
SURFACE ROUGHNESS
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution
[AD-A183531] p 816 N87-29428
SURFACE STABILITY
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545
SURFACE TEMPERATURE
Measurement of spectral emissivity of technical surfaces in high-performance engines p 832 A87-53575
SURVEYS
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
SUSPENDING (HANGING)
A new model of a self-controlled system --- cross-flow excited elastically suspended body vibration
p 847 A87-51158
SWEAT COOLING
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475
SWEPT FORWARD WINGS
Experimental aeroelastic behavior of forward-swept graphite/epoxy wings with rigid-body freedom
p 824 A87-53781
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543
SWEPT WINGS
Effect of a round airfoil nose on leading-edge suction
p 809 A87-53784

Contribution of wing dihedral to sideforce, yawing moment and rolling moment derivatives due to rate of roll at subsonic speeds, (Y sub p)sub gamma, (N sub p)sub gamma and (L sub p)sub gamma
[ESDU-85006] p 813 N87-29409
SWIRLING
Measurement of swirling flow field using the single slanted hot-wire technique p 847 A87-51469
SYNCHRONISM
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
SYNCHRONOUS SATELLITES
The Navstar/GPS program - An evolution or a revolution in the world of navigation p 840 A87-53581
SYNOPTIC METEOROLOGY
Weather Research Program
[PB87-196390] p 854 N87-29065
SYNTHETIC APERTURE RADAR
Preliminary simultaneous L/C-band images from the JPL aircraft synthetic aperture radar p 853 A87-53159
SYSTEM FAILURES
Investigation of F-16 control surface failures and optimal setting of functional controls
[AD-A182667] p 825 N87-28542
SYSTEMS ANALYSIS
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
SYSTEMS ENGINEERING
Infrared simulation model SENSAT-2
[DFVLR-FB-87-10] p 854 N87-28950
The SIFT hardware/software systems. Volume 1: A detailed description
[NASA-TM-87574] p 858 N87-29186
SYSTEMS INTEGRATION
Advances in Guidance and Control Systems and Technology
[AGARD-CP-411] p 822 N87-29474
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
Configuration design of a helicopter integrated navigation system p 823 N87-29480
SYSTEMS SIMULATION
Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation --- conference
[DFVLR-MITT-86-24] p 821 N87-28530
Modeling of the fault situation in navigation systems p 821 N87-28534
Simulation of strapdown systems for error analysis, and modeling for navigation with other sensor systems p 821 N87-28535
A multichannel model for the description of the pilot in the closed control system, for the evaluation of future aircraft guidance systems p 822 N87-28537
Models of the description of air traffic control scenarios, for the evaluation of future air traffic control systems p 822 N87-28538
Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539
Systems evaluation procedure using simulation illustrated by the Computer Oriented Metering Planning and Advisory System (COMPAS) project p 822 N87-28540

T

TABLES (DATA)
Census of US civil aircraft, calendar year 1986
[AD-A183423] p 802 N87-29406
FAA (Federal Aviation Administration) air traffic activity FY 1986
[AD-A183624] p 802 N87-29407
TACTILE DISCRIMINATION
Voice control of cockpit systems p 837 N87-29526
TAIL ASSEMBLIES
Development of a reduced area horizontal tail for a wide body jet aircraft
[NASA-CR-172278] p 837 N87-28564
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
Estimation of sideforce, yawing moment and rolling moment derivatives due to rate of roll for complete aircraft at subsonic speeds
[ESDU-85010] p 826 N87-29490
TAKEOFF
The problem of the aviation-meteorological prediction of strong surface winds in eastern Bulgaria p 853 A87-51195
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962
Analysis of Convair 990 rejected-takeoff accident with emphasis on decision making, training and procedures
[NASA-TM-100189] p 819 N87-29471
TARS
Combustion by-products on F-4 drogue parachutes
[AD-A182929] p 819 N87-29472
TASK COMPLEXITY
An assessment of variable format information presentation p 861 N87-29512
TAXIING
An active control landing gear for the alleviation of aircraft taxi ground loads p 824 A87-53573
TECHNOLOGICAL FORECASTING
Airborne navigation plots its future p 821 A87-53800
Fiscal year 1988 technical objective document
[AD-A180311] p 861 N87-29364
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224
TECHNOLOGY ASSESSMENT
Aerogasdynamics and its development at the Institute of Theoretical and Applied Mechanics of the Siberian Section of the Academy of Sciences of the USSR p 809 A87-53544
Study of utilization of advanced composites in fuselage structures of large transports
[NASA-CR-172404] p 845 N87-28619
TECHNOLOGY UTILIZATION
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
Advanced Propfan Engine Technology (APET) definition study, single and counter-rotation gearbox/pitch change mechanism design
[NASA-CR-168115] p 833 N87-28554
TEMPERATURE DISTRIBUTION
Vortex-scalar element calculations of a diffusion flame stabilized on a plane mixing layer
[NASA-TM-100133] p 802 N87-28501
TEMPERATURE EFFECTS
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869
TEMPERATURE MEASUREMENT
Measurement of spectral emissivity of technical surfaces in high-performance engines p 832 A87-53575
Airflow calibration and exhaust pressure/temperature survey of an F404, S/N 215-109, turbofan engine
[NASA-TM-100159] p 834 N87-29537
TENSILE PROPERTIES
Mechanical properties of thick section AF2-1DA-6 powder metal turbine rotors p 841 A87-51648
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604
TERMINAL FACILITIES
FAA (Federal Aviation Administration) air traffic activity FY 1986
[AD-A183624] p 802 N87-29407
TERMINAL GUIDANCE
Pilot evaluation of population-minimal ground tracks in the airport community p 838 A87-52879
TEST FACILITIES
The NASA strain gage laboratory p 838 A87-52494
Rotor dynamics test facility
[ONERA-RT-20/3239-RY-054R-0] p 839 N87-28567
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
Parachute systems technology: Fundamentals, concepts, and applications
[DE87-011722] p 815 N87-29416
Langley Aircraft Landing Dynamics Facility
[NASA-RP-1189] p 839 N87-29544
TETRACHLORIDES
Applications of the titanium tetrachloride method for flow visualization in aerodynamic testing p 806 A87-52324
THERMAL ABSORPTION
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
THERMAL CONTROL COATINGS
New ZrO2-Yb2O3 plasma-sprayed coatings for thermal barrier applications p 843 A87-53623
THERMAL FATIGUE
Non-isothermal fatigue crack growth in Hastelloy-X p 840 A87-51400
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
THERMAL PROTECTION
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
THERMAL RESISTANCE
High-strength, high-temperature intermetallic compounds p 840 A87-51301
High-temperature polymers for adhesive and composite applications p 843 A87-53888
THERMAL STABILITY
Military aircraft 4-cSt gas turbine engine oil development p 841 A87-52403
THERMAL STRESSES
Toward improved durability in advanced combustors and turbines: Progress in the prediction of thermomechanical loads
[NASA-TM-88932] p 832 N87-28551
THIN AIRFOILS
Supersonic and transonic supersonic flow
[MPIS-16/1986] p 811 N87-28508
THIN BODIES
An analysis of the approximation of the aerodynamic coefficients of thin bodies in a rarefied gas p 808 A87-53526
THIN FILMS
Thin film strain gage development program
[NASA-CR-174707] p 850 N87-28883
THIN PLATES
Scattering of sound by a semi-infinite elastic plate with a soft backing - A matrix Wiener-Hopf problem p 859 A87-52846
THIN WINGS
Solution of the Volterra integral equation in the problem of the unsteady motion of a thin wing p 808 A87-53522
THREE DIMENSIONAL BODIES
Aerodynamics of 3-dimensional bodies in transitional flow
[NASA-CR-181395] p 816 N87-29429
THREE DIMENSIONAL BOUNDARY LAYER
A three-dimensional boundary layer on blunt bodies with a porous surface at angles of attack and sideslip p 803 A87-51007
THREE DIMENSIONAL FLOW
Three-dimensional flow around and radiative heating of blunt bodies p 804 A87-51653
Calculation of three-dimensional supersonic flow past cone-like bodies with a separated shock wave p 805 A87-51671
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
Aerogasdynamics and its development at the Institute of Theoretical and Applied Mechanics of the Siberian Section of the Academy of Sciences of the USSR p 809 A87-53544
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
Application of digital interferogram evaluation techniques to the measurement of 3-D flow fields p 851 N87-29451
Full-potential modeling of blade-vortex interactions p 817 N87-29465
THROATS
The flow field in the second throat region of a wind tunnel, computed by an Euler method p 809 A87-53574
THRUST MEASUREMENT
High accuracy thrust measurement of aeronautical propulsion systems with particular consideration to a hydraulic force measuring device, part 1
[NASA-TT-20080] p 834 N87-28558
THUNDERSTORMS
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
TILT ROTOR AIRCRAFT
T406-AD-400 full-scale development p 831 A87-53423
A strategy for advancing tilt-rotor technology
[NASA-CR-181420] p 827 N87-29500
Cost characteristics of tilt-rotor, conventional air and high speed rail short-haul intercity passenger service
[NASA-CR-181421] p 828 N87-29501
TIME DEPENDENCE
NYANS: A package for time varying control systems --- computer aided design
[FOA-C-20642-2.1] p 858 N87-29174
TIME LAG
Effect of dynamic stall on helicopter trim and flap-lag response p 835 A87-54139
TIME OPTIMAL CONTROL
Time-scale synthesis of a closed-loop discrete optimal control system p 857 A87-52960
TITANIUM ALLOYS
Diffusion bonding of metals p 852 N87-29646

TITANIUM COMPOUNDS
Applications of the titanium tetrachloride method for flow visualization in aerodynamic testing p 806 A87-52324
TOLERANCES (MECHANICS)
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
TRACKING (POSITION)
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367
Velocity accuracy measurement of GPS user equipment p 822 N87-29477
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051
TRADEOFFS
Processor tradeoffs in distributed real-time systems p 857 A87-52796
TRAILING EDGE FLAPS
Leading- and trailing-edge flaps on a low Reynolds number airfoil p 808 A87-52886
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425
TRAILING EDGES
Near wake of an unsteady symmetric airfoil p 803 A87-51221
Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513
The structure of leading edge vortex flows including vortex breakdown p 818 N87-29467
TRAINING SIMULATORS
Simulating Hermes p 840 A87-54195
TRAJECTORY OPTIMIZATION
On the feasibility of low-speed aircraft maneuvers involving extreme angles of attack p 835 A87-54140
Singular trajectories in airplane cruise-dash optimization p 825 N87-28544
TRANSATMOSPHERIC VEHICLES
Aerothermodynamics of transatmospheric vehicles p 807 A87-52878
TRANSDUCERS
PSI multitransducer in low-velocity wind tunnel in Braunschweig p 838 A87-53569
TRANSFER FUNCTIONS
Application of a sensitivity analysis technique to high-order digital flight control systems
[NASA-CR-179429] p 837 N87-28565
TRANSITION FLOW
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
Aerodynamics of 3-dimensional bodies in transitional flow
[NASA-CR-181395] p 816 N87-29429
TRANSMISSIONS (MACHINE ELEMENTS)
The 214ST drive system Lead-the-Fleet program --- inspections of component durability in helicopter engines p 801 A87-53414
Design and development of a high contact ratio helicopter transmission utilizing self-aligning bearingless planetary (SABP) p 849 A87-53418
Advances and applications of Pyrowear 53 in helicopter transmission systems p 849 A87-53419
TRANSOCEANIC FLIGHT
Voyager crew faces turbulence, fatigue on world flight attempt p 801 A87-53552
Around-the-world flight p 801 A87-53553
Once around the earth without refueling p 801 A87-54252
TRANSONIC COMPRESSORS
Modified characteristic method for calculation of supersonic S2 flow field in compressor p 804 A87-51473
TRANSONIC FLOW
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
Moving shock waves in transonic flows p 806 A87-52304
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890
On the computation of transonic leading-edge vortices using the Euler equations p 809 A87-54361
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile
[ETN-87-90038] p 810 N87-28505
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement
[DFVLR-FB-86-59] p 810 N87-28506
Theoretical evaluation of the aerodynamic performance of a transonic wing
[ONERA-20/3423-AY] p 810 N87-28507
Supersonic and transonic supersonic flow
[MPIS-16/1986] p 811 N87-28508
Analysis and design of airfoils and axisymmetric bodies in transonic nonuniform flow p 811 N87-28509
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations p 811 N87-28510
Future Research on Transonic Unsteady Aerodynamics and Its Aeroelastic Applications
[AGARD-R-749] p 812 N87-28518
Transonic rotor flow-measurement technique using holographic interferometry p 851 N87-29434
Reconstruction of a three-dimensional, transonic rotor flow field from holographic interferogram data p 817 N87-29445
Full-potential modeling of blade-vortex interactions p 817 N87-29465
TRANSONIC FLUTTER
Comparison between 2D transonic flutter calculations in the time and frequency domain p 812 N87-28520
TRANSONIC SPEED
Transonic rotor tip design using numerical optimization
[NASA-TM-86771] p 816 N87-29431
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
TRANSONIC WIND TUNNELS
The flow field in the second throat region of a wind tunnel, computed by an Euler method p 809 A87-53574
Evolution, calibration, and operational characteristics of the two-dimensional test section of the Langley 0.3-meter transonic cryogenic tunnel
[NASA-TP-2749] p 839 N87-28570
Transonic interference reduction by limited ventilation wall panels
[NASA-CR-175039] p 815 N87-29419
Optical interferometry in fluid dynamics research p 851 N87-29447
TRANSPIRATION
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475
TRANSPORT AIRCRAFT
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft p 841 A87-51792
Prospects for destructive self-induced interactions in a vortex pair --- due to sinusoidal disturbances from large transport aircraft wakes p 809 A87-53778
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780
Standard test evaluation of graphite fiber/resin matrix composite materials for improved toughness
[NASA-TM-86298] p 845 N87-28618
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469
TURBINE BLADES
Calculation of noise caused by interaction of supersonic cascade and varied oncoming gust p 859 A87-51812
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
TURBINE ENGINES
Mathematical model partitioning and packing for parallel computer calculation p 856 A87-52534
Compound cycle engine program p 831 A87-53428
Toward improved durability in advanced combustors and turbines: Progress in the prediction of thermomechanical loads
[NASA-TM-88932] p 832 N87-28551
TURBINE WHEELS
Hot corrosion site environment in gas turbines p 830 A87-51353
Mechanical properties of thick section AF2-1DA-6 powder metal turbine rotors p 841 A87-51648
TURBINES
Evaluation of naphthene rich turbine fuels as heat sinks for hypersonic aircraft
[AD-A182118] p 845 N87-28658
TURBOCOMPRESSORS
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
An experimental investigation of the effect of inlet flow distortion on compressor performance p 805 A87-51813
Compound cycle engine program p 831 A87-53428
A design system for erosion tolerant helicopter engines p 831 A87-53430
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
Contribution to the description of rotating flow instabilities and inlet perturbations in axial flow compressors
[ETN-87-90040] p 850 N87-28845
TURBOFAN ENGINES
Computation of optimum turbofan mixing with a subaccurate varying specific heat solution p 830 A87-51808
Acoustic mode measurements in the inlet of a turbofan engine p 859 A87-52877
Advanced Propfan Engine Technology (APET) and single-rotation gearbox/pitch change mechanism
[NASA-CR-168113] p 833 N87-28553
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
Airflow calibration and exhaust pressure/temperature survey of an F404, S/N 215-109, turbofan engine
[NASA-TM-100159] p 834 N87-29537
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539
TURBOJET ENGINES
Measurement uncertainty for the Uniform Engine Testing Program conducted at NASA Lewis Research Center
[NASA-TM-88943] p 833 N87-28557
Thin film strain gage development program
[NASA-CR-174707] p 850 N87-28883
TURBOMACHINE BLADES
Fatigue of gas turbine blades under random vibrations p 832 A87-53442
TURBOMACHINERY
Processes in turbomachinery: Applications and exercises --- Romanian book p 808 A87-53412
TURBOPROP AIRCRAFT
Piaggio's Avanti combines jet-like handling with turboprop efficiency p 823 A87-51347
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555
TURBOPROP ENGINES
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan
[AIAA PAPER 87-1893] p 806 A87-52251
Smoke emission tests on series 2 and series 3 Allison T56 turboprop engines
[AD-A182385] p 832 N87-28549
Advanced Propfan Engine Technology (APET) and single-rotation gearbox/pitch change mechanism
[NASA-CR-168113] p 833 N87-28553
Advanced Propfan Engine Technology (APET) definition study, single and counter-rotation gearbox/pitch change mechanism design
[NASA-CR-168115] p 833 N87-28554
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
TURBOSHAFTS
Compressors for advanced turboshaft engines p 831 A87-53427
Multi-variable control concepts for turboshaft engines p 832 A87-53431
TURBULENT BOUNDARY LAYER
Manipulated turbulence structure in flight p 806 A87-52056
KC-135 aero-optical turbulent boundary layer/shear layer experiment revisited p 852 N87-29454
TURBULENT FLOW
Control of the intensity of convective heat transfer in a Laval nozzle under conditions of turbulent flow and in the presence of local separation zones p 803 A87-50972
Manipulated turbulence structure in flight p 806 A87-52056
A numerical study of flow in gas-turbine combustor
[AIAA PAPER 87-2132] p 832 A87-53986
Numerical simulation of compressible homogeneous flows in the turbulent regime p 809 A87-54363
Vortex-scalar element calculations of a diffusion flame stabilized on a plane mixing layer
[NASA-TM-100133] p 802 N87-28501
An analysis of the crossover between local and massive separation on airfoils
[NASA-CR-4096] p 814 N87-29411
An experimental investigation of wing-tip turbulence and sound radiated from the tip region of a blunt-tipped airfoil p 818 N87-29466

High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629
TWO DIMENSIONAL FLOW
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
Numerical simulation of compressible homogeneous flows in the turbulent regime p 809 A87-54363
Evolution, calibration, and operational characteristics of the two-dimensional test section of the Langley 0.3-meter transonic cryogenic tunnel
[NASA-TP-2749] p 839 N87-28570
A numerical model for unsteady two-dimensional flow calculations with flow separation
[DE87-012316] p 850 N87-28866
Full-potential modeling of blade-vortex interactions
p 817 N87-29465
TWO PHASE FLOW
Numerical modeling of supersonic muliphase flows
p 804 A87-51659

U

UH-60A HELICOPTER
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495
ULTRASONIC FLAW DETECTION
Practical application to composite materials of a portable digital ultrasound device controlled by a microprocessor
p 849 A87-53585
UNIFORM FLOW
Numerical simulation of compressible homogeneous flows in the turbulent regime p 809 A87-54363
UNSTEADY FLOW
The measurement of oscillatory pressures with discrete and sweep excitation p 837 A87-51213
Self-excited oscillations in jet engine test cells
p 859 A87-51215
Near wake of an unsteady symmetric airfoil
p 803 A87-51221
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
The application of the method of streams to the numerical modeling of unsteady aerohydrodynamics problems p 804 A87-51654
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810
Parametric exploration of unsteady wing tip vortices
p 807 A87-52355
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890
Unsteady test method applied to wind tunnel studies of flutter p 838 A87-54189
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile
[ETN-87-90038] p 810 N87-28505
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations
p 811 N87-28510
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
A numerical model for unsteady two-dimensional flow calculations with flow separation
[DE87-012316] p 850 N87-28866
UNSTEADY STATE
Future Research on Transonic Unsteady Aerodynamics and Its Aeroelastic Applications
[AGARD-R-749] p 812 N87-28518
USER MANUALS (COMPUTER PROGRAMS)
User's manual for ADAM (Advanced Dynamic Airfoil Model)
[DE87-012342] p 813 N87-28524
USER REQUIREMENTS
Application of artificial intelligence (AI) to aerospace manufacturing - A user perspective p 857 A87-53075
Navigation systems for the new generation of combat and transport helicopters and associated flight tests
p 823 N87-29481

V

VANES
Experimental evaluation of corner turning vanes
[NASA-TM-100143] p 839 N87-28571
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869
VAPOR DEPOSITION
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
VARIABLE GEOMETRY STRUCTURES
A variable geometry combustor for broadened properties fuels
[AIAA PAPER 87-1832] p 830 A87-52246
VARIATIONAL PRINCIPLES
Direct variational method in flight dynamics boundary value problems --- Russian book p 856 A87-52233
VECTORS (MATHEMATICS)
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531
VEGETATIVE INDEX
Aircraft microwave radiometry of land
p 853 A87-53269
VELOCITY MEASUREMENT
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
Application of particle imaging velocimetry in windtunnels p 848 A87-52314
Velocity accuracy measurement of GPS user equipment p 822 N87-29477
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629
VERTICAL LANDING
Multimission STOVL application of a hybrid powered-lift system p 824 A87-53776
VERTICAL TAKEOFF AIRCRAFT
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
VERY HIGH FREQUENCIES
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
VERY LOW FREQUENCIES
Radiation resistance of thin antennas of arbitrary elevation and configuration over perfectly conducting ground p 848 A87-52189
VIBRATION
Propfan test assessment testbed aircraft flutter model test report
[NASA-CR-179458] p 814 N87-29413
VIBRATION DAMPING
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system
p 825 A87-53901
Small-scale rotor test rig capabilities for testing vibration alleviation algorithms
[NASA-TM-100002] p 858 N87-30102
VIBRATORY LOADS
The prediction of the vibratory airloads of helicopter rotors in forward flight p 823 A87-51214
Fatigue of gas turbine blades under random vibrations
p 832 A87-53442
VIDEO COMMUNICATION
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469
VIDEO EQUIPMENT
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
VISCOELASTICITY
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893
VISCOSITY
Military aircraft 4-cSt gas turbine engine oil development p 841 A87-52403
VISCOUS FLOW
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
Finite element methods for incompressible viscous flow p 848 A87-52393
An analysis of the crossover between local and massive separation on airfoils
[NASA-CR-4096] p 814 N87-29411
The aerothermodynamic environment for holes in hypersonic configurations
[DE87-003790] p 814 N87-29414
VISUAL PERCEPTION
Organization of displays in the visual space of the combat aircraft pilot p 856 N87-29516
VOICE COMMUNICATION
Voice control of cockpit systems p 837 N87-29526
The flight evaluation of a speech recognition and a speech output system in an advanced cockpit display and flight management system for helicopters
p 829 N87-29527
VOICE CONTROL
Voice control of cockpit systems p 837 N87-29526
VOLTERRA EQUATIONS
Solution of the Volterra integral equation in the problem of the unsteady motion of a thin wing
p 808 A87-53522
VORTEX BREAKDOWN
Visualization of vortex breakdown on a delta wing
p 807 A87-52357
Prospects for destructive self-induced interactions in a vortex pair --- due to sinusoidal disturbances from large transport aircraft wakes p 809 A87-53778
The structure of leading edge vortex flows including vortex breakdown p 818 N87-29467
VORTEX RINGS
Supersonic vortex rings - Visualization techniques
p 807 A87-52360
VORTEX SHEDDING
Implementation and validation of a wake model for low-speed forward flight
[NASA-CR-181341] p 811 N87-28514
VORTICES
The prediction of the vibratory airloads of helicopter rotors in forward flight p 823 A87-51214
Applications of the titanium tetrachloride method for flow visualization in aerodynamic testing p 806 A87-52324
Influence of forebody cross-sectional shape on wing vortex-burst location p 808 A87-52885
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777
On the computation of transonic leading-edge vortices using the Euler equations p 809 A87-54361
Numerical simulation of compressible homogeneous flows in the turbulent regime p 809 A87-54363
Vortex-scalar element calculations of a diffusion flame stabilized on a plane mixing layer
[NASA-TM-100133] p 802 N87-28501
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations
p 811 N87-28510
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
Enhanced mixing of an axisymmetric jet by aerodynamic excitation
[NASA-CR-175059] p 815 N87-29418
Full-potential modeling of blade-vortex interactions
p 817 N87-29465

W

WAKES
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement
[DFVLR-FB-86-59] p 810 N87-28506
WALL FLOW
Transonic interference reduction by limited ventilation wall panels
[NASA-CR-175039] p 815 N87-29419
WAVE DRAG
Wave drag analysis of realistic fighter aircraft using a full-potential method p 807 A87-52882
WAVE PROPAGATION
KC-135 aero-optical turbulent boundary layer/shear layer experiment revisited p 852 N87-29454
WEAPON SYSTEM MANAGEMENT
Automation at the man-machine interface
p 855 N87-29504
WEAR
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
WEATHER
Preliminary Memphis FAA (Federal Aviation Administration)/Lincoln Laboratory operational weather studies results
[AD-A182730] p 854 N87-29057
WEATHER FORECASTING
Weather Research Program
[PB87-196390] p 854 N87-29065
WEIGHT REDUCTION
Application of modern materials technologies in small gas turbine engines p 831 A87-53429
WELD STRENGTH
Diffusion bonding of metals p 852 N87-29646
WIENER HOPF EQUATIONS
Scattering of sound by a semi-infinite elastic plate with a soft backing - A matrix Wiener-Hopf problem
p 859 A87-52846

WIND DIRECTION
Determination of wind velocity and direction in the lower part of the atmospheric boundary layer on the basis of ground data p 854 A87-53969
WIND SHEAR
Wind shear p 853 A87-51232
Preliminary Memphis FAA (Federal Aviation Administration)/Lincoln Laboratory operational weather studies results
[AD-A182730] p 854 N87-29057
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060
WIND TUNNEL APPARATUS
PSI multitransducer in low-velocity wind tunnel in Braunschweig p 838 A87-53569
Some proposed enhancements to the NASA Langley 13-inch magnetic suspension and balance system
[NASA-CR-181152] p 839 N87-29543
WIND TUNNEL MODELS
Simultaneous active controls on wind tunnel model p 836 A87-54190
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191
WIND TUNNEL STABILITY TESTS
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543
WIND TUNNEL TESTS
The measurement of oscillatory pressures with discrete and sweep excitation p 837 A87-51213
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan
[AIAA PAPER 87-1893] p 806 A87-52251
Moving shock waves in transonic flows p 806 A87-52304
Application of particle imaging velocimetry in windtunnels p 848 A87-52314
Parametric exploration of unsteady wing tip vortices p 807 A87-52355
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
Rain effects at low Reynolds number p 808 A87-52884
Aerogasdynamics and its development at the Institute of Theoretical and Applied Mechanics of the Siberian Section of the Academy of Sciences of the USSR p 809 A87-53544
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782
Unsteady test method applied to wind tunnel studies of flutter p 838 A87-54189
Investigation of F-16 control surface failures and optimal setting of functional controls
[AD-A182667] p 825 N87-28542
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555
Toward comparing experiment and theory for corroborative research on hingeless rotor stability in forward flight
[NASA-CR-181354] p 836 N87-28562
Development of a reduced area horizontal tail for a wide body jet aircraft
[NASA-CR-172278] p 837 N87-28564
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425
Status of holographic interferometry at Wright Patterson Air Force Base p 851 N87-29436
Optical interferometry in fluid dynamics research p 851 N87-29447
The results of a wind tunnel investigation of a model rotor with a free tip
[NASA-TM-86758] p 827 N87-29496
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
WIND TUNNEL WALLS
The flow field in the second throat region of a wind tunnel, computed by an Euler method p 809 A87-53574
WIND TUNNELS
Experimental evaluation of corner turning vanes
[NASA-TM-100143] p 839 N87-28571
Application of a panel method to wake-vortex/wing interaction and comparison with experimental data
[NASA-TM-88337] p 817 N87-29461
WIND TURBINES
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956
WIND VELOCITY
The problem of the aviation-meteorological prediction of strong surface winds in eastern Bulgaria p 853 A87-51195
WIND VELOCITY MEASUREMENT
Determination of wind velocity and direction in the lower part of the atmospheric boundary layer on the basis of ground data p 854 A87-53969
WING FLAPS
The design and analysis of simple low speed flap systems with the aid of linearized theory computer programs
[NASA-CR-3913] p 812 N87-28522
WING OSCILLATIONS
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
Solution of the Volterra integral equation in the problem of the unsteady motion of a thin wing p 808 A87-53522
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
WING PLANFORMS
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425
WING PROFILES
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile
[ETN-87-90038] p 810 N87-28505
Theoretical evaluation of the aerodynamic performance of a transonic wing
[ONERA-20/3423-AY] p 810 N87-28507
WING TIP VORTICES
Parametric exploration of unsteady wing tip vortices p 807 A87-52355
An experimental investigation of wing-tip turbulence and sound radiated from the tip region of a blunt-tipped airfoil p 818 N87-29466
WING TIPS
An experimental investigation of wing-tip turbulence and sound radiated from the tip region of a blunt-tipped airfoil p 818 N87-29466
The results of a wind tunnel investigation of a model rotor with a free tip
[NASA-TM-86758] p 827 N87-29496
WINGS
Profiling of a lifting convex wing by a hodograph method p 805 A87-51672
Age forming aluminum in an autoclave p 848 A87-52678
Rain effects at low Reynolds number p 808 A87-52884
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
The design and analysis of simple low speed flap systems with the aid of linearized theory computer programs
[NASA-CR-3913] p 812 N87-28522
Flow energizers. Task A
[NASA-CR-176202] p 812 N87-28523
Some numerical calculations by using linear classical sonic theories approached from sub- or supersonic speeds
[NASA-TT-20112] p 813 N87-28527
ACEE composite structures technology
[NASA-CR-172359] p 844 N87-28613
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
Standard test evaluation of graphite fiber/resin matrix composite materials for improved toughness
[NASA-TM-86298] p 845 N87-28618
WIRE
PTFE (polytetrafluoroethylene) resin selection for high performance wire and cable
[AD-P005211] p 846 N87-29227
WORK CAPACITY
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949
WORKLOADS (PSYCHOPHYSIOLOGY)
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469
Automation at the man-machine interface p 855 N87-29504
Organization of displays in the visual space of the combat aircraft pilot p 856 N87-29516
WORKSTATIONS
JPL multipolarization workstation - Hardware, software and examples of data analysis p 858 A87-53231

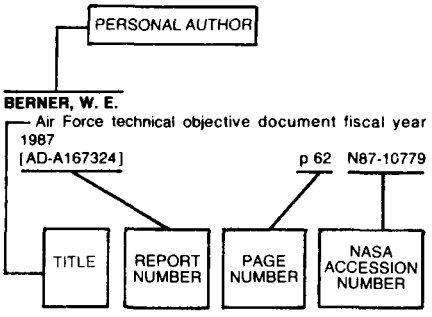
Y

YAW
Jet spoiler as a yaw control device p 835 A87-52880
YAWING MOMENTS
Contribution of wing dihedral to sideforce, yawing moment and rolling moment derivatives due to rate of roll at subsonic speeds, (Y sub p)sub gamma, (N sub p)sub gamma and (L sub p)sub gamma
[ESDU-85006] p 813 N87-29409
Estimation of sideforce, yawing moment and rolling moment derivatives due to rate of roll for complete aircraft at subsonic speeds
[ESDU-85010] p 826 N87-29490
YIELD POINT
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316
YTTERBIUM COMPOUNDS
New ZrO2-Yb2O3 plasma-sprayed coatings for thermal barrier applications p 843 A87-53623
YTTRIUM OXIDES
Dispersion strengthened alloys for aerospace p 844 A87-53894

Z

ZIRCONIUM OXIDES
New ZrO2-Yb2O3 plasma-sprayed coatings for thermal barrier applications p 843 A87-53623

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

ABDELWAHAB, MAHMOOD
Measurement uncertainty for the Uniform Engine Testing Program conducted at NASA Lewis Research Center
[NASA-TM-88943] p 833 N87-28557

ABRAHAMS, I. D.
Scattering of sound by a semi-infinite elastic plate with a soft backing - A matrix Wiener-Hopf problem
p 859 A87-52846

ADELMAN, HENRY G.
Aerothermodynamics of transatmospheric vehicles
p 807 A87-52878

AHMED, OMAR AMRANI
Solution of aerodynamic integral equations without matrix inversion p 808 A87-52889

AKISHITA, S.
Development of supersonic computational aerodynamic program using panel method
[NASA-TT-20113] p 813 N87-28526

ALCORN, CHARLES W.
Some proposed enhancements to the NASA Langley 13-inch magnetic suspension and balance system
[NASA-CR-181152] p 839 N87-29543

ALLEN, C.
KC-135 aero-optical turbulent boundary layer/shear layer experiment revisited p 852 N87-29454

AMALBERTI, R.
Sophisticated integral control methods for use in flight
p 856 N87-29510
Organization of displays in the visual space of the combat aircraft pilot p 856 N87-29516

ANDERSON, C.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502

ANDERSON, R. D.
Advanced Propfan Engine Technology (APET) definition study, single and counter-rotation gearbox/pitch change mechanism design
[NASA-CR-168115] p 833 N87-28554

ANDERSON, W. L.
Thin film strain gage development program
[NASA-CR-174707] p 850 N87-28883

ANDO, S.
Some numerical calculations by using linear classical sonic theories approached from sub- or supersonic speeds
[NASA-TT-20112] p 813 N87-28527

ANDREEV, V.
The problem of the aviation-meteorological prediction of strong surface winds in eastern Bulgaria
p 853 A87-51195

ANDREWS, ALISON E.
AI at Ames: Artificial Intelligence research and application at NASA Ames Research Center, Moffett Field, California, February 1985 p 858 N87-29140

ANDREWS, G. E.
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475

ANFIMOV, N. A.
Three-dimensional flow around and radiative heating of blunt bodies p 804 A87-51653

ANISIMOV, A. V.
Investigation of the life cycles of complex engineering systems using Petri nets p 857 A87-52832

ANTONOV, A. M.
Calculation of the aerodynamic coefficients of aircraft on a computer with allowance for physicochemical reactions p 803 A87-50876

AOKI, TOSHIYUKI
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370

APPLIN, ZACHARY T.
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462

ARNOLD, J. E.
SPACE/COHMEX data inventory document
[NASA-TM-4006] p 854 N87-29068

ARPASI, DALE J.
Mathematical model partitioning and packing for parallel computer calculation p 856 A87-52534

ARSENEAUX, P. J.
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555

ARVIN, J. R.
T406-AD-400 full-scale development
p 831 A87-53423

ASERE, A. A.
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475

ASHILL, P. R.
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782

ASHLEY, H.
On the feasibility of low-speed aircraft maneuvers involving extreme angles of attack p 835 A87-54140

AWFORD, IAN
Civil liability concerning unlawful interference with civil aviation p 861 A87-52900

AZHAEV, A. N.
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949

B

BAALS, ROBERT A.
Acoustic effects on profile drag of a laminar flow airfoil
[NASA-TM-100505] p 860 N87-30155

BABA, Y.
Development of fine-grained 7075-O sheet for aircraft taper-rolled stringer p 842 A87-52661

BABAKOV, A. V.
The application of the method of streams to the numerical modeling of unsteady aerohydrodynamics problems p 804 A87-51654

BACHALO, W. D.
Optical interferometry in fluid dynamics research
p 851 N87-29447

BACK, L. H.
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783

BAEUMKER, M.
Navigation systems for the new generation of combat and transport helicopters and associated flight tests
p 823 N87-29481

BAGHDADI, S.
Compressors for advanced turboshaft engines
p 831 A87-53427

BAILEY, MELVIN L.
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531

BAILEY, R. S.
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869

BAILLIE, R. L.
PTFE (polytetrafluoroethylene) resin selection for high performance wire and cable
[AD-P005211] p 846 N87-29227

BAIRD, J. P.
Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies
p 807 A87-52371

BAIRD, JOHN P.
Supersonic vortex rings - Visualization techniques
p 807 A87-52360

BAKKER, P. G.
Calculation of pressure distributions on supersonic delta wings using stagnation solutions
[VTH-LR-484] p 815 N87-29417

BALANIN, B. A.
A supersonic jet in a chamber with a diaphragm
p 808 A87-53520

BANDO, S.
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft
p 841 A87-51792

BANK, W.
Applications of the titanium tetrachloride method for flow visualization in aerodynamic testing p 806 A87-52324
Parametric exploration of unsteady wing tip vortices
p 807 A87-52355

BANKSTON, C. P.
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783

BANSAL, P. N.
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555

BARBI, C.
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777

BARENBERG, ERNEST J.
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545

BARNETT, M.
An analysis of the crossover between local and massive separation on airfoils
[NASA-CR-4096] p 814 N87-29411

BARTEL, H. W.
Static tests of the propulsion system
[AIAA PAPER 87-1728] p 830 A87-52245

BASHUTSKAIA, T. V.
An approach to the numerical modeling of the dynamics of reacting gases in nozzles p 847 A87-50872

BATTHAUER, BYRON E.
Analysis of Convair 990 rejected-takeoff accident with emphasis on decision making, training and procedures
[NASA-TM-100189] p 819 N87-29471

BAUMEISTER, HARTMUT
A contribution to the aerodynamics of unsymmetrical aircraft configurations
[ETN-87-90030] p 810 N87-28504

BEANE, G. A.
Military aircraft 4-cSt gas turbine engine oil development p 841 A87-52403

BECKER, ALFRED
Modeling of radio navigation systems in the neighborhood of airports p 821 N87-28533

AUTHOR

BECKER, F.
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452
BECKER, FRIEDHELM
Application of digital interferogram evaluation techniques to the measurement of 3-D flow fields p 851 N87-29451
BECKETT, P.
Voice control of cockpit systems p 837 N87-29526
BEDIAKO, E. D.
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
BEDNARCZYK, J. J.
PTFE (polytetrafluoroethylene) resin selection for high performance wire and cable
[AD-P005211] p 846 N87-29227
BEN-DOR, G.
A reconsideration of the three-shock theory for a pseudo-steady Mach reflection p 810 A87-54364
BERBENTE, CORNELIU
Processes in turbomachinery: Applications and exercises p 808 A87-53412
BERBIUK, V. E.
Optimization of the controlled rotations of a rigid body with an elastic rod using first integrals of a free system p 859 A87-50915
BERTELRUD, A.
Manipulated turbulence structure in flight p 806 A87-52056
BERTIN, JOHN J.
The aerothermodynamic environment for holes in hypersonic configurations
[DE87-003790] p 814 N87-29414
BHANDARI, INDERPAL S.
Processor tradeoffs in distributed real-time systems p 857 A87-52796
BICKERDIKE, R. L.
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
BIESIADNY, THOMAS J.
Measurement uncertainty for the Uniform Engine Testing Program conducted at NASA Lewis Research Center
[NASA-TM-88943] p 833 N87-28557
BILIMORIA, KARL D.
Singular trajectories in airplane cruise-dash optimization p 825 N87-28544
BILLMANN, BARRY R.
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
BINFORD, R.
Flow energizers. Task A
[NASA-CR-176202] p 812 N87-28523
BISCHLER, P. J. E.
The effect of prestrain and of ageing at room temperature on the mechanical properties of an Al-Li-Cu-Mg alloy p 842 A87-52683
BISCOS, Y.
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
BISMES, F.
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
BLELLOCH, P. A.
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system p 825 A87-53901
BO, TAO
Modified characteristic method for calculation of supersonic S2 flow field in compressor p 804 A87-51473
BOBULA, G. A.
Compound cycle engine program p 831 A87-53428
BOLDMAN, DONALD R.
Experimental evaluation of corner turning vanes
[NASA-TM-100143] p 839 N87-28571
BONSIGNORI, R.
Aircraft microwave radiometry of land p 853 A87-53269
BOREISHA, IU. E.
Investigation of the life cycles of complex engineering systems using Petri nets p 857 A87-52832
BORODIN, A. I.
A three-dimensional boundary layer on blunt bodies with a porous surface at angles of attack and sideslip p 803 A87-51007
BORONOW, W.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
BOUSMAN, WILLIAM G.
Estimation of blade airloads from rotor blade bending moments
[NASA-TM-100020] p 815 N87-29421
BRAATEN, MARK E.
A numerical study of flow in gas-turbine combustor
[AIAA PAPER 87-2132] p 832 A87-53986
BRADLEY, WALTER L.
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604
BRAUN, A.
Measurement of spectral emissivity of technical surfaces in high-performance engines p 832 A87-53575
BRAUSCH, J. F.
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
BRENDEL, M.
Visualization of the laminar separation bubble on airfoils at low Reynolds numbers p 806 A87-52348
BRIAUD, J.-L.
Pressuremeter moduli for airport pavement design and evaluation
[DOT/FAA/PM-87/10] p 839 N87-28572
BRITCHER, COLIN P.
Some proposed enhancements to the NASA Langley 13-inch magnetic suspension and balance system
[NASA-CR-181152] p 839 N87-29543
BROKOF, ULRICH
Models for the description of holding procedures in air traffic as an aid for optimization with respect to safety and efficiency p 822 N87-28536
BROOKS, B. M.
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555
BROWN, W.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
BRYANT, WAYNE H.
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
BUITKAMP, H.
A comparison between integrated and separated navigation and flight control motion sensing equipment and a concept for aircraft motion sensing and attitude/heading determination p 828 A87-51941
BULLOCH, CHRIS
Aviation satcoms p 820 A87-51322
Space-age navigation p 820 A87-51325
BURKET, HAROLD D.
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
BURNETTE, FRED
JPL multipolarization workstation - Hardware, software and examples of data analysis p 858 A87-53231
BURNS, J. A.
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893
BURNS, MAUREEN E.
Airflow calibration and exhaust pressure/temperature survey of an F404, S/N 215-109, turbofan engine
[NASA-TM-100159] p 834 N87-29537
BUSTAMANTE, ALBINO C.
The aerothermodynamic environment for holes in hypersonic configurations
[DE87-003790] p 814 N87-29414

C

CAMPBELL-WILSON, DUNCAN
Supersonic vortex rings - Visualization techniques p 807 A87-52360
CAMPION, M. C.
Study of utilization of advanced composites in fuselage structures of large transports
[NASA-CR-172404] p 845 N87-28619
CAPIT, B.
Inertial-GPS - A marriage of convenience under test p 820 A87-53578
CAREL, OLIVIER
The role of Navstar/GPS in civil aviation p 820 A87-53582
CARLSON, HARRY W.
The design and analysis of simple low speed flap systems with the aid of linearized theory computer programs
[NASA-CR-3913] p 812 N87-28522
CARTER, J. E.
An analysis of the crossover between local and massive separation on airfoils
[NASA-CR-4096] p 814 N87-29411
CASSAING, J.
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191
CASSIL, CHARLES E.
Preliminary airworthiness evaluation of the UH-1H helicopter with the T53-L-703 engine installed
[AD-A182369] p 825 N87-28541
CASTEL, J. G.
Practical application to composite materials of a portable digital ultrasound device controlled by a microprocessor p 849 A87-53585
CASTELBOU, C.
Satellites for air navigation - An airline view p 820 A87-53580
CASTEX, A.
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777
CASTOR, J. G.
Compound cycle engine program p 831 A87-53428
CATALANO, GEORGE D.
Lift and pitching moment coefficient changes from low-level freestream turbulence p 808 A87-52888
CENTERS, PHILLIP W.
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
CHAMBERLAIN, JOHN C.
Lightweight 2 fiber aviation cable featuring low fiber stress levels
[AD-P005282] p 826 N87-29297
CHANG, HO-PEN
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060
CHANG, JEN-FU
Analysis and design of airfoils and axisymmetric bodies in transonic nonuniform flow p 811 N87-28509
CHAPMAN, ANDREW J.
Standard test evaluation of graphite fiber/resin matrix composite materials for improved toughness
[NASA-TM-86298] p 845 N87-28618
CHEN, GUN-SHING
Experimental aeroelastic behavior of forward-swept graphite/epoxy wings with rigid-body freedom p 824 A87-53781
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543
CHEN, S.-H.
Near wake of an unsteady symmetric airfoil p 803 A87-51221
CHERNYI, G. G.
Numerical modeling in aerohydrodynamics p 804 A87-51651
CHETTY, SHYAM
An improved design technique for model following control systems in in-flight simulation
[DFVLR-FB-87-09] p 836 N87-28561
CHIARANTINI, L.
Aircraft microwave radiometry of land p 853 A87-53269
CHIN, YA-TUNG
Multimission STOVL application of a hybrid powered-lift system p 824 A87-53776
CHO, Y. I.
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783
CHOUCHANE, M.
Effect of dynamic stall on helicopter trim and flap-lag response p 835 A87-54139
CHRISTENSEN, J.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
CHRISTODOULOU, THEODOROS
Reducing fuel consumption of subsonic aircraft by optimal cyclic cruise p 824 A87-52881
CHUSHKIN, P. I.
Calculation of three-dimensional supersonic flow past cone-like bodies with a separated shock wave p 805 A87-51671
CLAING, R. G.
Thin film strain gage development program
[NASA-CR-174707] p 850 N87-28883
CLARK, D.
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
CLARK, RONALD K.
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
CLARKE, J.
Approach to study of PRF sensitivity in airborne pulse-Doppler radar p 829 A87-53802

CLIFF, E. M.
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893
COGGESHALL, RANDY L.
The 737 graphite composite flight spoiler flight service evaluation
[NASA-CR-178322] p 846 N87-29609
CONDOM, PIERRE
Airborne navigation plots its future
p 821 A87-53800
COPPA, ANTHONY P.
Structural changes occurring in composite ring-disk flywheels under high speed rotation p 841 A87-51757
CORRIGAN, ROBERT D.
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956
COSENTINO, P. J.
Pressuremeter moduli for airport pavement design and evaluation
[DOT/FAA/PM-87/10] p 839 N87-28572
COSTES, M.
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
COWAN, R.
A flight evaluation of voice interaction as a component of an integrated helicopter avionics system
[RAE-TM-FS(B)-637] p 829 N87-28547
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data
[RAE-TM-FS(B)-638] p 829 N87-28548
COWLEY, E. B.
Approach to study of PRF sensitivity in airborne pulse-Doppler radar p 829 A87-53802
COY, J. J.
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
CRAIG, J.
KC-135 aero-optical turbulent boundary layer/shear layer experiment revisited p 852 N87-29454
CROPPER, D. J.
The effect of load dwells on the fatigue of carbon fiber composites
[BAE-MSM-R-GEN-0547] p 844 N87-28606

D

DAMODARAN, MURALI
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations
p 811 N87-28510
DAVIS, PAMELA A.
Langley Aircraft Landing Dynamics Facility
[NASA-RP-1189] p 839 N87-29544
DAY, LEE
Simulating Hermes p 840 A87-54195
DE CHEZELLES, NICOLAS
The Navstar/GPS program - An evolution or a revolution in the world of navigation p 840 A87-53581
DELOACH, RICHARD
Pilot evaluation of population-minimal ground tracks in the airport community p 838 A87-52879
DENISON, ROBERT L.
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224
DESTUYNDER, R.
Unsteady test method applied to wind tunnel studies of flutter p 838 A87-54189
Simultaneous active controls on wind tunnel model
p 836 A87-54190
DILK, ANDREW J.
Aviation tort litigation against the United States - Judicial inroads on the pilot-in-command concept
p 861 A87-52171
DILLENIUS, MARNIX F. E.
Program LRCDM2: Improved aerodynamic prediction program for supersonic canard-tail missiles with axisymmetric bodies
[NASA-CR-3883] p 813 N87-28525
DIRUSSO, ROBERT
Advances and applications of Pyrowear 53 in helicopter transmission systems p 849 A87-53419
DISTEFANO, J. T.
Preliminary Memphis FAA (Federal Aviation Administration)/Lincoln Laboratory operational weather studies results
[AD-A182730] p 854 N87-29057
DODDS, W. J.
A variable geometry combustor for broadened properties fuels
[AIAA PAPER 87-1832] p 830 A87-52246
DOW, MARVIN B.
The ACEE program and basic composites research at Langley Research Center (1975 to 1986): Summary and bibliography
[NASA-RP-1177] p 846 N87-29612
DOWNING, DAVID R.
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
Application of a sensitivity analysis technique to high-order digital flight control systems
[NASA-CR-179429] p 837 N87-28565
DREVET, J.-P.
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191
DROZHZHIN, V. L.
Fatigue strength of 30KhGSN2A steel lugs under programmed loading p 843 A87-53441
DU, ANDI
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel
p 837 A87-51968
DUDLEY, MICHAEL R.
Experimental techniques for three-axes load cells used at the National Full-Scale Aerodynamics Complex
[NASA-TM-86693] p 826 N87-28546
DUGUNDJI, JOHN
Experimental aeroelastic behavior of forward-swept graphite/epoxy wings with rigid-body freedom
p 824 A87-53781
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543
DULOV, V. G.
Aerogasdynamics and its development at the Institute of Theoretical and Applied Mechanics of the Siberian Section of the Academy of Sciences of the USSR
p 809 A87-53544
DUNHAM, DANA MORRIS
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
DUTTON, J. C.
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629

E

EGER, SERGEI MIKHAILOVICH
Principles of the computer-aided design of aircraft
p 858 A87-53957
EGUCHI, YUZURU
Finite element methods for incompressible viscous flow p 848 A87-52393
EHERNBERGER, L. J.
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
ELMORE, K. L.
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060
ELVES, ROBERT G.
Combustion by-products on F-4 drogue parachutes
[AD-A182929] p 819 N87-29472
ELZEBDA, JAMAL M.
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
EMSLEY, HOWARD T.
Rain effects at low Reynolds number
p 808 A87-52884
ENSIGN, C. ROBERT
Toward improved durability in advanced combustors and turbines: Progress in the prediction of thermomechanical loads
[NASA-TM-88932] p 832 N87-28551
ENSWORTH, CLINTON B. F., III
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956
EPPS, JON A.
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545
ERSHOV, B. A.
Solution of the Volterra integral equation in the problem of the unsteady motion of a thin wing
p 808 A87-53522
EVANS, B.
Development of aluminium-lithium alloys in the UK
p 843 A87-53893

F

FAGAN, J. R.
T406-AD-400 full-scale development
p 831 A87-53423
FAIRMAN, TERRY M.
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
FAN, FEIDA
Calculation of noise caused by interaction of supersonic cascade and varied oncoming gust p 859 A87-51812
FANG, ZONGYI
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
FAVIER, D.
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777
FEAR, J. S.
A variable geometry combustor for broadened properties fuels
[AIAA PAPER 87-1832] p 830 A87-52246
FEMLING, GARY W.
General aviation aircraft utilization in the construction industry
[AD-A183155] p 802 N87-29404
FENG, X. H.
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471
FERRAZZOLI, P.
Aircraft microwave radiometry of land
p 853 A87-53269
FIELDS, JAMES M.
Community reactions to helicopter noise - Results from an experimental study p 853 A87-52064
FINAISH, F.
Applications of the titanium tetrachloride method for flow visualization in aerodynamic testing p 806 A87-52324
Parametric exploration of unsteady wing tip vortices
p 807 A87-52355
FINGEROTE, S. I.
Configuration design of a helicopter integrated navigation system p 823 N87-29480
FISKE, G. H.
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539
FLEISCHER, R. L.
High-strength, high-temperature intermetallic compounds p 840 A87-51301
FLOWER, H. M.
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
FOLENTA, D. J.
Design and development of a high contact ratio helicopter transmission utilizing self-aligning bearingless planetary (SABP) p 849 A87-53418
FOMIN, V. M.
Aerogasdynamics and its development at the Institute of Theoretical and Applied Mechanics of the Siberian Section of the Academy of Sciences of the USSR
p 809 A87-53544
FOMIN, V. N.
Three-dimensional flow around and radiative heating of blunt bodies p 804 A87-51653
FORD, DAVID
Reducing total cost of ownership - A challenge to helicopter propulsion specialists p 861 A87-53417
FORESTER, J. A.
An assessment of variable format information presentation p 861 N87-29512
FRANK, W.
Moving shock waves in transonic flows
p 806 A87-52304
FRASER, H. L.
Mechanical properties of rapidly solidified Al-4Be
p 842 A87-52658
FREMAUX, CHARLES M.
Lift and pitching moment coefficient changes from low-level freestream turbulence p 808 A87-52888

FREYMANN, R.
Interactions between an aircraft structure and active control systems p 835 A87-52964
An active control landing gear for the alleviation of aircraft taxi ground loads p 824 A87-53573
FREYMUTH, P.
Applications of the titanium tetrachloride method for flow visualization in aerodynamic testing p 806 A87-52324
Parametric exploration of unsteady wing tip vortices p 807 A87-52355
FRIEDMANN, P. P.
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system p 825 A87-53901
FRIELINGHAUS, G.
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823
FROST, WALTER
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060
FRUBOESE, JOACHIM
High accuracy thrust measurement of aeronautical propulsion systems with particular consideration to a hydraulic force measuring device, part 1
[NASA-TT-20080] p 834 N87-28558
FU, C. G.
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471
FUJIKAWA, T.
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373

G

GAI, S. L.
Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies p 807 A87-52371
GAI, SUDHIR
Supersonic vortex rings - Visualization techniques p 807 A87-52360
GAINES, MIKE
Corsair with more - A-7 plus p 824 A87-53744
GALLAGHER, DONALD W.
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
GALLIMORE, F.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
GANNON, J. K.
Future impact of manufacturing technology and automation in Pratt & Whitney Canada p 849 A87-53416
GAONKAR, G.
Toward comparing experiment and theory for corroborative research on hingeless rotor stability in forward flight
[NASA-CR-181354] p 836 N87-28562
GARCIA-FOGEDA, PABLO NUNEZ
Supersonic flow over elastic bodies in oscillation p 817 N87-29464
GAVAGHAN, HELEN
Aircraft fires - Living through the smoke p 818 A87-54315
GELDER, THOMAS F.
Experimental evaluation of corner turning vanes
[NASA-TM-100143] p 839 N87-28571
GENTRY, GARL L., JR.
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
GEORGES, J.-F.
Head-up flying p 835 A87-53583
GHONIEM, AHMED F.
Vortex-scalar element calculations of a diffusion flame stabilized on a plane mixing layer
[NASA-TM-100133] p 802 N87-28501
GILMOUR, J. DAVID
Problems associated with the integration of artificial intelligence into crew systems p 857 A87-53062
GIVI, PEYMAN
Vortex-scalar element calculations of a diffusion flame stabilized on a plane mixing layer
[NASA-TM-100133] p 802 N87-28501
GLISTA, ANDREW S., JR.
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
GODARD, J. L.
Theoretical evaluation of the aerodynamic performance of a transonic wing
[ONERA-20/3423-AY] p 810 N87-28507
GOLOVACHEV, IU. P.
Numerical modeling of supersonic muliphase flows p 804 A87-51659
GONG, HONGRUI
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810
GOODMAN, H. M.
SPACE/COHMEX data inventory document
[NASA-TM-4006] p 854 N87-29068
GOSWAMI, D. Y.
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503
GRABER, E. J.
Static tests of the propulsion system
[AIAA PAPER 87-1728] p 830 A87-52245
GRADOBOEV, M. I.
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880
GRAHAM, DAVID R.
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422
GRANT, H. P.
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869
Thin film strain gage development program
[NASA-CR-174707] p 850 N87-28883
GRAUE, R.
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483
GRAVELLE, A.
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
Simultaneous active controls on wind tunnel model p 836 A87-54190
GRAY, DAVID F.
Mechanical properties of thick section AF2-1DA-6 powder metal turbine rotors p 841 A87-51648
GREELEY, BRENDAN M., JR.
Piaggio's Avanti combines jet-like handling with turboprop efficiency p 823 A87-51347
GREENE, C.
Configuration design of a helicopter integrated navigation system p 823 N87-29480
GREGSON, P. J.
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
GRENICH, A. F.
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 1
[AD-A183690] p 826 N87-29493
GRISHCHENKO, A. E.
An approach to the numerical modeling of the dynamics of reacting gases in nozzles p 847 A87-50872
GSCHWENDER, LOIS J.
Military aircraft 4-cSt gas turbine engine oil development p 841 A87-52403
GUFFOND, D.
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191
GUPTA, R. N.
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
GUTTMAN, JERRY
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532
GUYNN, E. GAIL
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604

H

HAASE, W.
The flow field in the second throat region of a wind tunnel, computed by an Euler method p 809 A87-53574
HACK, G. A. J.
Dispersion strengthened alloys for aerospace p 844 A87-53894
HALL, ROBERT M.
Influence of forebody cross-sectional shape on wing vortex-burst location p 808 A87-52885
HAMBRICK, DENISE M.
Age forming aluminum in an autoclave p 848 A87-52678
HAN, ZHAOYUAN
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel p 837 A87-51968
HANDSCHUH, R. F.
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
HASLIM, LEONARD A.
Electro-expulsive separation system
[NASA-CASE-ARC-11613-1] p 849 N87-28833
HASSAN, H. A.
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890
HASSENPFLUG, W.
A comparison between integrated and separated navigation and flight control motion sensing equipment and a concept for aircraft motion sensing and attitude/heading determination p 828 A87-51941
Navigation systems for the new generation of combat and transport helicopters and associated flight tests p 823 N87-29481
HAYDUK, ROBERT J.
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780
HAZARIKA, BIRINCHI K.
An investigation of the flow characteristics in the blade endwall corner region
[NASA-CR-4076] p 814 N87-29412
HEBRARD, P.
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
HEITMEIR, F.
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483
HENSCHEL, FROHMUT
An improved design technique for model following control systems in in-flight simulation
[DFVLR-FB-87-09] p 836 N87-28561
HERBST, MICHAEL K.
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495
HILEY, P. E.
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521
HINZ, BERNHARD
Development and testing of highly loaded engine components made of carbon fiber reinforced plastics
[ETN-87-90036] p 832 N87-28550
HIRAHARA, HIROYUKI
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370
HIROSE, Y.
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft p 841 A87-51792
HIXSON, W. C.
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051
HO, C.-M.
Near wake of an unsteady symmetric airfoil p 803 A87-51221
HOBART, HOWARD F.
The NASA strain gage laboratory p 838 A87-52494
HOFFLER, KEITH D.
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425
HOLLISTER, WALTER M.
Automation at the man-machine interface p 855 N87-29504
HOMMA, K.
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
HOUCK, JACOB A.
Pilot evaluation of population-minimal ground tracks in the airport community p 838 A87-52879
HOUSER, M. J.
Optical interferometry in fluid dynamics research p 851 N87-29447
HOWE, M. S.
Self-excited oscillations in jet engine test cells p 859 A87-51215
HOWELL, T. J.
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 2
[AD-A183781] p 826 N87-29494
HU, Z. A.
Measurement of swirling flow field using the single slanted hot-wire technique p 847 A87-51469
HU, ZIQIN
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810

HUA, YAONAN
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
HUGHES, G.
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
HULSE, C. O.
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869
HURLEY, PAUL J.
LHTEC - Meeting the LHX cost challence p 801 A87-53425
HURRASS, KARLHEINZ
Modeling of the fault situation in navigation systems p 821 N87-28534
HUSAREK, V.
Practical application to composite materials of a portable digital ultrasound device controlled by a microprocessor p 849 A87-53585

I

IARYGIN, V. N.
Pulsation structure of the mixing layer of underexpanded jets p 847 A87-50974
ILIFF, KENNETH W.
Bibliography for aircraft parameter estimation
[NASA-TM-86804] p 827 N87-29498
Application of parameter estimation to aircraft stability and control: The output-error approach
[NASA-RP-1168] p 827 N87-29499
ILSCHNER, B.
Non-isothermal fatigue crack growth in Hastelloy-X p 840 A87-51400
IM, B. J.
User's manual for ADAM (Advanced Dynamic Airfoil Model)
[DE87-012342] p 813 N87-28524
A numerical model for unsteady two-dimensional flow calculations with flow separation
[DE87-012316] p 850 N87-28866
IVANOV, I.
The problem of the aviation-meteorological prediction of strong surface winds in eastern Bulgaria p 853 A87-51195

J

JACKLIN, STEPHEN A.
Small-scale rotor test rig capabilities for testing vibration alleviation algorithms
[NASA-TM-100002] p 858 N87-30102
JACKSON, A.
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
JACKSON, A. C.
Advanced composite vertical fin for L-1011 aircraft
[NASA-CR-3816] p 845 N87-28617
Study of utilization of advanced composites in fuselage structures of large transports
[NASA-CR-172404] p 845 N87-28619
JAMES, A. M.
ACEE composite structures technology
[NASA-CR-172360] p 845 N87-28615
JANARDAN, B. A.
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
JANKOVITZ, JACK
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
JENNESS, C. M. J.
Propfan test assessment testbed aircraft flutter model test report
[NASA-CR-179458] p 814 N87-29413
JIANG, ZIKANG
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810
JOFFE, E. B.
Ground testing of an operational fighter aircraft for p-static discharge effects p 824 A87-52522
JOHNSON, D. W.
Parachute systems technology: Fundamentals, concepts, and applications. Advanced parachute design
[DE87-011634] p 814 N87-29415
Parachute systems technology: Fundamentals, concepts, and applications
[DE87-011722] p 815 N87-29416
JOHNSON, J. BLAIR
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
JOHNSON, RONALD W.
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
JONES, HENRY EDWARD
Full-potential modeling of blade-vortex interactions p 817 N87-29465
JONES, MICHAEL G.
Acoustic effects on profile drag of a laminar flow airfoil
[NASA-TM-100505] p 860 N87-30155
JONES, PAUL H.
A simulator evaluation of alternative heliport approach lighting systems
[AIAA PAPER 87-2635] p 838 A87-52290
JONES, R.
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316
JOPPA, P. D.
Acoustic mode measurements in the inlet of a turbofan engine p 859 A87-52877
JOSHI, M. C.
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539
JUERGENS, W.
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823

K

KABIERSCH, WOLF-DIETER
Modeling of radio navigation systems in the neighborhood of airports p 821 N87-28533
KALEKTA, JUERGEN
Simulation and characteristic value determination in helicopters p 824 A87-53564
KAMENETSKII, V. F.
Interaction of bodies with a nonuniform supersonic flow p 804 A87-51663
KANAI, KIMIO
On design of restructurable control systems for aircraft with some failures p 835 A87-51981
KANDA, T.
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
KAPRALOV, V. M.
Fatigue of gas turbine blades under random vibrations p 832 A87-53442
KELLER, WILLIAM C.
Combustion by-products on F-4 drogue parachutes
[AD-A182929] p 819 N87-29472
KERELIUK, S.
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559
KHON'KIN, A. D.
Characteristics of separated flow past a delta wing p 805 A87-51669
KIMURA, TAKEYOSHI
Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge p 806 A87-52322
KING, H. H.
Application of artificial intelligence (AI) to aerospace manufacturing - A user perspective p 857 A87-53075
KING, RANDALL M.
Prototype aircraft sustainability model
[AD-A183183] p 802 N87-29405
KIRCHGESSNER, THOMAS A.
Airflow calibration and exhaust pressure/temperature survey of an F404, S/N 215-109, turbofan engine
[NASA-TM-100159] p 834 N87-29537
KISELEV, A. F.
Characteristics of separated flow past a delta wing p 805 A87-51669
KITTLESON, JOHN K.
Transonic rotor flow-measurement technique using holographic interferometry p 851 N87-29434
Reconstruction of a three-dimensional, transonic rotor flow field from holographic interferogram data p 817 N87-29445
KLOTZSCHE, M.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
ACEE composite structures technology
[NASA-CR-172359] p 844 N87-28613
KNACKE, THEO W.
Parachute recovery systems design manual, chapter 5
[AD-A183191] p 816 N87-29426
KNOTT, P. R.
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
KNUPP, K. R.
SPACE/COHMEX data inventory document
[NASA-TM-4006] p 854 N87-29068
KOMERATH, NARAYANAN M.
Implementation and validation of a wake model for low-speed forward flight
[NASA-CR-181341] p 811 N87-28514
KOMPENHANS, J.
Application of particle imaging velocimetry in windtunnels p 848 A87-52314
KORDULLA, WILHELM
Numerical aerodynamics using large computers p 809 A87-53562
KORNEV, V. I.
A method for controlling a centrifuge cabin p 857 A87-52823
KOTOV, V. M.
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
KOURTIDES, DEMETRIUS A.
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives
[NASA-CASE-ARC-11425-2] p 844 N87-28605
KOZAREV, D.
The problem of the aviation-meteorological prediction of strong surface winds in eastern Bulgaria p 853 A87-51195
KRABILL, WILLIAM B.
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367
KRAFT, R. E.
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539
KRASNJANSKI, DAVID
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
KRIER, H.
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629
KRISHNA, C. M.
Processor tradeoffs in distributed real-time systems p 857 A87-52796
KROGMANN, PAUL
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement
[DFVLR-FB-86-59] p 810 N87-28506
KROLL, NORBERT
Calculation of frictionless flow about airfoil wings and propellers by numerical solution of the Euler equations p 809 A87-53563
KUHLMAN, BRIAN P.
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
KURATH, P.
Mechanical properties of rapidly solidified Al-4Be p 842 A87-52658

L

LADSON, CHARLES L.
Evolution, calibration, and operational characteristics of the two-dimensional test section of the Langley 0.3-meter transonic cryogenic tunnel
[NASA-TP-2749] p 839 N87-28570
LAI, CHUNCAI
An experimental investigation of the effect of inlet flow distortion on compressor performance p 805 A87-51813
LAMBERT, MARK
Canadair's CL-227 Sentinel gains credibility p 824 A87-53798
LAN, C. EDWARD
Effect of a round airfoil nose on leading-edge suction p 809 A87-53784
LANGHI, RONALD G.
Transonic rotor tip design using numerical optimization
[NASA-TM-86771] p 816 N87-29431
LARSON, TERRY J.
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
LAVERGNE, G.
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334

LAWRENCE, R. W.
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985
p 853 A87-53206
LEDERICH, RICHARD J.
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650
LEE, C. S.
Jet spoiler as a yaw control device
p 835 A87-52880
LEE, JOHN D.
Transonic interference reduction by limited ventilation wall panels
[NASA-CR-175039] p 815 N87-29419
LEE, K. P.
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
LEE, ROBERT D.
Electro-expulsive separation system
[NASA-CASE-ARC-11613-1] p 849 N87-28833
LEFEBVRE, A. H.
Fuel effects on gas turbine combustion
p 830 A87-51474
LEFTHERIS, BASIL P.
Residual stresses in 2024-T81 aluminum using caustics and moire interferometry p 843 A87-53785
LEGRAIN, I.
Simultaneous active controls on wind tunnel model
p 836 A87-54190
LENTZ, J. M.
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051
LEWERENZ, WILLIAM T.
UHB demonstrator flight test program
[AIAA PAPER 87-1732] p 824 A87-52844
LEYENDECKER, HAGEN
The model inverse as an element of a predetermined control system for helicopters p 836 N87-28532
LEYLAND, JANE ANNE
Small-scale rotor test rig capabilities for testing vibration alleviation algorithms
[NASA-TM-100002] p 858 N87-30102
LI, FENGWEI
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile
[ETN-87-90038] p 810 N87-28505
LI, X. F.
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471
LIANG, D. F.
Configuration design of a helicopter integrated navigation system p 823 N87-29480
LIEBST, BRADLEY S.
Accelerometer placement in active flutter suppression systems p 828 A87-52963
LILLIS, BRIAN J.
Evaluation of naphthene rich turbine fuels as heat sinks for hypersonic aircraft
[AD-A182118] p 845 N87-28658
LISEITSEV, NIKOLAI KONSTANTINOVICH
Principles of the computer-aided design of aircraft
p 858 A87-53957
LITTLE, DALLAS N.
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545
LITTLE, R.
A flight evaluation of voice interaction as a component of an integrated helicopter avionics system
[RAE-TM-FS(B)-637] p 829 N87-28547
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data
[RAE-TM-FS(B)-638] p 829 N87-28548
The flight evaluation of a speech recognition and a speech output system in an advanced cockpit display and flight management system for helicopters
p 829 N87-29527
LITVIN, F. L.
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
LIU, C. T.
Design of high-temperature, ordered intermetallic alloys p 840 A87-51177
LLORET, P.
Inertial-GPS - A marriage of convenience under test
p 820 A87-53578
LOC, TA PHUOC
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
LOCKWOOD, ROY A.
Preliminary airworthiness evaluation of the UH-1H helicopter with the T53-L-703 engine installed
[AD-A182369] p 825 N87-28541
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495
LODGE, K. J.
A designers' guide to the achievement of electrical continuity in carbon fibre composite structures
[CD6500551] p 844 N87-28607
LOU, YUNLING
Preliminary simultaneous L/C-band images from the JPL aircraft synthetic aperture radar p 853 A87-53159
LOUIE, ALEXANDER W.
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422
LOWER, M. C.
Noise attenuation properties of headsets in a helicopter noise environment
[CAA-PAPER-87004] p 860 N87-29311
LUCA, VALENTIN
Processes in turbomachinery: Applications and exercises p 808 A87-53412
LUN'KIN, IU. P.
Numerical modeling of supersonic muliphase flows
p 804 A87-51659
LUSHCHIKOV, E. A.
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949
LYCHKIN, E. N.
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
LYLE, KAREN H.
Laboratory study of sidewall noise transmission and treatment for a light aircraft fuselage
p 824 A87-52887

M

MABEY, D. G.
The measurement of oscillatory pressures with discrete and sweep excitation p 837 A87-51213
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782
MADER, GERALD L.
Dynamic positioning using GPS carrier phase measurements p 820 A87-52765
MAGROGAN, MICHAEL
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488
MAHESH, J.
Configuration design of a helicopter integrated navigation system p 823 N87-29480
MAINE, RICHARD E.
Bibliography for aircraft parameter estimation
[NASA-TM-86804] p 827 N87-29498
Application of parameter estimation to aircraft stability and control: The output-error approach
[NASA-RP-1168] p 827 N87-29499
MAIR, W. N.
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
MAJJIGI, R. K.
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
MALIK, M.
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823
MALININ, I. D.
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949
MAMASUEV, A. V.
A method for controlling a centrifuge cabin
p 857 A87-52823
MANE, LAURE
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
MANUEL, GREGORY S.
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
MARCHAND, N. J.
Non-isothermal fatigue crack growth in Hastelloy-X
p 840 A87-51400
MARCHMAN, J. F., III
Rain effects at low Reynolds number
p 808 A87-52884
MARESCA, C.
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777
MARTIN, CHRESTON F.
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367
MARTIN, J. W.
The effect of prestrain and of ageing at room temperature on the mechanical properties of an Al-Li-Cu-Mg alloy
p 842 A87-52683
MARUYAMA, Y.
Development of supersonic computational aerodynamic program using panel method
[NASA-TT-20113] p 813 N87-28526
MASAEDA, H.
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft
p 841 A87-51792
MATSUO, KAZUYASU
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370
MATSUO, T.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
MCCARTHY, J.
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060
MCCOMB, HARVEY G., JR.
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780
MCCONNELL, M .C.
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
MCCREATH, C. G.
Hot corrosion site environment in gas turbines
p 830 A87-51353
MCDANIEL, J. C.
Flow visualization studies of transverse fuel injection patterns in a nonreacting Mach 2 combustor
p 807 A87-52386
MCDARMAID, D. S.
Development of aluminium-lithium alloys in the UK
p 843 A87-53893
MCDONALD, JAMES J., JR.
Airline management prerogative in the deregulation era p 861 A87-52172
MCFARLAND, RICHARD E.
Anticipation of the landing shock phenomenon in flight simulation
[NASA-TM-89465] p 826 N87-29491
Trimming an aircraft model for flight simulation
[NASA-TM-89466] p 828 N87-29502
MCGOWAN, JOSEPH
Velocity accuracy measurement of GPS user equipment p 822 N87-29477
MCINERNY, SALLY ANNE
An experimental investigation of wing-tip turbulence and sound radiated from the tip region of a blunt-tipped airfoil p 818 N87-29466
MEHTA, P.
PTFE (polytetrafluoroethylene) resin selection for high performance wire and cable
[AD-P005211] p 846 N87-29227
MEIER, G. E. A.
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452
MELLIAR-SMITH, MICHAEL
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099
MENEES, GENE P.
Aerothermodynamics of transatmospheric vehicles
p 807 A87-52878
MENON, S.
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
MENSEN, HEINRICH
The problems of the calculation of the capacity of flight operation surfaces of airports
[ILR-MITT-170] p 838 N87-28566
MENU, J.-P.
Sophisticated integral control methods for use in flight
p 856 N87-29510
Organization of displays in the visual space of the combat aircraft pilot p 856 N87-29516
MESCHTER, PETER
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650
MIKROYANNIDIS, JOHN A.
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives
[NASA-CASE-ARC-11425-2] p 844 N87-28605
MILLER, DEAN R.
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956

MILLER, R. H.
The prediction of the vibratory airloads of helicopter rotors in forward flight p 823 A87-51214
MILLS, CHARLES T.
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425
MILNER, EDWARD J.
Mathematical model partitioning and packing for parallel computer calculation p 856 A87-52534
MIXSON, JOHN S.
Laboratory study of sidewall noise transmission and treatment for a light aircraft fuselage
p 824 A87-52887
MKPADI, M. C.
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475
MONDZHI, VLADIMIR GEORGIEVICH
Direct variational method in flight dynamics boundary value problems p 856 A87-52233
MOORE, ROYCE D.
Experimental evaluation of corner turning vanes
[NASA-TM-100143] p 839 N87-28571
MORDOFF, KEITH F.
Voyager crew faces turbulence, fatigue on world flight attempt p 801 A87-53552
MORIN, L. M.
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072
MORITOKI, M.
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
MORLOK, EDWARD K.
A strategy for advancing tilt-rotor technology
[NASA-CR-181420] p 827 N87-29500
Cost characteristics of tilt-rotor, conventional air and high speed rail short-haul intercity passenger service
[NASA-CR-181421] p 828 N87-29501
MORRELL, FREDERICK R.
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531
MORROW, JOHN G.
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
MOSER, LOUISE
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099
MOSS, J. N.
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
MOTSINGER, R. E.
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539
MRAZ, M. R.
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521
MUELLER, T. J.
Visualization of the laminar separation bubble on airfoils at low Reynolds numbers p 806 A87-52348
Leading- and trailing-edge flaps on a low Reynolds number airfoil p 808 A87-52886
MUKHOPADHYAY, A. K.
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
MURRELL, REGINALD C.
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495
MYERS, MATTHEW RONALD
Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513

N

NAIDU, D. S.
Time-scale synthesis of a closed-loop discrete optimal control system p 857 A87-52960
NAKAMURA, A.
Development of supersonic computational aerodynamic program using panel method
[NASA-TT-20113] p 813 N87-28526
NARITSA, V. S.
An analysis of the approximation of the aerodynamic coefficients of thin bodies in a rarefied gas
p 808 A87-53526
NEBENDAHL, P.
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483
NEGULESCU, DIMITRIE
Processes in turbomachinery: Applications and exercises p 808 A87-53412
NELSON, R. C.
Visualization of vortex breakdown on a delta wing
p 807 A87-52357
NEUHOFF, HEINZ GEORG
Contribution to the description of rotating flow instabilities and inlet perturbations in axial flow compressors
[ETN-87-90040] p 850 N87-28845
NG, T. T.
Visualization of vortex breakdown on a delta wing
p 807 A87-52357
NGUYEN, QUYEN
Preliminary simultaneous L/C-band images from the JPL aircraft synthetic aperture radar p 853 A87-53159
NISHIO, MASATOMI
Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge
p 806 A87-52322
NORIKANE, LYNNE
JPL multipolarization workstation - Hardware, software and examples of data analysis p 858 A87-53231
NOVOPASHIN, S. A.
Pulsation structure of the mixing layer of underexpanded jets p 847 A87-50974

O

OBERMEIER, F.
Supersonic and transonic supersonic flow
[MPIS-16/1986] p 811 N87-28508
OCHI, YOSHIMASA
On design of restructurable control systems for aircraft with some failures p 835 A87-51981
OERTEL, HERBERT
Numerical aerodynamics using large computers
p 809 A87-53562
OKADA, H.
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
OLER, J. W.
User's manual for ADAM (Advanced Dynamic Airfoil Model)
[DE87-012342] p 813 N87-28524
A numerical model for unsteady two-dimensional flow calculations with flow separation
[DE87-012316] p 850 N87-28866
ONEAL, JAMES E.
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650
ORLENKO, L. R.
Determination of wind velocity and direction in the lower part of the atmospheric boundary layer on the basis of ground data p 854 A87-53969
OROURKE, D. M.
Propfan test assessment propfan propulsion system static test report
[NASA-CR-179613] p 834 N87-29536

P

PADUANO, JAMES D.
Application of a sensitivity analysis technique to high-order digital flight control systems
[NASA-CR-179429] p 837 N87-28565
PAGE, GREGORY S.
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545
PALOSCIA, S.
Aircraft microwave radiometry of land
p 853 A87-53269
PALUMBO, DANIEL L.
The SIFT hardware/software systems. Volume 1: A detailed description
[NASA-TM-87574] p 858 N87-29186
PAMPALONI, P.
Aircraft microwave radiometry of land
p 853 A87-53269
PAPPERT, RICHARD A.
Radiation resistance of thin antennas of arbitrary elevation and configuration over perfectly conducting ground p 848 A87-52189
PARKER, R.
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
PARSONS, CHESTER L.
Airborne multibeam radar altimetry
p 853 A87-53115
PARTRIDGE, P. G.
Diffusion bonding of metals p 852 N87-29646
PASQUET, B.
Helicopter certification - New test techniques
p 825 A87-54201
PASSOT, T.
Numerical simulation of compressible homogeneous flows in the turbulent regime p 809 A87-54363
PAUL, B.
Flow energizers. Task A
[NASA-CR-176202] p 812 N87-28523
PAYNE, F. M.
Visualization of vortex breakdown on a delta wing
p 807 A87-52357
PAYNE, FRANCIS MICHAEL
The structure of leading edge vortex flows including vortex breakdown p 818 N87-29467
PEARCE, W.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
PEEL, C. J.
Development of aluminium-lithium alloys in the UK
p 843 A87-53893
PEI, G.
Study of utilization of advanced composites in fuselage structures of large transports
[NASA-CR-172404] p 845 N87-28619
PEIGIN, S. V.
A three-dimensional boundary layer on blunt bodies with a porous surface at angles of attack and sideslip
p 803 A87-51007
PELEAU, B.
Rotor dynamics test facility
[ONERA-RT-20/3239-RY-054R-0] p 839 N87-28567
PELLOUX, R. M.
Non-isothermal fatigue crack growth in Hastelloy-X
p 840 A87-51400
PEREPELKIN, A. L.
Pulsation structure of the mixing layer of underexpanded jets p 847 A87-50974
PERRY, M. L.
Leading- and trailing-edge flaps on a low Reynolds number airfoil p 808 A87-52886
PETERS, D. A.
Effect of dynamic stall on helicopter trim and flap-lag response p 835 A87-54139
PETERSON, C. W.
Parachute systems technology: Fundamentals, concepts, and applications. Advanced parachute design
[DE87-011634] p 814 N87-29415
PFEIL, WILLIAM H.
Multi-variable control concepts for turboshaft engines
p 832 A87-53431
PHILIPPE, J. J.
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
PIMSNER, VICTOR
Processes in turbomachinery: Applications and exercises p 808 A87-53412
PLATZER, MAX F.
Multimission STOVL application of a hybrid powered-lift system p 824 A87-53776
PODBOY, GARY G.
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan
[AIAA PAPER 87-1893] p 806 A87-52251
POHLMANN, LAWRENCE D.
Problems associated with the integration of artificial intelligence into crew systems p 857 A87-53062
POITRAST, BRUCE J.
Combustion by-products on F-4 drogue parachutes
[AD-A182929] p 819 N87-29472
POSNETT, WILLIAM L., III
Multimission STOVL application of a hybrid powered-lift system p 824 A87-53776
POTTER, J. LEITH
Aerodynamics of 3-dimensional bodies in transitional flow
[NASA-CR-181395] p 816 N87-29429
POUQUET, A.
Numerical simulation of compressible homogeneous flows in the turbulent regime p 809 A87-54363
POWELL, CLEMANS A.
Community reactions to helicopter noise - Results from an experimental study p 853 A87-52064
PRICE, D. B.
Time-scale synthesis of a closed-loop discrete optimal control system p 857 A87-52960
PRICE, F. D.
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842

PRIMAVERA, G.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
PROBST, H. B.
Structural ceramics in heat engines - The NASA viewpoint p 842 A87-53352
PRZYBYSZEWSKI, J. S.
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869
Thin film strain gage development program
[NASA-CR-174707] p 850 N87-28883
PURCELL, CHARLES J.
On the computation of transonic leading-edge vortices using the Euler equations p 809 A87-54361

Q

QUINLIVAN, JOHN T.
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
QUINTO, P. FRANK
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462

R

RADKE, HANS
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115
RAJ, RISHI S.
An investigation of the flow characteristics in the blade endwall corner region
[NASA-CR-4076] p 814 N87-29412
RAMAN, GANESH
Enhanced mixing of an axisymmetric jet by aerodynamic excitation
[NASA-CR-175059] p 815 N87-29418
RAO, DHANVADA M.
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425
RAY, EDWARD J.
Evolution, calibration, and operational characteristics of the two-dimensional test section of the Langley 0.3-meter transonic cryogenic tunnel
[NASA-TP-2749] p 839 N87-28570
REAZER, JEAN S.
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
REDDAN, MICHEL R.
Wind shear p 853 A87-51232
REECE, ERIC W.
The aerothermodynamic environment for holes in hypersonic configurations
[DE87-003790] p 814 N87-29414
REEHORST, ANDREW L.
New methods and materials for molding and casting ice formations
[NASA-TM-100126] p 819 N87-29470
REICHMUTH, J.
Application of particle imaging velocimetry in windtunnels p 848 A87-52314
REID, D. B.
Configuration design of a helicopter integrated navigation system p 823 N87-29480
RENIE, J. P.
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629
RENSON, PETER H.
Improved reliability and maintainability (RAM) in advanced technology engines p 831 A87-53426
RESHETIN, A. G.
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
REYNOLDS, C. N.
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-1] p 833 N87-28552
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-2] p 833 N87-28556
REYNOLDS, N. T.
Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies
p 807 A87-52371
RHEMER, C. C.
Application of modern materials technologies in small gas turbine engines p 831 A87-53429
RIABINKOV, G. M.
Characteristics of separated flow past a delta wing
p 805 A87-51669
RICE, E. J.
Control of shear flows by artificial excitation
[NASA-TM-100201] p 815 N87-29420
RICHTER, G. PAUL
New methods and materials for molding and casting ice formations
[NASA-TM-100126] p 819 N87-29470
RICHTER, RUDOLF
Infrared simulation model SENSAT-2
[DFVLR-FB-87-10] p 854 N87-28950
RINEHART, R. E.
Preliminary Memphis FAA (Federal Aviation Administration)/Lincoln Laboratory operational weather studies results
[AD-A182730] p 854 N87-29057
RISING, JERRY J.
Development of a reduced area horizontal tail for a wide body jet aircraft
[NASA-CR-172278] p 837 N87-28564
RIZK, M. H.
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835
RIZZI, ARTHUR
On the computation of transonic leading-edge vortices using the Euler equations p 809 A87-54361
ROBERTON, B. E.
Supportability model - Quantifies reliability and maintainability influence on cost p 801 A87-53415
ROBERTS, L.
Jet spoiler as a yaw control device
p 835 A87-52880
ROBERTSON, EDWARD A.
Rain effects at low Reynolds number
p 808 A87-52884
ROCKWOOD, JAMES D.
The 214ST drive system Lead-the-Fleet program
p 801 A87-53414
ROQUEMORE, MEL
Holographic interferometry at Wright Aeronautical Laboratories p 851 N87-29435
ROSE, GAYLE E.
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan
[AIAA PAPER 87-1893] p 806 A87-52251
ROSS, JAMES C.
Application of a panel method to wake-vortex/wing interaction and comparison with experimental data
[NASA-TM-88337] p 817 N87-29461
ROSSOW, VERNON J.
Prospects for destructive self-induced interactions in a vortex pair p 809 A87-53778
ROY, DIPANKAR
Doppler frequency shift in a refractive atmosphere
p 859 A87-52876
RUIJGROK, G. J. J.
Calculation of noise around airports for powered gliders
[VTH-LR-475] p 860 N87-30150
RUMYNSKII, A. N.
Three-dimensional flow around and radiative heating of blunt bodies p 804 A87-51653
RUSTAN, PEDRO L., JR.
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
RYKOV, V. A.
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880

S

SACHS, GOTTFRIED
Reducing fuel consumption of subsonic aircraft by optimal cyclic cruise p 824 A87-52881
SAGAWA, KOHICHI
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
SAITO, SHIGERU
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
SALKIND, MICHAEL J.
Composites - What next p 841 A87-51807
SALUS, ALAN M.
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224
SAMOILOVICH, OLEG SERGEEVICH
Principles of the computer-aided design of aircraft
p 858 A87-53957
SANDIFER, J.
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
SANDORFF, P.
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
SANTUCCI, G.
Sophisticated integral control methods for use in flight
p 856 N87-29510
SARGISSON, D. F.
Advanced Propfan Engine Technology (APET) and single-rotation gearbox/pitch change mechanism
[NASA-CR-168113] p 833 N87-28553
SATTLER, D. E.
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559
SCHERR, STEPHEN J.
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
SCHICK, FRED-VOLKER
Systems evaluation procedure using simulation illustrated by the Computer Oriented Metering Planning and Advisory System (COMPAS) project
p 822 N87-28540
SCHILLIGER, M.
The MLS angle receiver p 820 A87-51231
SCHMIDT, G. S.
Visualization of the laminar separation bubble on airfoils at low Reynolds numbers p 806 A87-52348
SCHMUGGE, T. J.
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985
p 853 A87-53206
SCHOENDORFER, DAVID L.
A strategy for advancing tilt-rotor technology
[NASA-CR-181420] p 827 N87-29500
Cost characteristics of tilt-rotor, conventional air and high speed rail short-haul intercity passenger service
[NASA-CR-181421] p 828 N87-29501
SCHREIBER, OLIVIER A.
Implementation and validation of a wake model for low-speed forward flight
[NASA-CR-181341] p 811 N87-28514
SCHUBERT, MANFRED
Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539
SCHUDY, ROBERT
In real time with a pilot in the loop
p 857 A87-53066
SCHUETZE, RAINER
Nondestructive tests of Carbon Fiber Reinforced Plastics (CFRP) in the framework of damage mechanics investigations
[DFVLR-MITT-86-09] p 851 N87-28923
SCHULZE, BERND
Comparison between 2D transonic flutter calculations in the time and frequency domain p 812 N87-28520
SCHWARTZ, RICHARD
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099
SCHWARZ, ROBERT
Residual stresses in 2024-T81 aluminum using caustics and moire interferometry p 843 A87-53785
SCHWARZER, H.
Experimental comparison of radiometric scales from laboratory standards and solar radiation
p 849 A87-53576
SCHWEITZER, G.
Dynamics of a high-speed rotor touching a boundary
p 848 A87-51614
SEIBERT, GEORGE
Status of holographic interferometry at Wright Patterson Air Force Base p 851 N87-29436
SERRANO, ARTURO
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
SHAKKOTTAI, P.
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783
SHAN SUNDER, K.
A two-dimensional finite element stress analysis of radial impellers p 847 A87-51472
SHANG, JOSEPH J.
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
SHARPE, ELLSWORTH L.
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643

SHAW, S. J.
High-temperature polymers for adhesive and composite applications p 843 A87-53888
SHCHELKONOGOV, A. N.
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
SHEARIN, JOHN G.
Acoustic effects on profile drag of a laminar flow airfoil [NASA-TM-100505] p 860 N87-30155
SHELNUTT, JACK B.
Problems associated with the integration of artificial intelligence into crew systems p 857 A87-53062
SHEN, PEIYING
An experimental investigation of the effect of inlet flow distortion on compressor performance p 805 A87-51813
SHEN, PING-CHENG
Modified characteristic method for calculation of supersonic S2 flow field in compressor p 804 A87-51473
SHIFRIN, E. G.
Profiling of a lifting convex wing by a hodograph method p 805 A87-51672
SHIH, W. C.
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution [AD-A183531] p 816 N87-29428
SHIN, H. W.
Measurement of swirling flow field using the single slanted hot-wire technique p 847 A87-51469
SHIN, KANG G.
Processor tradeoffs in distributed real-time systems p 857 A87-52796
SHU, RICHARD
In real time with a pilot in the loop p 857 A87-53066
SHYNE, RICKEY J.
Experimental evaluation of corner turning vanes [NASA-TM-100143] p 839 N87-28571
SHYY, WEI
A numerical study of flow in gas-turbine combustor [AIAA PAPER 87-2132] p 832 A87-53986
SIEBERT, RUEDIGER
PSI multitransducer in low-velocity wind tunnel in Braunschweig p 838 A87-53569
SIEMERS, PAUL M., III
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack [NASA-TP-2716] p 827 N87-29497
SILVER, DEAN
Measurement uncertainty for the Uniform Engine Testing Program conducted at NASA Lewis Research Center [NASA-TM-88943] p 833 N87-28557
SKIBA, G. G.
Calculation of the aerodynamic coefficients of aircraft on a computer with allowance for physicochemical reactions p 803 A87-50876
SKIDMORE, F. W.
Smoke emission tests on series 2 and series 3 Allison T56 turboprop engines [AD-A182385] p 832 N87-28549
SKINNER, GARY L.
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected [AD-A183954] p 827 N87-29495
SKLEPOVOI, V. N.
An approach to the numerical modeling of the dynamics of reacting gases in nozzles p 847 A87-50872
SLAY, F. M.
Prototype aircraft sustainability model [AD-A183183] p 802 N87-29405
SMITH, A. F.
Aluminium-lithium alloys for helicopter structures p 843 A87-53892
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models [NASA-CR-174814] p 833 N87-28555
SMITH, BRIAN E.
Application of a panel method to wake-vortex/wing interaction and comparison with experimental data [NASA-TM-88337] p 817 N87-29461
SMITH, GREGORY E.
Wave drag analysis of realistic fighter aircraft using a full-potential method p 807 A87-52882
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890
SMITH, PETER J.
ACEE composite structures technology [NASA-CR-172358] p 844 N87-28614
SNYDER, CARL E., JR.
Military aircraft 4-cSt gas turbine engine oil development p 841 A87-52403
SNYDER, LYNN E.
LHTEC - Meeting the LHX cost challenge p 801 A87-53425
SOBIECZKY, HELMUT
Numerical aerodynamics using large computers p 809 A87-53562
SOKOLOWSKI, DANIEL E.
Toward improved durability in advanced combustors and turbines: Progress in the prediction of thermomechanical loads [NASA-TM-88932] p 832 N87-28551
SRIVATSAN, R.
Development of a takeoff performance monitoring system [AIAA PAPER 86-2145] p 828 A87-52962
STANCIU, VIRGIL
Processes in turbomachinery: Applications and exercises p 808 A87-53412
STECURA, STEPHAN
New ZrO2-Yb2O3 plasma-sprayed coatings for thermal barrier applications p 843 A87-53623
STEELE, GUY L., JR.
Some principles of parallel programming p 857 A87-53069
STEFKO, GEORGE L.
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan [AIAA PAPER 87-1893] p 806 A87-52251
STEPANOVA, V. M.
Determination of wind velocity and direction in the lower part of the atmospheric boundary layer on the basis of ground data p 854 A87-53969
STERN, J. A.
Closing the man-machine loop: On the use of physiological measures to affect computer-controlled devices p 855 N87-29507
STIELER, BERNHARD
Simulation of strapdown systems for error analysis, and modeling for navigation with other sensor systems p 821 N87-28535
STOCK, H. W.
The flow field in the second throat region of a wind tunnel, computed by an Euler method p 809 A87-53574
STOEWER, GERD
The problems of the calculation of the capacity of flight operation surfaces of airports [ILR-MITT-170] p 838 N87-28566
STONEMAN, S. A. T.
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
STORM, ROGER S.
Alpha silicon carbide components for heat engine applications p 842 A87-53354
STRAUB, D.
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483
STRENGNELL, HANS
NYANS: A package for time varying control systems [FOA-C-20642-2.1] p 858 N87-29174
STRICKLAND, J. H.
User's manual for ADAM (Advanced Dynamic Airfoil Model) [DE87-012342] p 813 N87-28524
A numerical model for unsteady two-dimensional flow calculations with flow separation [DE87-012316] p 850 N87-28866
STROUB, ROBERT H.
Investigation of generic hub fairing and pylon shapes to reduce hub drag [NASA-TM-100008] p 816 N87-29422
The results of a wind tunnel investigation of a model rotor with a free tip [NASA-TM-86758] p 827 N87-29496
STUBBS, SANDY M.
Langley Aircraft Landing Dynamics Facility [NASA-RP-1189] p 839 N87-29544
STUFF, R.
Supersonic rotor noise calculation with sonic boom prediction methods p 860 A87-53903
SU, INGCHUNG
Effect of a round airfoil nose on leading-edge suction p 809 A87-53784
SUEMNICH, K.-H.
Experimental comparison of radiometric scales from laboratory standards and solar radiation p 849 A87-53576
SUZUKI, KOJIRO
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
SYED, A. A.
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data [NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study [NASA-CR-175067] p 834 N87-29539
SZCZYGIELSKI, W.
Dynamics of a high-speed rotor touching a boundary p 848 A87-51614

T

TAM, C. K. W.
Stochastic model theory of broadband shock associated noise from supersonic jets p 859 A87-52069
TAMURA, YOSHIAKI
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
TANNER, JOHN A.
Langley Aircraft Landing Dynamics Facility [NASA-RP-1189] p 839 N87-29544
TARANENKO, VASILII TROFIMOVICH
Direct variational method in flight dynamics boundary value problems p 856 A87-52233
TAUBER, MICHAEL E.
Aerothermodynamics of transatmospheric vehicles p 807 A87-52878
Transonic rotor tip design using numerical optimization [NASA-TM-86771] p 816 N87-29431
TAVELLA, D. A.
Jet spoiler as a yaw control device p 835 A87-52880
TAY, T. E.
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316
TEDESCHI, WILLIAM J.
The aerothermodynamic environment for holes in hypersonic configurations [DE87-003790] p 814 N87-29414
TEEGEN, UWE
A multichannel model for the description of the pilot in the closed control system, for the evaluation of future aircraft guidance systems p 822 N87-28537
TERRELL, RONALD L.
Soil stabilization for roadways and airfields [AD-A183382] p 839 N87-29545
TERRY, T. A.
Pressuremeter moduli for airport pavement design and evaluation [DOT/FAA/PM-87/10] p 839 N87-28572
THEISSEN, M.
Closing the man-machine loop: On the use of physiological measures to affect computer-controlled devices p 855 N87-29507
THELANDER, J.
Development of laminar flow control wing surface porous structure [NASA-CR-172424] p 802 N87-28502
THOMAS, JOSEF
Models of the description of air traffic control scenarios, for the evaluation of future air traffic control systems p 822 N87-28538
THOMPSON, MARSHAL R.
Soil stabilization for roadways and airfields [AD-A183382] p 839 N87-29545
THOMSON, ROBERT G.
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780
TIMM, R.
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452
TIRMAHI, A.
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475
TITE, C. N. J.
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
TIWARI, S. N.
Viscous shock-layer analysis of hypersonic flows over long slender bodies [AIAA PAPER 87-2487] p 806 A87-52291
TONDL, ALES
A new model of a self-controlled system p 847 A87-51158
TOULOUSE, G.
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
TREMBLEY, NANCY
FAA (Federal Aviation Administration) air traffic activity FY 1986 [AD-A183624] p 802 N87-29407
TRIEBSTEIN, H.
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
TROFIMOV, V. M.
Control of the intensity of convective heat transfer in a Laval nozzle under conditions of turbulent flow and in the presence of local separation zones p 803 A87-50972

TSAR'KOV, A. N.
Calculation of the aerodynamic coefficients of aircraft on a computer with allowance for physicochemical reactions p 803 A87-50876
TSAY, C.-B. P.
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
TSUDA, N.
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft p 841 A87-51792
TSUI, CHIH-YA
Computation of optimum turbofan mixing with a subaccurate varying specific heat solution p 830 A87-51808
TSUNG, W.-J.
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
TURCHAK, L. I.
Interaction of bodies with a nonuniform supersonic flow p 804 A87-51663
TURHAL, ERTUGRUL Y.
Investigation of F-16 control surface failures and optimal setting of functional controls
[AD-A182667] p 825 N87-28542
TURNBERG, J. E.
Static tests of the propulsion system
[AIAA PAPER 87-1728] p 830 A87-52245
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555
TURNIPSEED, G. T.
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051

U

UCKERMANN, RAINER
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115
UNO, T.
Development of fine-grained 7075-O sheet for aircraft taper-rolled stringer p 842 A87-52661
UNRUH, J. F.
Detection of in-flight propeller-induced structure-borne noise p 838 A87-53779

V

VALLOT, L.
Configuration design of a helicopter integrated navigation system p 823 N87-29480
VAN AKEN, D. C.
Mechanical properties of rapidly solidified Al-4Be p 842 A87-52658
VANCLEAVE, R.
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
VANNICE, W. L.
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 1
[AD-A183690] p 826 N87-29493
VANPAASSEN, D. M.
Calculation of noise around airports for powered gliders
[VTH-LR-475] p 860 N87-30150
VERNON, DAVID F.
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545
VERSTYNEN, HARRY A.
A simulator evaluation of alternative heliport approach lighting systems
[AIAA PAPER 87-2635] p 838 A87-52290
VITTAL, BAILY R.
A design system for erosion tolerant helicopter engines p 831 A87-53430
VOELCKERS, UWE
Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539
VOGEL, S.
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
VOGEL, WILLIAM H.
Engine Structural Integrity Program (ENSIP) - A viewpoint based on experience p 831 A87-53424
VON GRUENHAGEN, WOLFGANG
Simulation and characteristic value determination in helicopters p 824 A87-53564
VON NOORDEN, WOLF D.
Space communications to aircraft: A new development in international space law. I p 861 A87-51477
VONLAVANTE, E.
Flow energizers. Task A
[NASA-CR-176202] p 812 N87-28523
VOROTNIKOV, P. P.
Characteristics of separated flow past a delta wing p 805 A87-51669
VREENEGOOR, A. J. N.
Calculation of pressure distributions on supersonic delta wings using stagnation solutions
[VTH-LR-484] p 815 N87-29417

W

WAGENKNECHT, C. D.
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
WALKLEY, KENNETH B.
Wave drag analysis of realistic fighter aircraft using a full-potential method p 807 A87-52882
WANG, CHIUN
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution
[AD-A183531] p 816 N87-29428
WANG, J. R.
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985 p 853 A87-53206
WANG, JIANAN
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
WANG, QINGHUAN
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
WANG, ZHENQIU
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel p 837 A87-51968
WARD, D.
Flow energizers. Task A
[NASA-CR-176202] p 812 N87-28523
WATANUKI, TADAHARU
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
WEBB, GRANVILLE L.
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
WEBB, MICHAEL M.
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
WEGNER, H.
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452
WELGE, H. ROBERT
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545
WELLS, DOUGLAS C.
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469
WELSH, B. L.
The measurement of oscillatory pressures with discrete and sweep excitation p 837 A87-51213
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782
WENDIGGENSEN, KLAUS
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115
WENSKUS, R.
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452
WERLE, HENRI
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
WHEELER, P. D.
Noise attenuation properties of headsets in a helicopter noise environment
[CAA-PAPER-87004] p 860 N87-29311
WHITE, J. T.
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072
WHITLOW, WOODROW, JR.
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890
WHITMORE, STEPHEN A.
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
WILCOX, BRUCE
In real time with a pilot in the loop p 857 A87-53066
WILL, HERBERT A.
The NASA strain gage laboratory p 838 A87-52494
WILLIAMS, DAVID H.
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469
WILLIAMS, J. F.
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316
WILLIAMS, ROBERT A.
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495
WILLIAMS, S. F.
SPACE/COHMEX data inventory document
[NASA-TM-4006] p 854 N87-29068
WILSON, G. F.
Closing the man-machine loop: On the use of physiological measures to affect computer-controlled devices p 855 N87-29507
WILSON, ROBERT D.
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
WINTER, HEINZ
Role and task of models as tools for research and development p 821 N87-28531
WINTUCKY, W. T.
Compound cycle engine program p 831 A87-53428
WITHERS, C. C.
Static tests of the propulsion system
[AIAA PAPER 87-1728] p 830 A87-52245
WOLF, CHRISTOPHER J.
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
WOLFSON, M. M.
Preliminary Memphis FAA (Federal Aviation Administration)/Lincoln Laboratory operational weather studies results
[AD-A182730] p 854 N87-29057
WOOD, N. J.
Jet spoiler as a yaw control device p 835 A87-52880
WU, CHUNG-HUA
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
WU, WENQUAN
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
WU, XINGYUAN
A technique of holographic visualization to flow fields of a model with variable angles of attack p 806 A87-52306
WURST, TH. K.
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483

X

XU, S. A.
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471

Y

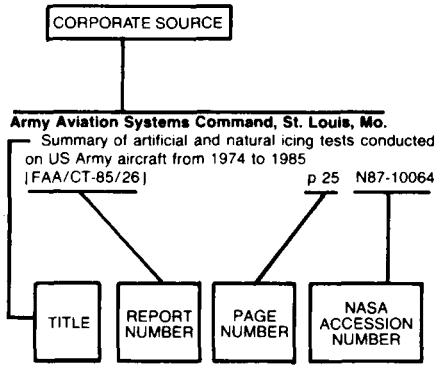
YAGAWA, GENKI
Finite element methods for incompressible viscous flow p 848 A87-52393
YAMAMOTO, Y.
Some numerical calculations by using linear classical sonic theories approached from sub- or supersonic speeds
[NASA-TT-20112] p 813 N87-28527
YAO, JIUCHENG
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel p 837 A87-51968
YIN, XIEZHEN
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel p 837 A87-51968
YOSHIDA, H.
Development of fine-grained 7075-O sheet for aircraft taper-rolled stringer p 842 A87-52661

YOUNG, LARRY A.
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422
The results of a wind tunnel investigation of a model rotor with a free tip
[NASA-TM-86758] p 827 N87-29496
YU, YUNG H.
Transonic rotor flow-measurement technique using holographic interferometry p 851 N87-29434
Reconstruction of a three-dimensional, transonic rotor flow field from holographic interferogram data
p 817 N87-29445
Application of digital interferogram evaluation techniques to the measurement of 3-D flow fields
p 851 N87-29451

Z

ZAMAN, K. B. M. Q.
Control of shear flows by artificial excitation
[NASA-TM-100201] p 815 N87-29420
ZAULICHNYI, E. G.
Control of the intensity of convective heat transfer in a Laval nozzle under conditions of turbulent flow and in the presence of local separation zones p 803 A87-50972
ZELENKOV, O. S.
A supersonic jet in a chamber with a diaphragm
p 808 A87-53520
ZHOU, LIHUA
An experimental investigation of the effect of inlet flow distortion on compressor performance
p 805 A87-51813
ZHUK, V. I.
Forced oscillations in a boundary layer at frequencies close to the upper branch of the neutral curve
p 803 A87-50890
ZIMMERMANN, BERND D.
Lightweight 2 fiber aviation cable featuring low fiber stress levels
[AD-P005282] p 826 N87-29297
ZIMMERMANN, HELMUT
Comparison between 2D transonic flutter calculations in the time and frequency domain p 812 N87-28520
ZOBY, E. V.
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291

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

Advanced Technologies and Testing Labs., Greensboro, N.C.
Radiative and convective heat transfer over ablating composite flat surface in hypersonic flow regime
[AD-A182119] p 810 N87-28503

Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
Future Research on Transonic Unsteady Aerodynamics and Its Aeroelastic Applications
[AGARD-R-749] p 812 N87-28518
Advances in Guidance and Control Systems and Technology
[AGARD-CP-411] p 822 N87-29474

Aerometrics, Inc., Mountain View, Calif.
Optical interferometry in fluid dynamics research
p 851 N87-29447

Aeronautical Research Labs., Melbourne (Australia).
Smoke emission tests on series 2 and series 3 Allison T56 turboprop engines
[AD-A182385] p 832 N87-28549

Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
An assessment of variable format information presentation p 861 N87-29512

Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
Investigation of F-16 control surface failures and optimal setting of functional controls
[AD-A182667] p 825 N87-28542

Air Force Occupational and Environmental Health Lab., Brooks AFB, Tex.
First article noise survey of the A/F32T-9 large turbo fan engine enclosed noise suppressor system, far-field noise, McConnell AFB, Kansas
[AD-A182475] p 860 N87-29308
Combustion by-products on F-4 drogue parachutes
[AD-A182929] p 819 N87-29472

Air Force Systems Command, Wright-Patterson AFB, Ohio.
Acta aeronautica et astronautica sinica (selected articles)
[AD-A182447] p 802 N87-28500

Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
Fiscal year 1988 technical objective document
[AD-A180311] p 861 N87-29364
Numerical simulation of X24C-10D
[AD-A183287] p 816 N87-29427
Holographic interferometry at Wright Aeronautical Laboratories p 851 N87-29435
Status of holographic interferometry at Wright Patterson Air Force Base p 851 N87-29436
Low altitude lightning attachment to an aircraft
[AD-A183290] p 819 N87-29473
Real time simultaneous in-line wear and lubricant condition monitoring
[AD-A183286] p 852 N87-29842
Air force technical objective document fiscal year 1988
[AD-A183017] p 862 N87-30224

Arizona State Univ., Tempe.
Supersonic flow over elastic bodies in oscillation
p 817 N87-29464

Arizona Univ., Tucson.
Effect of airfoil mean loading on high-frequency gust interaction noise p 811 N87-28513

Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
Preliminary airworthiness evaluation of the UH-1H helicopter with the T53-L-703 engine installed
[AD-A182369] p 825 N87-28541
Flight evaluation of the UH-60A helicopter with the pitch bias actuator centered and electrically disconnected
[AD-A183954] p 827 N87-29495

Army Aviation Research and Development Command, Cleveland, Ohio.
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
Compound cycle engine program p 831 A87-53428

Army Avionics Research and Development Activity, Fort Monmouth, N. J.
Velocity accuracy measurement of GPS user equipment p 822 N87-29477

Army Research and Technology Labs., Moffett Field, Calif.
Transonic rotor flow-measurement technique using holographic interferometry p 851 N87-29434
Reconstruction of a three-dimensional, transonic rotor flow field from holographic interferogram data
p 817 N87-29445
Application of digital interferogram evaluation techniques to the measurement of 3-D flow fields
p 851 N87-29451

B

Bionetics Corp., Hampton, Va.
Community reactions to helicopter noise - Results from an experimental study p 853 A87-52064

Boeing Commercial Airplane Co., Seattle, Wash.
Integrated Application of Active Controls (IAAC) technology to an advanced subsonic transport project: Test act system validation
[NASA-CR-172525] p 836 N87-28563
ACEE composite structures technology
[NASA-CR-172358] p 844 N87-28614
The 737 graphite composite flight spoiler flight service evaluation
[NASA-CR-178322] p 846 N87-29609

Boeing Military Airplane Development, Seattle, Wash.
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 1
[AD-A183690] p 826 N87-29493
Fighter aircraft OBIGGS (On-Board Inert Gas Generator System) study, volume 2
[AD-A183781] p 826 N87-29494

British Aerospace Aircraft Group, Preston (England).
Voice control of cockpit systems p 837 N87-29526

British Aerospace Public Ltd. Co., Kingston-upon-Thames (England).
The effect of load dwells on the fatigue of carbon fiber composites
[BAE-MSM-R-GEN-0547] p 844 N87-28606

C

California Univ., Los Angeles.
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system
p 825 A87-53901
An experimental investigation of wing-tip turbulence and sound radiated from the tip region of a blunt-tipped airfoil p 818 N87-29466

Carnegie-Mellon Univ., Pittsburgh, Pa.
Processor tradeoffs in distributed real-time systems
p 857 A87-52796

Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).
Sophisticated integral control methods for use in flight
p 856 N87-29510
Organization of displays in the visual space of the combat aircraft pilot p 856 N87-29516

City Coll. of the City Univ. of New York.
An investigation of the flow characteristics in the blade endwall corner region
[NASA-CR-4076] p 814 N87-29412

Civil Aviation Authority, London (England).
Noise attenuation properties of headsets in a helicopter noise environment
[CAA-PAPER-87004] p 860 N87-29311

Cleveland State Univ., Ohio.
Enhanced mixing of an axisymmetric jet by aerodynamic excitation
[NASA-CR-175059] p 815 N87-29418

Cornell Univ., Ithaca, N.Y.
Numerical calculation of unsteady inviscid rotational transonic flow past airfoils using Euler equations
p 811 N87-28510

D

Defense Technical Information Center, Alexandria, Va.
PTFE (polytetrafluoroethylene) resin selection for high performance wire and cable
[AD-P005211] p 846 N87-29227

Department of Agriculture, Beltsville, Md.
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985
p 853 A87-53206

Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation
[DFVLR-MITT-86-24] p 821 N87-28530
Role and task of models as tools for research and development p 821 N87-28531
The model inverse as an element of a predetermined control system for helicopters p 836 N87-28532
Modeling of radio navigation systems in the neighborhood of airports p 821 N87-28533
Modeling of the fault situation in navigation systems
p 821 N87-28534
Simulation of strapdown systems for error analysis, and modeling for navigation with other sensor systems
p 821 N87-28535
Models for the description of holding procedures in air traffic as an aid for optimization with respect to safety and efficiency p 822 N87-28536
A multichannel model for the description of the pilot in the closed control system, for the evaluation of future aircraft guidance systems p 822 N87-28537
Models of the description of air traffic control scenarios, for the evaluation of future air traffic control systems
p 822 N87-28538
Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539

SOURCE

Systems evaluation procedure using simulation illustrated by the Computer Oriented Metering Planning and Advisory System (COMPAS) project
p 822 N87-28540
An improved design technique for model following control systems in in-flight simulation
[DFVLR-FB-87-09] p 836 N87-28561
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment
[DFVLR-FB-86-61] p 855 N87-29115

Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement
[DFVLR-FB-86-59] p 810 N87-28506

Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
Infrared simulation model SENSAT-2
[DFVLR-FB-87-10] p 854 N87-28950

E

EG and G Washington Analytical Services Center, Inc., Lanham, Md.
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367

Eloret Corp., Sunnyvale, Calif.
Aerothermodynamics of transatmospheric vehicles
p 807 A87-52878

Embry-Riddle Aeronautical Univ., Daytona Beach, Fla.
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469

ESDU International Ltd., London (England).
Contribution of wing dihedral to sideforce, yawing moment and rolling moment derivatives due to rate of roll at subsonic speeds, (Y sub p)sub gamma, (N sub p)sub gamma and (L sub p)sub gamma
[ESDU-85006] p 813 N87-29409
Pitot and static errors due to non-steady flight
[ESDU-85011] p 813 N87-29410
Estimation of sideforce, yawing moment and rolling moment derivatives due to rate of roll for complete aircraft at subsonic speeds
[ESDU-85010] p 826 N87-29490

European Space Agency, Paris (France).
Nondestructive tests of Carbon Fiber Reinforced Plastics (CFRP) in the framework of damage mechanics investigations
[DFVLR-MITT-86-09] p 851 N87-28923

F

Federal Aviation Administration, Atlantic City, N.J.
Heliport critical area flight test results
[AD-A183153] p 823 N87-29487
Test plan for helicopter GPS (Global Positioning System) applications
[AD-A183299] p 823 N87-29488

Federal Aviation Administration, Washington, D.C.
Census of US civil aircraft, calendar year 1986
[AD-A183423] p 802 N87-29406
FAA (Federal Aviation Administration) air traffic activity FY 1986
[AD-A183624] p 802 N87-29407

Florida Atlantic Univ., Boca Raton.
Toward comparing experiment and theory for corroborative research on hingeless rotor stability in forward flight
[NASA-CR-181354] p 836 N87-28562

Florida State Univ., Tallahassee.
Stochastic model theory of broadband shock associated noise from supersonic jets p 859 A87-52069

Flow Research, Inc., Kent, Wash.
Large-eddy numerical simulation of an array of three-dimensional impinging jets
[AD-A182459] p 850 N87-28835

G

Garrett Corp., Phoenix, Ariz.
Compound cycle engine program p 831 A87-53428

General Accounting Office, Washington, D. C.
Aviation safety: Procedures for registering and certifying air carriers
[PB87-193249] p 819 N87-29468

General Electric Co., Cincinnati, Ohio.
Advanced Propfan Engine Technology (APET) and single-rotation gearbox/pitch change mechanism
[NASA-CR-168113] p 833 N87-28553
Free-jet investigation of mechanically suppressed, high radius ratio coannular plug model nozzles
[NASA-CR-3596] p 860 N87-29315
Aerodynamic performance investigation of advanced mechanical suppressor and ejector nozzle concepts for jet noise reduction
[NASA-CR-174860] p 834 N87-29534
Turbofan aft duct suppressor study. Contractor's data report of mode probe signal data
[NASA-CR-175067] p 834 N87-29538
Turbofan aft duct suppressor study
[NASA-CR-175067] p 834 N87-29539

General Electric Co., Evendale, Ohio.
A variable geometry combustor for broadened properties fuels
[AIAA PAPER 87-1832] p 830 A87-52246

General Motors Corp., Indianapolis, Ind.
Advanced Propfan Engine Technology (APET) definition study, single and counter-rotation gearbox/pitch change mechanism design
[NASA-CR-168115] p 833 N87-28554

George Washington Univ., Washington, D.C.
Full-potential modeling of blade-vortex interactions
p 817 N87-29465

Georgia Inst. of Tech., Atlanta.
Implementation and validation of a wake model for low-speed forward flight
[NASA-CR-181341] p 811 N87-28514

Gesamthochschule, Duisburg (West Germany).
Contribution to the description of rotating flow instabilities and inlet perturbations in axial flow compressors
[ETN-87-90040] p 850 N87-28845

H

Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn.
Static tests of the propulsion system
[AIAA PAPER 87-1728] p 830 A87-52245

Honeywell Advanced Technology Centre, North York (Ontario).
Configuration design of a helicopter integrated navigation system p 823 N87-29480

I

Illinois Univ., Chicago.
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420

Illinois Univ., Urbana.
High-speed reacting flows: Research to understand processes in supersonic combustors
[AD-A183952] p 846 N87-29629

J

J and A Associates, Inc., Golden, Colo.
Evaluation of naphthene rich turbine fuels as heat sinks for hypersonic aircraft
[AD-A182118] p 845 N87-28658

Jet Propulsion Lab., California Inst. of Tech., Pasadena.
Preliminary simultaneous L/C-band images from the JPL aircraft synthetic aperture radar p 853 A87-53159
JPL multipolarization workstation - Hardware, software and examples of data analysis p 858 A87-53231
Pool fires in a simulated aircraft cabin interior with ventilation p 818 A87-53783

K

Kansas Univ., Lawrence.
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
Effect of a round airfoil nose on leading-edge suction
p 809 A87-53784
Analysis and design of airfoils and axisymmetric bodies in transonic nonuniform flow p 811 N87-28509

Kansas Univ. Center for Research, Inc., Lawrence.
Application of a sensitivity analysis technique to high-order digital flight control systems
[NASA-CR-179429] p 837 N87-28565

Kentron International, Inc., Hampton, Va.
The design and analysis of simple low speed flap systems with the aid of linearized theory computer programs
[NASA-CR-3913] p 812 N87-28522

L

Little (Dallas N.) and Associates, Bryan, Tex.
Soil stabilization for roadways and airfields
[AD-A183382] p 839 N87-29545

Litton Technische Werke, Freiburg (West Germany).
Navigation systems for the new generation of combat and transport helicopters and associated flight tests
p 823 N87-29481

Lockheed-California Co., Burbank.
Development of a reduced area horizontal tail for a wide body jet aircraft
[NASA-CR-172278] p 837 N87-28564
ACEE composite structures technology
[NASA-CR-172360] p 845 N87-28615
Advanced manufacturing development of a composite empennage component for L-1011 aircraft. Phase 3: Production readiness verification testing
[NASA-CR-172383-PH-3] p 845 N87-28616
Advanced composite vertical fin for L-1011 aircraft
[NASA-CR-3816] p 845 N87-28617
Study of utilization of advanced composites in fuselage structures of large transports
[NASA-CR-172404] p 845 N87-28619

Lockheed-Georgia Co., Marietta.
Static tests of the propulsion system
[AIAA PAPER 87-1728] p 830 A87-52245
Propfan test assessment testbed aircraft flutter model test report
[NASA-CR-179458] p 814 N87-29413
Propfan test assessment propfan propulsion system static test report
[NASA-CR-179613] p 834 N87-29536

Logistics Management Inst., Bethesda, Md.
Prototype aircraft sustainability model
[AD-A183183] p 802 N87-29405

M

Massachusetts Inst. of Tech., Cambridge.
Dynamics and aeroelasticity of composite structures
[AD-A182713] p 825 N87-28543
Preliminary Memphis FAA (Federal Aviation Administration)/Lincoln Laboratory operational weather studies results
[AD-A182730] p 854 N87-29057
Automation at the man-machine interface
p 855 N87-29504

Massachusetts Univ., Amherst.
Processor tradeoffs in distributed real-time systems
p 857 A87-52796

Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
Supersonic and transonic supersonic flow
[MPIS-16/1986] p 811 N87-28508
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452

McDonnell Aircraft Co., St. Louis, Mo.
Propulsion and airframe aerodynamic interactions of supersonic V/STOL configurations, phase 1
[NASA-CR-177369] p 812 N87-28521

McDonnell-Douglas Corp., Long Beach, Calif.
Development of laminar flow control wing surface porous structure
[NASA-CR-172424] p 802 N87-28502
Propfan experimental data analysis
[NASA-CR-166582] p 826 N87-28545
ACEE composite structures technology
[NASA-CR-172359] p 844 N87-28613

Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (West Germany).
Comparison between 2D transonic flutter calculations in the time and frequency domain p 812 N87-28520

Michigan Univ., Ann Arbor.
Processor tradeoffs in distributed real-time systems
p 857 A87-52796

Minnesota Univ., Minneapolis.
Accelerometer placement in active flutter suppression systems p 828 A87-52963

N

National Aeronautical Establishment, Ottawa (Ontario).
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds
[AD-A182797] p 836 N87-28559

National Aeronautics and Space Administration, Washington, D.C.
Development of supersonic computational aerodynamic program using panel method
[NASA-TT-20113] p 813 N87-28526

Some numerical calculations by using linear classical sonic theories approached from sub- or supersonic speeds
[NASA-TT-20112] p 813 N87-28527
High accuracy thrust measurement of aeronautical propulsion systems with particular consideration to a hydraulic force measuring device, part 1
[NASA-TT-20080] p 834 N87-28558

National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
Aerothermodynamics of transatmospheric vehicles
p 807 A87-52878
Prospects for destructive self-induced interactions in a vortex pair p 809 A87-53778
Experimental techniques for three-axes load cells used at the National Full-Scale Aerodynamics Complex
[NASA-TM-86693] p 826 N87-28546
The 1-((diorganooxy phosphonyl) methyl)-2,4- and -2,6-diamino benzenes and their derivatives
[NASA-CASE-ARC-11425-2] p 844 N87-28605
Electro-expulsive separation system
[NASA-CASE-ARC-11613-1] p 849 N87-28833
AI at Ames: Artificial Intelligence research and application at NASA Ames Research Center, Moffett Field, California, February 1985 p 858 N87-29140
Estimation of blade airloads from rotor blade bending moments
[NASA-TM-100020] p 815 N87-29421
Investigation of generic hub fairing and pylon shapes to reduce hub drag
[NASA-TM-100008] p 816 N87-29422
Transonic rotor tip design using numerical optimization
[NASA-TM-86771] p 816 N87-29431
Application of a panel method to wake-vortex/wing interaction and comparison with experimental data
[NASA-TM-88337] p 817 N87-29461
Anticipation of the landing shock phenomenon in flight simulation
[NASA-TM-89465] p 826 N87-29491
The results of a wind tunnel investigation of a model rotor with a free tip
[NASA-TM-86758] p 827 N87-29496
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
Bibliography for aircraft parameter estimation
[NASA-TM-86804] p 827 N87-29498
Trimming an aircraft model for flight simulation
[NASA-TM-89466] p 828 N87-29502
Small-scale rotor test rig capabilities for testing vibration alleviation algorithms
[NASA-TM-100002] p 858 N87-30102

National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985
p 853 A87-53206

National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
Application of parameter estimation to aircraft stability and control: The output-error approach
[NASA-RP-1168] p 827 N87-29499

National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
Community reactions to helicopter noise - Results from an experimental study p 853 A87-52064
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
Pilot evaluation of population-minimal ground tracks in the airport community p 838 A87-52879
Influence of forebody cross-sectional shape on wing vortex-burst location p 808 A87-52885
Laboratory study of sidewall noise transmission and treatment for a light aircraft fuselage
p 824 A87-52887
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890
Time-scale synthesis of a closed-loop discrete optimal control system p 857 A87-52960
Development of a takeoff performance monitoring system
[AIAA PAPER 86-2145] p 828 A87-52962
Flight test of a digital controller used in a helicopter autoland system p 835 A87-53079
Results from the pushbroom microwave radiometer flights over the Konza Prairie in 1985
p 853 A87-53206
Structural dynamics research in a full-scale transport aircraft crash test p 818 A87-53780
Evolution, calibration, and operational characteristics of the two-dimensional test section of the Langley 0.3-meter transonic cryogenic tunnel
[NASA-TP-2749] p 839 N87-28570
Standard test evaluation of graphite fiber/resin matrix composite materials for improved toughness
[NASA-TM-86298] p 845 N87-28618
Thermal fatigue tests of a radiative heat shield panel for a hypersonic transport
[NASA-TM-87583] p 845 N87-28643
The SIFT hardware/software systems. Volume 1: A detailed description
[NASA-TM-87574] p 858 N87-29186
Low-speed aerodynamic characteristics of a twin-engine general aviation configuration with aft-fuselage-mounted pusher propellers
[NASA-TP-2763] p 817 N87-29462
Jet transport flight operations using cockpit display of traffic information during instrument meteorological conditions: Simulation evaluation
[NASA-TP-2567] p 819 N87-29469
Qualitative evaluation of a flush air data system at transonic speeds and high angles of attack
[NASA-TP-2716] p 827 N87-29497
A vector-based failure detection and isolation algorithm for a dual fail-operational redundant strapdown inertial measurement unit
[NASA-TM-100493] p 829 N87-29531
Langley Aircraft Landing Dynamics Facility
[NASA-RP-1189] p 839 N87-29544
The ACEE program and basic composites research at Langley Research Center (1975 to 1986): Summary and bibliography
[NASA-RP-1177] p 846 N87-29612
Elevated temperature aluminum alloys
[NASA-CASE-LAR-13632-1] p 846 N87-29650
Acoustic effects on profile drag of a laminar flow airfoil
[NASA-TM-100505] p 860 N87-30155

National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
Static tests of the propulsion system
[AIAA PAPER 87-1728] p 830 A87-52245
A variable geometry combustor for broadened properties fuels
[AIAA PAPER 87-1832] p 830 A87-52246
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan
[AIAA PAPER 87-1893] p 806 A87-52251
The NASA strain gage laboratory p 838 A87-52494
Mathematical model partitioning and packing for parallel computer calculation p 856 A87-52534
Structural ceramics in heat engines - The NASA viewpoint p 842 A87-53352
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420
Compound cycle engine program p 831 A87-53428
New ZrO2-Yb2O3 plasma-sprayed coatings for thermal barrier applications p 843 A87-53623
Vortex-scalar element calculations of a diffusion flame stabilized on a plane mixing layer
[NASA-TM-100133] p 802 N87-28501
Toward improved durability in advanced combustors and turbines: Progress in the prediction of thermomechanical loads
[NASA-TM-88932] p 832 N87-28551
Measurement uncertainty for the Uniform Engine Testing Program conducted at NASA Lewis Research Center
[NASA-TM-88943] p 833 N87-28557
Experimental evaluation of corner turning vanes
[NASA-TM-100143] p 839 N87-28571
Control of shear flows by artificial excitation
[NASA-TM-100201] p 815 N87-29420
New methods and materials for molding and casting ice formations
[NASA-TM-100126] p 819 N87-29470
Analysis of Convair 990 rejected-takeoff accident with emphasis on decision making, training and procedures
[NASA-TM-100189] p 819 N87-29471
Airflow calibration and exhaust pressure/temperature survey of an F404, S/N 215-109, turbofan engine
[NASA-TM-100159] p 834 N87-29537
Performance and power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor on the Mod-O turbine
[NASA-TM-100136] p 855 N87-29956

National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SPACE/COHMEX data inventory document
[NASA-TM-4006] p 854 N87-29068

National Aeronautics and Space Administration. Wallops Flight Center, Wallops Island, Va.
Airborne multibeam radar altimetry
p 853 A87-53115
Aircraft positioning using Global Positioning System carrier phase data p 821 A87-54367

National Center for Atmospheric Research, Boulder, Colo.
A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation
[DOT/FAA/PM-87/11] p 854 N87-29060

National Chiao Tung Univ., Hsinchu (Taiwan).
New generation methods for spur, helical, and spiral-bevel gears p 849 A87-53420

National Oceanic and Atmospheric Administration, Boulder, Colo.
Weather Research Program
[PB87-196390] p 854 N87-29065

National Transportation Safety Board, Washington, D. C.
Aircraft accident reports. Brief format, US civil and foreign aviation, issue number 2, 1986 accidents
[PB87-916904] p 818 N87-28528
Aircraft accident reports. Brief format, US civil and foreign aviation, issue number 3, 1986 accidents
[PB87-916905] p 819 N87-28529

Naval Aerospace Medical Research Lab., Pensacola, Fla.
Tracking a laser-projected horizon indicator
[AD-A183384] p 856 N87-30051
Incompatibility of the M-1 maneuver with US Navy tactical aircraft oxygen systems
[AD-A183731] p 856 N87-30072

Naval Air Development Center, Warminster, Pa.
Joint development of the Multi-function Integrated Inertial Sensor Assembly (MIISA) p 852 N87-29479
Evaluation of the F/A-18 head-up-display for recovery from unusual attitudes
[AD-A183303] p 829 N87-29532

Naval Weapons Center, China Lake, Calif.
Parachute recovery systems design manual, chapter 5
[AD-A183191] p 816 N87-29426

Nielsen Engineering and Research, Inc., Mountain View, Calif.
Program LRCDM2: Improved aerodynamic prediction program for supersonic canard-tail missiles with axisymmetric bodies
[NASA-CR-3883] p 813 N87-28525

North Carolina State Univ., Raleigh.
Unsteady transonic flows past airfoils using the Euler equations p 808 A87-52890

Notre Dame Univ., Ind.
Visualization of the laminar separation bubble on airfoils at low Reynolds numbers p 806 A87-52348
Visualization of vortex breakdown on a delta wing
p 807 A87-52357
The structure of leading edge vortex flows including vortex breakdown p 818 N87-29467

O

Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
Theoretical evaluation of the aerodynamic performance of a transonic wing
[ONERA-20/3423-AY] p 810 N87-28507
Rotor dynamics test facility
[ONERA-RT-20/3239-RY-054R-0] p 839 N87-28567

Ohio State Univ., Columbus.
Transonic interference reduction by limited ventilation wall panels
[NASA-CR-175039] p 815 N87-29419

Old Dominion Univ., Norfolk, Va.
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
Some proposed enhancements to the NASA Langley 13-inch magnetic suspension and balance system
[NASA-CR-181152] p 839 N87-29543

P

Pennsylvania Univ., Philadelphia.
A strategy for advancing tilt-rotor technology
[NASA-CR-181420] p 827 N87-29500
Cost characteristics of tilt-rotor, conventional air and high speed rail short-haul intercity passenger service
[NASA-CR-181421] p 828 N87-29501

Physical Research, Inc., Torrance, Calif.
High Reynolds number flows around smooth and rough cylinders. Volume 1. Mean surface pressure distribution
[AD-A183531] p 816 N87-29428

Plessey Research (Caswell) Ltd., Towcester (England).
A designers' guide to the achievement of electrical continuity in carbon fibre composite structures
[CD6500551] p 844 N87-28607

Pratt and Whitney Aircraft Group, East Hartford, Conn.
Thin film strain gage development program
[NASA-CR-174707] p 850 N87-28883

R

Research Inst. of National Defence, Stockholm (Sweden).
NYANS: A package for time varying control systems
[FOA-C-20642-2.1] p 858 N87-29174
Royal Aircraft Establishment, Bedford (England).
The flight evaluation of a speech recognition and a speech output system in an advanced cockpit display and flight management system for helicopters
p 829 N87-29527
Royal Aircraft Establishment, Farnborough (England).
A flight evaluation of voice interaction as a component of an integrated helicopter avionics system
[RAE-TM-FS(B)-637] p 829 N87-28547
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data
[RAE-TM-FS(B)-638] p 829 N87-28548
Diffusion bonding of metals p 852 N87-29646

S

Sandia National Labs., Albuquerque, N. Mex.
User's manual for ADAM (Advanced Dynamic Airfoil Model)
[DE87-012342] p 813 N87-28524
The aerothermodynamic environment for holes in hypersonic configurations
[DE87-003790] p 814 N87-29414
Parachute systems technology: Fundamentals, concepts, and applications. Advanced parachute design
[DE87-011634] p 814 N87-29415
Parachute systems technology: Fundamentals, concepts, and applications
[DE87-011722] p 815 N87-29416
SDRC, Inc., San Diego, Calif.
A study of some approximations in the modeling of a coupled rotor/fuselage aeromechanical system
p 825 A87-53901
Slecor Corp., Hickory, N.C.
Lightweight 2 fiber aviation cable featuring low fiber stress levels
[AD-P005282] p 826 N87-29297
Southampton Univ. (England).
Noise attenuation properties of headsets in a helicopter noise environment
[CAA-PAPER-87004] p 860 N87-29311
Southwest Research Inst., San Antonio, Tex.
Detection of in-flight propeller-induced structure-borne noise p 838 A87-53779
Spectron Development Labs., Inc., Costa Mesa, Calif.
KC-135 aero-optical turbulent boundary layer/shear layer experiment revisited p 852 N87-29454
SRI International Corp., Menlo Park, Calif.
Design verification of SIFT
[NASA-CR-4097] p 858 N87-30099
Stuttgart Univ. (West Germany).
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile
[ETN-87-90038] p 810 N87-28505
Development and testing of highly loaded engine components made of carbon fiber reinforced plastics
[ETN-87-90036] p 832 N87-28550
Sverdrup Technology, Inc., Cleveland, Ohio.
Wind tunnel performance results of an aeroelastically scaled 2/9 model of the PTA flight test prop-fan
[AIAA PAPER 87-1893] p 806 A87-52251

T

Technische Hogeschool, Delft (Netherlands).
Calculation of pressure distributions on supersonic delta wings using stagnation solutions
[VTH-LR-484] p 815 N87-29417
Calculation of noise around airports for powered gliders
[VTH-LR-475] p 860 N87-30150
Technische Univ., Berlin (West Germany).
The problems of the calculation of the capacity of flight operation surfaces of airports
[ILR-MITT-170] p 838 N87-28566
Technische Univ., Brunswick (West Germany).
A contribution to the aerodynamics of unsymmetrical aircraft configurations
[ETN-87-90030] p 810 N87-28504
Texas A&M Univ., College Station.
Flow energizers. Task A
[NASA-CR-176202] p 812 N87-28523
Pressuremeter moduli for airport pavement design and evaluation
[DOT/FAA/PM-87/10] p 839 N87-28572
Micromechanics of compression failures in open hole composite laminates
[NASA-CR-181278] p 846 N87-29604
Texas Technological Univ., Lubbock.
User's manual for ADAM (Advanced Dynamic Airfoil Model)
[DE87-012342] p 813 N87-28524
A numerical model for unsteady two-dimensional flow calculations with flow separation
[DE87-012316] p 850 N87-28866

U

United Technologies Corp., East Hartford, Conn.
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-1] p 833 N87-28552
Advanced Prop-fan Engine Technology (APET) single- and counter-rotation gearbox/pitch change mechanism
[NASA-CR-168114-VOL-2] p 833 N87-28556
United Technologies Corp., Windsor Locks, Conn.
Analysis and test evaluation of the dynamic response and stability of three advanced turboprop models
[NASA-CR-174814] p 833 N87-28555
United Technologies Research Center, East Hartford, Conn.
High temperature static strain gage development contract, tasks 1 and 2
[NASA-CR-180811] p 850 N87-28869
An analysis of the crossover between local and massive separation on airfoils
[NASA-CR-4096] p 814 N87-29411

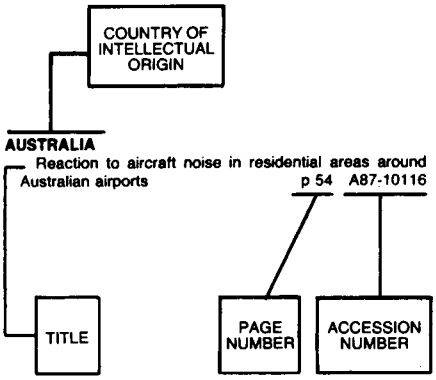
V

Vanderbilt Univ., Nashville, Tenn.
Aerodynamics of 3-dimensional bodies in transitional flow
[NASA-CR-181395] p 816 N87-29429
Vigyan Research Associates, Inc., Hampton, Va.
Viscous shock-layer analysis of hypersonic flows over long slender bodies
[AIAA PAPER 87-2487] p 806 A87-52291
Low-speed investigations of Apex fence and cavity flap concepts on a 60 degrees delta configuration
[AD-A183138] p 816 N87-29425
Virginia Polytechnic Inst. and State Univ., Blacksburg.
Two-degree-of-freedom subsonic wing rock and nonlinear aerodynamic interference p 811 N87-28511
Singular trajectories in airplane cruise-dash optimization p 825 N87-28544
Modeling and computational algorithms for parameter estimation and optimal control of aeroelastic systems and large flexible structures
[AD-A183302] p 852 N87-29893
Virginia Univ., Charlottesville.
Flow visualization studies of transverse fuel injection patterns in a nonreacting Mach 2 combustor
p 807 A87-52386

W

Washington Univ., Seattle.
General aviation aircraft utilization in the construction industry
[AD-A183155] p 802 N87-29404
Washington Univ., St. Louis, Mo.
Closing the man-machine loop: On the use of physiological measures to affect computer-controlled devices p 855 N87-29507

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.

A

AUSTRALIA
Supersonic vortex rings - Visualization techniques p 807 A87-52360
Flow behind a rearward facing step in hypersonic high enthalpy flow - Some interferometric studies p 807 A87-52371
Is fatigue testing of impact damaged laminates necessary? p 844 A87-54316
Smoke emission tests on series 2 and series 3 Allison T56 turboprop engines [AD-A182385] p 832 N87-28549

B

BULGARIA
The problem of the aviation-meteorological prediction of strong surface winds in eastern Bulgaria p 853 A87-51195

C

CANADA
Future impact of manufacturing technology and automation in Pratt & Whitney Canada p 849 A87-53416
Determination of handling qualities and display requirements for helicopter instrument flight during decelerating approaches to slow speeds [AD-A182797] p 836 N87-28559
Configuration design of a helicopter integrated navigation system p 823 N87-29480

CHINA, PEOPLE'S REPUBLIC OF
An experimental and theoretical investigation of an uncentralized squeeze-film damper bearing and the test results on a jet engine p 847 A87-51471
Modified characteristic method for calculation of supersonic S2 flow field in compressor p 804 A87-51473
Computation of optimum turbofan mixing with a subaccurate varying specific heat solution p 830 A87-51808
Three-dimensional calculation in a high subsonic axial compressor rotor and its compared with L2F velocity measurement p 805 A87-51809
The unsteady flow Euler amplitude equation in vibrating cascades and its numerical method p 830 A87-51810
Numerical solution of transonic stream function equation on S1 stream surface p 805 A87-51811
Calculation of noise caused by interaction of supersonic cascade and varied oncoming gust p 859 A87-51812
An experimental investigation of the effect of inlet flow distortion on compressor performance p 805 A87-51813
A method for producing oblique shock-bow shock interaction in double-driver shock tunnel p 837 A87-51968
A technique of holographic visualization to flow fields of a model with variable angles of attack p 806 A87-52306
Acta aeronautica et astronautica sinica (selected articles) [AD-A182447] p 802 N87-28500

CZECHOSLOVAKIA
A new model of a self-controlled system p 847 A87-51158

F

FRANCE
The MLS angle receiver p 820 A87-51231
Wind shear p 853 A87-51232
Dynamic stall around an airfoil at high Reynolds numbers - A comparison between numerical results and experimental visualization p 804 A87-51454
Digital video image processing applications to drop size and concentration measurements p 848 A87-52334
Investigation of unsteady subsonic spoiler and flap aerodynamics p 808 A87-52883
Inertial-GPS - A marriage of convenience under test p 820 A87-53578
Satellites for air navigation - An airline view p 820 A87-53580
The Navstar/GPS program - An evolution or a revolution in the world of navigation p 840 A87-53581
The role of Navstar/GPS in civil aviation p 820 A87-53582
Head-up flying p 835 A87-53583
Practical application to composite materials of a portable digital ultrasound device controlled by a microprocessor p 849 A87-53585
Vortex influence on oscillating airfoils at high angle of attack p 809 A87-53777
Unsteady test method applied to wind tunnel studies of flutter p 838 A87-54189
Simultaneous active controls on wind tunnel model p 836 A87-54190
Icing and de-icing on a downscale model in ONERA S1 MA wind tunnel p 818 A87-54191
Helicopter certification - New test techniques p 825 A87-54201
Numerical simulation of compressible homogeneous flows in the turbulent regime p 809 A87-54363
Theoretical evaluation of the aerodynamic performance of a transonic wing [ONERA-20/3423-AY] p 810 N87-28507
Future Research on Transonic Unsteady Aerodynamics and Its Aeroelastic Applications [AGARD-R-749] p 812 N87-28518
Rotor dynamics test facility [ONERA-RT-20/3239-RY-054R-0] p 839 N87-28567
Advances in Guidance and Control Systems and Technology [AGARD-CP-411] p 822 N87-29474
Sophisticated integral control methods for use in flight p 856 N87-29510
Organization of displays in the visual space of the combat aircraft pilot p 856 N87-29516

G

GERMANY DEMOCRATIC REPUBLIC
Experimental comparison of radiometric scales from laboratory standards and solar radiation p 849 A87-53576

GERMANY,FEDERAL REPUBLIC OF
Fick's first law correction by an exact solution of the Boltzmann equation p 859 A87-51483
A comparison between integrated and separated navigation and flight control motion sensing equipment and a concept for aircraft motion sensing and attitude/heading determination p 828 A87-51941
Moving shock waves in transonic flows p 806 A87-52304
Application of particle imaging velocimetry in windtunnels p 848 A87-52314
Reducing fuel consumption of subsonic aircraft by optimal cyclic cruise p 824 A87-52881
Interactions between an aircraft structure and active control systems p 835 A87-52964
Numerical aerodynamics using large computers p 809 A87-53562
Calculation of frictionless flow about airfoil wings and propellers by numerical solution of the Euler equations p 809 A87-53563
Simulation and characteristic value determination in helicopters p 824 A87-53564
PSI multitransducer in low-velocity wind tunnel in Braunschweig p 838 A87-53569
An active control landing gear for the alleviation of aircraft taxi ground loads p 824 A87-53573
The flow field in the second throat region of a wind tunnel, computed by an Euler method p 809 A87-53574
Measurement of spectral emissivity of technical surfaces in high-performance engines p 832 A87-53575
Local recoating of components of high-pressure jet aircraft engines p 843 A87-53823
Once around the earth without refueling p 801 A87-54252
A contribution to the aerodynamics of unsymmetrical aircraft configurations [ETN-87-90030] p 810 N87-28504
A contribution to the computation of unsteady, transonic, inviscid flow about a wing profile [ETN-87-90038] p 810 N87-28505
Investigations on a transonic airfoil with a 30 mm wide perforation/cavity arrangement [DFVLR-FB-86-59] p 810 N87-28506
Supersonic and transonic supersonic flow [MPIS-16/1986] p 811 N87-28508
Comparison between 2D transonic flutter calculations in the time and frequency domain p 812 N87-28520
Modeling of Systems for Aircraft Guidance and Air Traffic Control for Research, Development, and Evaluation [DFVLR-MITT-86-24] p 821 N87-28530
Role and task of models as tools for research and development p 821 N87-28531
The model inverse as an element of a predetermined control system for helicopters p 836 N87-28532
Modeling of radio navigation systems in the neighborhood of airports p 821 N87-28533
Modeling of the fault situation in navigation systems p 821 N87-28534
Simulation of strapdown systems for error analysis, and modeling for navigation with other sensor systems p 821 N87-28535
Models for the description of holding procedures in air traffic as an aid for optimization with respect to safety and efficiency p 822 N87-28536
A multichannel model for the description of the pilot in the closed control system, for the evaluation of future aircraft guidance systems p 822 N87-28537
Models of the description of air traffic control scenarios, for the evaluation of future air traffic control systems p 822 N87-28538

FOREIGN

Models for the ground based approach planning system Computer Oriented Metering Planning and Advisory System (COMPAS) p 822 N87-28539
Systems evaluation procedure using simulation illustrated by the Computer Oriented Metering Planning and Advisory System (COMPAS) project p 822 N87-28540
Development and testing of highly loaded engine components made of carbon fiber reinforced plastics [ETN-87-90036] p 832 N87-28550
High accuracy thrust measurement of aeronautical propulsion systems with particular consideration to a hydraulic force measuring device, part 1 [NASA-TT-20080] p 834 N87-28558
An improved design technique for model following control systems in in-flight simulation [DFVLR-FB-87-09] p 836 N87-28561
The problems of the calculation of the capacity of flight operation surfaces of airports [ILR-MITT-170] p 838 N87-28566
Contribution to the description of rotating flow instabilities and inlet perturbations in axial flow compressors [ETN-87-90040] p 850 N87-28845
Nondestructive tests of Carbon Fiber Reinforced Plastics (CFRP) in the framework of damage mechanics investigations [DFVLR-MITT-86-09] p 851 N87-28923
Infrared simulation model SENSAT-2 [DFVLR-FB-87-10] p 854 N87-28950
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment [DFVLR-FB-86-61] p 855 N87-29115
The Fringe Reading Facility at the Max-Planck-Institut fuer Stroemungsforschung p 851 N87-29452
Navigation systems for the new generation of combat and transport helicopters and associated flight tests p 823 N87-29481

I

INDIA
A two-dimensional finite element stress analysis of radial impellers p 847 A87-51472
INTERNATIONAL ORGANIZATION
Space communications to aircraft: A new development in international space law. I p 861 A87-51477
ISRAEL
Ground testing of an operational fighter aircraft for p-static discharge effects p 824 A87-52522
A reconsideration of the three-shock theory for a pseudo-steady Mach reflection p 810 A87-54364
ITALY
Aircraft microwave radiometry of land p 853 A87-53269

J

JAPAN
Application studies of a new graphite/epoxy material for the vertical fin of a commercial transport aircraft p 841 A87-51792
On design of restructurable control systems for aircraft with some failures p 835 A87-51981
Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge p 806 A87-52322
Study of the flow visualization on the rotary wing with low aspect ratio p 807 A87-52359
Visual studies of characteristics of slip stream in Mach reflection of a shock wave p 848 A87-52370
Finite element methods for incompressible viscous flow p 848 A87-52393
Development of fine-grained 7075-O sheet for aircraft taper-rolled stringer p 842 A87-52661
Hot isostatic pressing - Its application in high performance ceramics p 842 A87-53373
Development of supersonic computational aerodynamic program using panel method [NASA-TT-20113] p 813 N87-28526
Some numerical calculations by using linear classical sonic theories approached from sub- or supersonic speeds [NASA-TT-20112] p 813 N87-28527

N

NETHERLANDS
Calculation of pressure distributions on supersonic delta wings using stagnation solutions [VTH-LR-484] p 815 N87-29417
Calculation of noise around airports for powered gliders [VTH-LR-475] p 860 N87-30150

R

ROMANIA (RUMANIA)
Processes in turbomachinery: Applications and exercises p 808 A87-53412

S

SAUDI ARABIA
Supersonic rotor noise calculation with sonic boom prediction methods p 860 A87-53903
SWEDEN
Manipulated turbulence structure in flight p 806 A87-52056
On the computation of transonic leading-edge vortices using the Euler equations p 809 A87-54361
NYANS: A package for time varying control systems [FOA-C-20642-2.1] p 858 N87-29174
SWITZERLAND
Aviation satcoms p 820 A87-51322
Space-age navigation p 820 A87-51325
Non-isothermal fatigue crack growth in Hastelloy-X p 840 A87-51400
Dynamics of a high-speed rotor touching a boundary p 848 A87-51614
Canadair's CL-227 Sentinel gains credibility p 824 A87-53798
Airborne navigation plots its future p 821 A87-53800

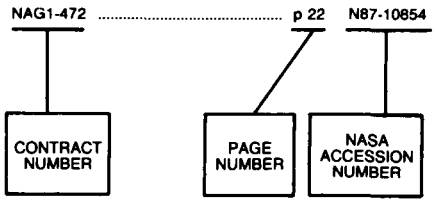
T

TAIWAN
A numerical study of flow in gas-turbine combustor [AIAA PAPER 87-2132] p 832 A87-53986

U

U.S.S.R.
An approach to the numerical modeling of the dynamics of reacting gases in nozzles p 847 A87-50872
Calculation of the aerodynamic coefficients of aircraft on a computer with allowance for physicochemical reactions p 803 A87-50876
Flow of a monoatomic rarefied gas around a rotating circular cylinder p 803 A87-50880
Forced oscillations in a boundary layer at frequencies close to the upper branch of the neutral curve p 803 A87-50890
Optimization of the controlled rotations of a rigid body with an elastic rod using first integrals of a free system p 859 A87-50915
The problems of aircraft microclimate (Review of the literature) p 855 A87-50949
Control of the intensity of convective heat transfer in a Laval nozzle under conditions of turbulent flow and in the presence of local separation zones p 803 A87-50972
Pulsation structure of the mixing layer of underexpanded jets p 847 A87-50974
A three-dimensional boundary layer on blunt bodies with a porous surface at angles of attack and sideslip p 803 A87-51007
Numerical modeling in aerohydrodynamics p 804 A87-51651
Three-dimensional flow around and radiative heating of blunt bodies p 804 A87-51653
The application of the method of streams to the numerical modeling of unsteady aerohydrodynamics problems p 804 A87-51654
Numerical modeling of supersonic muliphase flows p 804 A87-51659
Interaction of bodies with a nonuniform supersonic flow p 804 A87-51663
Calculation of the aerodynamic characteristics of bodies of complex shape in transition flow p 805 A87-51664
Characteristics of separated flow past a delta wing p 805 A87-51669
Calculation of three-dimensional supersonic flow past cone-like bodies with a separated shock wave p 805 A87-51671
Profiling of a lifting convex wing by a hodograph method p 805 A87-51672
Direct variational method in flight dynamics boundary value problems p 856 A87-52233
A method for controlling a centrifuge cabin p 857 A87-52823
Investigation of the life cycles of complex engineering systems using Petri nets p 857 A87-52832
Fatigue strength of 30KhGSN2A steel lugs under programmed loading p 843 A87-53441
Fatigue of gas turbine blades under random vibrations p 832 A87-53442
A supersonic jet in a chamber with a diaphragm p 808 A87-53520
Solution of the Volterra integral equation in the problem of the unsteady motion of a thin wing p 808 A87-53522
An analysis of the approximation of the aerodynamic coefficients of thin bodies in a rarefied gas p 808 A87-53526
Aerogasdynamics and its development at the Institute of Theoretical and Applied Mechanics of the Siberian Section of the Academy of Sciences of the USSR p 809 A87-53544
Principles of the computer-aided design of aircraft p 858 A87-53957
Determination of wind velocity and direction in the lower part of the atmospheric boundary layer on the basis of ground data p 854 A87-53969
UNITED KINGDOM
The measurement of oscillatory pressures with discrete and sweep excitation p 837 A87-51213
Conference on High-Temperature Corrosion of Superalloys, London, England, Feb 11, 12, 1986, Proceedings p 840 A87-51351
Hot corrosion site environment in gas turbines p 830 A87-51353
Transpiration cooling - Contribution of film cooling to the overall cooling effectiveness p 847 A87-51475
The preparation and properties of vapor deposited Al-Cr-Fe alloys p 841 A87-51634
The effect of composition and heat treatment upon microstructure/property relationships in Al-Li-Cu-Mg alloys p 842 A87-52673
The effect of prestrain and of ageing at room temperature on the mechanical properties of an Al-Li-Cu-Mg alloy p 842 A87-52683
Scattering of sound by a semi-infinite elastic plate with a soft backing - A matrix Wiener-Hopf problem p 859 A87-52846
Civil liability concerning unlawful interference with civil aviation p 861 A87-52900
Corsair with more - A-7 plus p 824 A87-53744
Aeroelastic oscillations caused by transitional boundary layers and their attenuation p 824 A87-53782
Approach to study of PRF sensitivity in airborne pulse-Doppler radar p 829 A87-53802
High-temperature polymers for adhesive and composite applications p 843 A87-53888
Aluminium-lithium alloys for helicopter structures p 843 A87-53892
Development of aluminium-lithium alloys in the UK p 843 A87-53893
Dispersion strengthened alloys for aerospace p 844 A87-53894
Simulating Hermes p 840 A87-54195
An experimental investigation of the generation and consequences of acoustic waves in an axial-flow compressor - The effect of variations in the axial spacing between blade rows p 860 A87-54239
Aircraft fires - Living through the smoke p 818 A87-54315
A flight evaluation of voice interaction as a component of an integrated helicopter avionics system [RAE-TM-FS(B)-637] p 829 N87-28547
The flight development of a color electronic display format and monitoring system of helicopter engine and transmission data [RAE-TM-FS(B)-638] p 829 N87-28548
The effect of load dwells on the fatigue of carbon fiber composites [BAE-MSM-R-GEN-0547] p 844 N87-28606
A designers' guide to the achievement of electrical continuity in carbon fibre composite structures [CD6500551] p 844 N87-28607
Noise attenuation properties of headsets in a helicopter noise environment [CAA-PAPER-87004] p 860 N87-29311
Contribution of wing dihedral to sideforce, yawing moment and rolling moment derivatives due to rate of roll at subsonic speeds, (Y sub p)sub gamma, (N sub p)sub gamma and (L sub p)sub gamma [ESDU-85006] p 813 N87-29409
Pitot and static errors due to non-steady flight [ESDU-85011] p 813 N87-29410
Estimation of sideforce, yawing moment and rolling moment derivatives due to rate of roll for complete aircraft at subsonic speeds [ESDU-85010] p 826 N87-29490
Voice control of cockpit systems p 837 N87-29526
The flight evaluation of a speech recognition and a speech output system in an advanced cockpit display and flight management system for helicopters p 829 N87-29527
Diffusion bonding of metals p 852 N87-29646

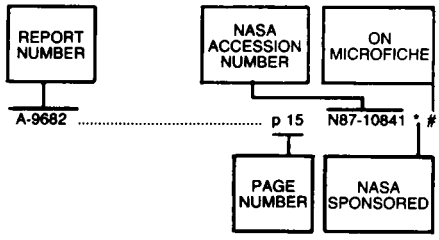
Typical Contract Number Index Listing



Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the AIAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in the abstract section. Preceding the accession number is the page number on which the citation may be found.

AF TASK 0130-26 ..... p 807 A87-52882
AF-AFOSR-0287-85 ..... p 852 N87-29893
AF-AFOSR-0356-84 ..... p 802 N87-28501
AF-AFOSR-81-0037 ..... p 806 A87-52324
AF-AFOSR-84-0099 ..... p 835 A87-54140
AF-AFOSR-85-0191 ..... p 842 A87-52658
CNRS-ATP-1227 ..... p 809 A87-54363
CNRS-RCP-080702 ..... p 809 A87-54363
DAAG29-80-C-0092 ..... p 835 A87-54139
DE-AC04-76DP-00789 ..... p 813 N87-28524
p 850 N87-28866
p 814 N87-29414
p 814 N87-29415
p 815 N87-29416
DE-AI01-76ET-20320 ..... p 855 N87-29956
DTFA01-80-Y-10546 ..... p 854 N87-29057
DTFA01-82-Y-10513 ..... p 854 N87-29060
F08637-81-C-0039 ..... p 839 N87-29545
F33615-85-C-2545 ..... p 826 N87-29493
p 826 N87-29494
F33615-85-C-3008 ..... p 816 N87-29425
F33615-86-C-2664 ..... p 845 N87-28658
F40600-84-C-0004 ..... p 859 A87-51215
F49620-84-C-0099 ..... p 825 N87-28543
F49620-85-C-0080 ..... p 803 A87-51221
F49620-85-C-0084 ..... p 850 N87-28835
F49620-85-C-0099 ..... p 824 A87-53781
F49620-86-C-0118 ..... p 810 N87-28503
MDA903-85-C-0139 ..... p 802 N87-29405
MOD(PE)-A94B/3593 ..... p 860 N87-29311
MOD-A81A/2038 ..... p 844 N87-28607
MOD-A93B/1336 ..... p 844 N87-28606
NAG1-217 ..... p 828 A87-52963
NAG1-296 ..... p 857 A87-52796
NAG1-344 ..... p 812 N87-28523
NAG1-373 ..... p 807 A87-52386
NAG1-421 ..... p 859 A87-52069
NAG1-549 ..... p 816 N87-29429
NAG1-659 ..... p 846 N87-29604
NAG1-693 ..... p 811 N87-28514
NAG1-716 ..... p 839 N87-29543
NAG2-116 ..... p 825 A87-53901
NAG2-209 ..... p 825 A87-53901
NAG2-258 ..... p 807 A87-52357
NAG2-305 ..... p 827 N87-29500
p 828 N87-29501
NAG3-109 ..... p 815 N87-29419
NAG3-122 ..... p 814 N87-29412
NASW-4005 ..... p 813 N87-28526
p 813 N87-28527
p 834 N87-28558
NAS1-11668 ..... p 846 N87-29609
NAS1-14000 ..... p 845 N87-28616
p 845 N87-28617
NAS1-14869 ..... p 844 N87-28613
NAS1-15025 ..... p 844 N87-28614
NAS1-15325 ..... p 836 N87-28563
NAS1-15326 ..... p 837 N87-28564
NAS1-15528 ..... p 858 N87-30099
NAS1-16000 ..... p 812 N87-28522
NAS1-16585 ..... p 814 N87-29411
NAS1-16770 ..... p 813 N87-28525
NAS1-16857 ..... p 844 N87-28613
NAS1-16863 ..... p 844 N87-28614
NAS1-17415 ..... p 845 N87-28619
NAS1-17506 ..... p 802 N87-28502
NAS1-17698 ..... p 845 N87-28615
NAS1-17701 ..... p 844 N87-28613
NAS1-17740 ..... p 844 N87-28614
NAS1-17921 ..... p 838 A87-53779
NAS2-10791 ..... p 812 N87-28521
NAS2-11672 ..... p 826 N87-28545
NAS3-21262 ..... p 850 N87-28883
NAS3-21608 ..... p 860 N87-29315
NAS3-22393 ..... p 833 N87-28555
NAS3-22755 ..... p 833 N87-28555
NAS3-22766 ..... p 834 N87-29538
p 834 N87-29539
NAS3-23038 ..... p 834 N87-29534
NAS3-23044 ..... p 833 N87-28553
NAS3-23045 ..... p 833 N87-28552
p 833 N87-28556
NAS3-23046 ..... p 833 N87-28554
NAS3-23722 ..... p 850 N87-28869
NAS3-24339 ..... p 830 A87-52245
p 814 N87-29413
p 834 N87-29536
NCC2-293 ..... p 837 N87-28565
NCC2-361 ..... p 836 N87-28562
NCC3-49 ..... p 815 N87-29418
NGT-34-002-800 ..... p 808 A87-52890
NSF CPE-84-0481 ..... p 802 N87-28501
NSG-1419 ..... p 806 A87-52348
NSG-1629 ..... p 809 A87-53784
N00014-83-K-0239 ..... p 806 A87-52348
p 808 A87-52886
N00014-85-C-0764 ..... p 816 N87-29428
N00014-86-K-0434 ..... p 846 N87-29629
N0014-85-K-0122 ..... p 857 A87-52796
RAE-7D/S/0416 ..... p 860 N87-29311
SERC-GR/B/00336 ..... p 847 A87-51475
SERC-GR/C/59192 ..... p 847 A87-51475
STPA-84-95-005 ..... p 809 A87-53777
STPA-85-95-009 ..... p 810 N87-28507
STPA-85-95-015 ..... p 839 N87-28567
505-31-32 ..... p 834 N87-29538
p 834 N87-29539
505-31-52 ..... p 850 N87-28883
505-34-13-32 ..... p 858 N87-29186
505-40-90 ..... p 860 N87-29315
505-42-11 ..... p 816 N87-29431
p 827 N87-29496
505-43-01 ..... p 812 N87-28521
p 826 N87-28546
505-43-23-02 ..... p 813 N87-28525
505-43-23-10 ..... p 812 N87-28522
505-45-54 ..... p 815 N87-29419
505-60-01-01 ..... p 814 N87-29411
505-60-21 ..... p 817 N87-29461
505-60-31-07 ..... p 860 N87-30155
505-61-01-02 ..... p 839 N87-28570
505-61-21 ..... p 816 N87-29422
505-61-51 ..... p 858 N87-30102
505-61 ..... p 827 N87-29498
505-62-21 ..... p 802 N87-28501
p 815 N87-29418
p 815 N87-29420
505-62-3B ..... p 834 N87-29537
505-63-41-02 ..... p 839 N87-29544
505-65-38 ..... p 833 N87-28557
505-66-21-01 ..... p 858 N87-30099
505-66-21-06 ..... p 829 N87-29531
505-66-71 ..... p 837 N87-28565
505-67-01-01 ..... p 819 N87-29469
505-67-51 ..... p 826 N87-29491
p 828 N87-29502
505-68-11 ..... p 819 N87-29470
505-68-31 ..... p 827 N87-29497
506-53-23-11 ..... p 845 N87-28643
506-63-01-06 ..... p 846 N87-29609
p 846 N87-29612
533-04-11 ..... p 832 N87-28551
p 850 N87-28869
534-06-13 ..... p 844 N87-28613
p 844 N87-28614
p 845 N87-28615
p 845 N87-28618
535-03-01-02 ..... p 817 N87-29462
535-03-01 ..... p 834 N87-29536
535-05-01 ..... p 839 N87-28571
776-33-41 ..... p 855 N87-29956
992-21-01 ..... p 815 N87-29421

Typical Report Number Index Listing



Listings in this index are arranged alphanumerically by report number. The page number indicates the page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

A-86330 ..... p 817 N87-29461 * #
A-87237 ..... p 826 N87-29491 * #
A-87238 ..... p 828 N87-29502 * #
A-87271 ..... p 858 N87-30102 * #
A-87287 ..... p 816 N87-29422 * #
A-87311 ..... p 815 N87-29421 * #

ACEE-28-FR ..... p 826 N87-28545 * #

AD-A180311 ..... p 861 N87-29364 #
AD-A182118 ..... p 845 N87-28658 #
AD-A182119 ..... p 810 N87-28503 #
AD-A182369 ..... p 825 N87-28541 #
AD-A182385 ..... p 832 N87-28549 #
AD-A182447 ..... p 802 N87-28500 #
AD-A182459 ..... p 850 N87-28835 #
AD-A182475 ..... p 860 N87-29308 #
AD-A182667 ..... p 825 N87-28542 #
AD-A182713 ..... p 825 N87-28543 #
AD-A182730 ..... p 854 N87-29057 #
AD-A182797 ..... p 836 N87-28559 #
AD-A182929 ..... p 819 N87-29472 #
AD-A183017 ..... p 862 N87-30224 #
AD-A183138 ..... p 816 N87-29425 #
AD-A183153 ..... p 823 N87-29487 #
AD-A183155 ..... p 802 N87-29404 #
AD-A183183 ..... p 802 N87-29405 #
AD-A183191 ..... p 816 N87-29426 #
AD-A183286 ..... p 852 N87-29842 #
AD-A183287 ..... p 816 N87-29427 #
AD-A183290 ..... p 819 N87-29473 #
AD-A183299 ..... p 823 N87-29488 #
AD-A183302 ..... p 852 N87-29893 #
AD-A183303 ..... p 829 N87-29532 #
AD-A183382 ..... p 839 N87-29545 #
AD-A183384 ..... p 856 N87-30051 #
AD-A183423 ..... p 802 N87-29406 #
AD-A183531 ..... p 816 N87-29428 #
AD-A183624 ..... p 802 N87-29407 #
AD-A183690 ..... p 826 N87-29493 #
AD-A183731 ..... p 856 N87-30072 #
AD-A183781 ..... p 826 N87-29494 #
AD-A183952 ..... p 846 N87-29629 #
AD-A183954 ..... p 827 N87-29495 #

AD-E900716 ..... p 816 N87-29426 #
AD-E951007 ..... p 825 N87-28541 #

AD-P005211 ..... p 846 N87-29227 #
AD-P005282 ..... p 826 N87-29297 #

AFIT/GAE/AA/86D-19 ..... p 825 N87-28542 #

AFOSR-87-0818TR ..... p 810 N87-28503 #
AFOSR-87-0845TR ..... p 825 N87-28543 #
AFOSR-87-0900TR ..... p 850 N87-28835 #
AFOSR-87-0956TR ..... p 852 N87-29893 #

AFWAL-TR-85-4000 ..... p 862 N87-30224 #
AFWAL-TR-86-2000 ..... p 861 N87-29364 #
AFWAL-TR-86-3009 ..... p 819 N87-29473 #
AFWAL-TR-86-3072 ..... p 816 N87-29427 #
AFWAL-TR-86-3114 ..... p 816 N87-29425 #
AFWAL-TR-86-4000 ..... p 862 N87-30224 #
AFWAL-TR-87-2000 ..... p 861 N87-29364 #
AFWAL-TR-87-2015 ..... p 852 N87-29842 #
AFWAL-TR-87-2024-VOL-1 ..... p 826 N87-29493 #
AFWAL-TR-87-2024-VOL-2 ..... p 826 N87-29494 #
AFWAL-TR-87-2026 ..... p 845 N87-28658 #

AGARD-CP-411 ..... p 822 N87-29474 #

AGARD-R-749 ..... p 812 N87-28518 #

AIAA PAPER 86-2145 ..... p 828 A87-52962 * #
AIAA PAPER 87-1728 ..... p 830 A87-52245 * #
AIAA PAPER 87-1732 ..... p 824 A87-52844 #
AIAA PAPER 87-1832 ..... p 830 A87-52246 * #
AIAA PAPER 87-1893 ..... p 806 A87-52251 * #
AIAA PAPER 87-2132 ..... p 832 A87-53986 #
AIAA PAPER 87-2487 ..... p 806 A87-52291 * #
AIAA PAPER 87-2635 ..... p 838 A87-52290 #

AIAA-87-2722 ..... p 815 N87-29420 * #

ARL-AERO-PROP-TM-438 ..... p 832 N87-28549 #

ATC-141 ..... p 854 N87-29057 #

B-226786 ..... p 819 N87-29468 #

BAE-MSM-R-GEN-0547 ..... p 844 N87-28606 #

BR100026 ..... p 844 N87-28606 #
BR100178 ..... p 844 N87-28607 #
BR100581 ..... p 829 N87-28547 #
BR100619 ..... p 829 N87-28548 #

B8707449 ..... p 860 N87-30150 #
B8707457 ..... p 815 N87-29417 #

CAA-PAPER-87004 ..... p 860 N87-29311

CD6500551 ..... p 844 N87-28607 #

CONF-8706165-1 ..... p 814 N87-29415 #
CONF-8706165-2 ..... p 815 N87-29416 #
CONF-870830-2 ..... p 814 N87-29414 #

DE87-003790 ..... p 814 N87-29414 #
DE87-011634 ..... p 814 N87-29415 #
DE87-011722 ..... p 815 N87-29416 #
DE87-012316 ..... p 850 N87-28866 #
DE87-012342 ..... p 813 N87-28524 #

DFVLR-FB-86-59 ..... p 810 N87-28506 #
DFVLR-FB-86-61 ..... p 855 N87-29115 #
DFVLR-FB-87-09 ..... p 836 N87-28561 #
DFVLR-FB-87-10 ..... p 854 N87-28950 #

DFVLR-MITT-86-09 ..... p 851 N87-28923 #
DFVLR-MITT-86-24 ..... p 821 N87-28530 #

DOE/NASA/20320-73 ..... p 855 N87-29956 * #

DOT/FAA/CT-TN86/64 ..... p 823 N87-29487 #
DOT/FAA/CT-TN87/16 ..... p 823 N87-29488 #

DOT/FAA/PM-86-40 ..... p 854 N87-29057 #
DOT/FAA/PM-87/10 ..... p 839 N87-28572 #
DOT/FAA/PM-87/11 ..... p 854 N87-29060 #

DRR-8607 ..... p 860 N87-29311

D180-29904-1 ..... p 826 N87-29493 #
D180-29904-2 ..... p 826 N87-29494 #

E-2472 ..... p 860 N87-29315 * #
E-3234 ..... p 833 N87-28557 * #
E-3374 ..... p 832 N87-28551 * #
E-3447 ..... p 834 N87-29537 * #
E-3500 ..... p 814 N87-29412 * #
E-3673 ..... p 819 N87-29470 * #
E-3683 ..... p 802 N87-28501 * #
E-3686 ..... p 855 N87-29956 * #
E-3695 ..... p 839 N87-28571 * #
E-3771 ..... p 819 N87-29471 * #
E-3794 ..... p 815 N87-29420 * #

EDR-11283 ..... p 833 N87-28554 * #

ESDU-85006 ..... p 813 N87-29409
ESDU-85010 ..... p 826 N87-29490
ESDU-85011 ..... p 813 N87-29410

ESL-TR-86-19 ..... p 839 N87-29545 #

ETN-87-90030 ..... p 810 N87-28504 #
ETN-87-90036 ..... p 832 N87-28550 #
ETN-87-90038 ..... p 810 N87-28505 #
ETN-87-90040 ..... p 850 N87-28845 #
ETN-87-90046 ..... p 821 N87-28530 #
ETN-87-90047 ..... p 810 N87-28506 #
ETN-87-90049 ..... p 855 N87-29115 #
ETN-87-90051 ..... p 838 N87-28566 #
ETN-87-90067 ..... p 858 N87-29174 #
ETN-87-90215 ..... p 860 N87-30150 #
ETN-87-90223 ..... p 815 N87-29417 #
ETN-87-90255 ..... p 860 N87-29311
ETN-87-90266 ..... p 829 N87-28547 #
ETN-87-90267 ..... p 829 N87-28548 #
ETN-87-90271 ..... p 844 N87-28606 #
ETN-87-90272 ..... p 844 N87-28607 #
ETN-87-90286 ..... p 839 N87-28567 #
ETN-87-90287 ..... p 810 N87-28507 #
ETN-87-90323 ..... p 811 N87-28508 #
ETN-87-90456 ..... p 836 N87-28561 #
ETN-87-90457 ..... p 854 N87-28950 #

FLOW-RR-403 ..... p 850 N87-28835 #

FOA-C-20642-2.1 ..... p 858 N87-29174 #

FTD-ID(RS)T-0134-87 ..... p 802 N87-28500 #

GAO/RCED-87-115FS ..... p 819 N87-29468 #

H-1277 ..... p 827 N87-29497 * #
H-1299 ..... p 827 N87-29499 * #
H-1358 ..... p 827 N87-29498 * #

HSER-8945 ..... p 833 N87-28555 * #

ICOMP-87-4 ..... p 802 N87-28501 * #

ILR-MITT-170 ..... p 838 N87-28566 #

ISBN-0-85679-512-7 ..... p 813 N87-29409
ISBN-0-85679-516-X ..... p 826 N87-29490
ISBN-0-85679-517-8 ..... p 813 N87-29410
ISBN-0-86039-299-6 ..... p 860 N87-29311
ISBN-92-835-0421-6 ..... p 822 N87-29474 #
ISBN-92-835-0425-9 ..... p 812 N87-28518 #

ISSN-0141-397X ..... p 813 N87-29409
ISSN-0141-397X ..... p 826 N87-29490
ISSN-0141-4054 ..... p 813 N87-29410
ISSN-0171-1342 ..... p 810 N87-28506 #
ISSN-0171-1342 ..... p 836 N87-28561 #
ISSN-0171-1342 ..... p 854 N87-28950 #
ISSN-0171-1342 ..... p 855 N87-29115 #
ISSN-0176-7739 ..... p 821 N87-28530 #
ISSN-0347-3694 ..... p 858 N87-29174 #
ISSN-0436-1199 ..... p 811 N87-28508 #

L-16091 ..... p 819 N87-29469 * #
L-16190 ..... p 839 N87-28570 * #
L-16290 ..... p 846 N87-29612 * #
L-16293 ..... p 839 N87-29544 * #
L-16331 ..... p 817 N87-29462 * #

LG85ER0187 ..... p 814 N87-29413 * #
LG86ER0173 ..... p 834 N87-29536 * #

LMI-AF601R2 ..... p 802 N87-29405 #

LR-30786 ..... p 845 N87-28619 * #

L86R1350 ..... p 814 N87-29413 * #
L87R1488 ..... p 834 N87-29536 * #

MPIS-16/1986 ..... p 811 N87-28508 #

NADC-86157-60 ..... p 829 N87-29532 #

NAE-AN-44 ..... p 836 N87-28559 #

NAMRL-TM-86-1 ..... p 856 N87-30072 #

NAMRL-1330 ..... p 856 N87-30051 #

NAS 1.15:100002 ..... p 858 N87-30102 * #
NAS 1.15:100008 ..... p 816 N87-29422 * #
NAS 1.15:100020 ..... p 815 N87-29421 * #
NAS 1.15:100126 ..... p 819 N87-29470 * #
NAS 1.15:100133 ..... p 802 N87-28501 * #
NAS 1.15:100136 ..... p 855 N87-29956 * #
NAS 1.15:100143 ..... p 839 N87-28571 * #
NAS 1.15:100159 ..... p 834 N87-29537 * #
NAS 1.15:100189 ..... p 819 N87-29471 * #
NAS 1.15:100201 ..... p 815 N87-29420 * #
NAS 1.15:100493 ..... p 829 N87-29531 * #
NAS 1.15:100505 ..... p 860 N87-30155 * #
NAS 1.15:4006 ..... p 854 N87-29068 * #
NAS 1.15:86298 ..... p 845 N87-28618 * #
NAS 1.15:86693 ..... p 826 N87-28546 * #
NAS 1.15:86758 ..... p 827 N87-29496 * #
NAS 1.15:86771 ..... p 816 N87-29431 * #
NAS 1.15:86804 ..... p 827 N87-29498 * #
NAS 1.15:87574 ..... p 858 N87-29186 * #
NAS 1.15:87583 ..... p 845 N87-28643 * #
NAS 1.15:88337 ..... p 817 N87-29461 * #
NAS 1.15:88932 ..... p 832 N87-28551 * #
NAS 1.15:88943 ..... p 833 N87-28557 * #
NAS 1.15:89465 ..... p 826 N87-29491 * #
NAS 1.15:89466 ..... p 828 N87-29502 * #
NAS 1.26:166582 ..... p 826 N87-28545 * #
NAS 1.26:168113 ..... p 833 N87-28553 * #
NAS 1.26:168114-VOL-1 ..... p 833 N87-28552 * #
NAS 1.26:168114-VOL-2 ..... p 833 N87-28556 * #
NAS 1.26:168115 ..... p 833 N87-28554 * #
NAS 1.26:172278 ..... p 837 N87-28564 * #
NAS 1.26:172358 ..... p 844 N87-28614 * #
NAS 1.26:172359 ..... p 844 N87-28613 * #
NAS 1.26:172360 ..... p 845 N87-28615 * #
NAS 1.26:172383-PH-3 ..... p 845 N87-28616 * #
NAS 1.26:172404 ..... p 845 N87-28619 * #
NAS 1.26:172424 ..... p 802 N87-28502 * #
NAS 1.26:172525 ..... p 836 N87-28563 * #
NAS 1.26:174707 ..... p 850 N87-28883 * #
NAS 1.26:174814 ..... p 833 N87-28555 * #
NAS 1.26:174860 ..... p 834 N87-29534 * #
NAS 1.26:175039 ..... p 815 N87-29419 * #
NAS 1.26:175059 ..... p 815 N87-29418 * #
NAS 1.26:175067 ..... p 834 N87-29538 * #
NAS 1.26:175067 ..... p 834 N87-29539 * #
NAS 1.26:176202 ..... p 812 N87-28523 * #
NAS 1.26:177369 ..... p 812 N87-28521 * #
NAS 1.26:178322 ..... p 846 N87-29609 * #
NAS 1.26:179429 ..... p 837 N87-28565 * #
NAS 1.26:179458 ..... p 814 N87-29413 * #
NAS 1.26:179613 ..... p 834 N87-29536 * #
NAS 1.26:180811 ..... p 850 N87-28869 * #
NAS 1.26:181152 ..... p 839 N87-29543 * #
NAS 1.26:181278 ..... p 846 N87-29604 * #
NAS 1.26:181341 ..... p 811 N87-28514 * #
NAS 1.26:181354 ..... p 836 N87-28562 * #
NAS 1.26:181395 ..... p 816 N87-29429 * #
NAS 1.26:181420 ..... p 827 N87-29500 * #
NAS 1.26:181421 ..... p 828 N87-29501 * #
NAS 1.26:3596 ..... p 860 N87-29315 * #
NAS 1.26:3816 ..... p 845 N87-28617 * #
NAS 1.26:3883 ..... p 813 N87-28525 * #
NAS 1.26:3913 ..... p 812 N87-28522 * #
NAS 1.26:4076 ..... p 814 N87-29412 * #
NAS 1.26:4096 ..... p 814 N87-29411 * #
NAS 1.26:4097 ..... p 858 N87-30099 * #
NAS 1.60:2567 ..... p 819 N87-29469 * #
NAS 1.60:2716 ..... p 827 N87-29497 * #
NAS 1.60:2749 ..... p 839 N87-28570 * #
NAS 1.60:2763 ..... p 817 N87-29462 * #
NAS 1.61:1168 ..... p 827 N87-29499 * #
NAS 1.61:1177 ..... p 846 N87-29612 * #
NAS 1.61:1189 ..... p 839 N87-29544 * #
NAS 1.71:LAR-13632-1 ..... p 846 N87-29650 * #
NAS 1.77:20080 ..... p 834 N87-28558 * #
NAS 1.77:20112 ..... p 813 N87-28527 * #
NAS 1.77:20113 ..... p 813 N87-28526 * #

NASA-CASE-ARC-11425-2 ..... p 844 N87-28605 *
NASA-CASE-ARC-11613-1 ..... p 849 N87-28833 *

NASA-CASE-LAR-13632-1 ..... p 846 N87-29650 * #

NASA-CR-166582 ..... p 826 N87-28545 * #
NASA-CR-168113 ..... p 833 N87-28553 * #
NASA-CR-168114-VOL-1 ..... p 833 N87-28552 * #
NASA-CR-168114-VOL-2 ..... p 833 N87-28556 * #
NASA-CR-168115 ..... p 833 N87-28554 * #
NASA-CR-172278 ..... p 837 N87-28564 * #
NASA-CR-172358 ..... p 844 N87-28614 * #
NASA-CR-172359 ..... p 844 N87-28613 * #
NASA-CR-172360 ..... p 845 N87-28615 * #
NASA-CR-172383-PH-3 ..... p 845 N87-28616 * #
NASA-CR-172404 ..... p 845 N87-28619 * #
NASA-CR-172424 ..... p 802 N87-28502 * #
NASA-CR-172525 ..... p 836 N87-28563 * #
NASA-CR-174707 ..... p 850 N87-28883 * #
NASA-CR-174814 ..... p 833 N87-28555 * #
NASA-CR-174860 ..... p 834 N87-29534 * #
NASA-CR-175039 ..... p 815 N87-29419 * #
NASA-CR-175059 ..... p 815 N87-29418 * #
NASA-CR-175067 ..... p 834 N87-29538 * #
NASA-CR-175067 ..... p 834 N87-29539 * #
NASA-CR-176202 ..... p 812 N87-28523 * #
NASA-CR-177369 ..... p 812 N87-28521 * #
NASA-CR-178322 ..... p 846 N87-29609 * #
NASA-CR-179429 ..... p 837 N87-28565 * #
NASA-CR-179458 ..... p 814 N87-29413 * #
NASA-CR-179613 ..... p 834 N87-29536 * #
NASA-CR-180811 ..... p 850 N87-28869 * #
NASA-CR-181152 ..... p 839 N87-29543 * #
NASA-CR-181278 ..... p 846 N87-29604 * #
NASA-CR-181341 ..... p 811 N87-28514 * #
NASA-CR-181354 ..... p 836 N87-28562 * #
NASA-CR-181395 ..... p 816 N87-29429 * #
NASA-CR-181420 ..... p 827 N87-29500 * #
NASA-CR-181421 ..... p 828 N87-29501 * #
NASA-CR-3596 ..... p 860 N87-29315 * #
NASA-CR-3816 ..... p 845 N87-28617 * #
NASA-CR-3883 ..... p 813 N87-28525 * #
NASA-CR-3913 ..... p 812 N87-28522 * #
NASA-CR-4076 ..... p 814 N87-29412 * #
NASA-CR-4096 ..... p 814 N87-29411 * #
NASA-CR-4097 ..... p 858 N87-30099 * #

NASA-RP-1168 ..... p 827 N87-29499 * #
NASA-RP-1177 ..... p 846 N87-29612 * #
NASA-RP-1189 ..... p 839 N87-29544 * #

NASA-TM-100002 ..... p 858 N87-30102 * #
NASA-TM-100008 ..... p 816 N87-29422 * #
NASA-TM-100020 ..... p 815 N87-29421 * #
NASA-TM-100126 ..... p 819 N87-29470 * #
NASA-TM-100133 ..... p 802 N87-28501 * #
NASA-TM-100136 ..... p 855 N87-29956 * #
NASA-TM-100143 ..... p 839 N87-28571 * #
NASA-TM-100159 ..... p 834 N87-29537 * #
NASA-TM-100189 ..... p 819 N87-29471 * #
NASA-TM-100201 ..... p 815 N87-29420 * #
NASA-TM-100493 ..... p 829 N87-29531 * #
NASA-TM-100505 ..... p 860 N87-30155 * #
NASA-TM-4006 ..... p 854 N87-29068 * #
NASA-TM-86298 ..... p 845 N87-28618 * #
NASA-TM-86693 ..... p 826 N87-28546 * #
NASA-TM-86758 ..... p 827 N87-29496 * #
NASA-TM-86771 ..... p 816 N87-29431 * #
NASA-TM-86804 ..... p 827 N87-29498 * #
NASA-TM-87574 ..... p 858 N87-29186 * #
NASA-TM-87583 ..... p 845 N87-28643 * #
NASA-TM-88337 ..... p 817 N87-29461 * #
NASA-TM-88932 ..... p 832 N87-28551 * #
NASA-TM-88943 ..... p 833 N87-28557 * #
NASA-TM-89465 ..... p 826 N87-29491 * #
NASA-TM-89466 ..... p 828 N87-29502 * #

NASA-TP-2567 ..... p 819 N87-29469 * #
NASA-TP-2716 ..... p 827 N87-29497 * #
NASA-TP-2749 ..... p 839 N87-28570 * #
NASA-TP-2763 ..... p 817 N87-29462 * #

NASA-TT-20080 ..... p 834 N87-28558 * #
NASA-TT-20112 ..... p 813 N87-28527 * #
NASA-TT-20113 ..... p 813 N87-28526 * #

NEAR-TR-287 ..... p 813 N87-28525 * #

NTSB/AAB-87/04 ..... p 818 N87-28528 #
NTSB/AAB-87/05 ..... p 819 N87-28529 #

NWC-TP-6575-CH-5-OFFPRINT .. p 816 N87-29426 #

ONERA-RT-20/3239-RY-054R-056
L ..... p 839 N87-28567 #

ONERA-20/3423-AY ..... p 810 N87-28507 #

PB87-193249 ..... p 819 N87-29468 #
PB87-196390 ..... p 854 N87-29065 #
PB87-916904 ..... p 818 N87-28528 #
PB87-916905 ..... p 819 N87-28529 #

PR-9 ..... p 846 N87-29609 * #

PRI-PV-87-R001-VOL-1 ..... p 816 N87-29428 #

PWA-5628-69 ..... p 850 N87-28883 * #
PWA-5869-88-VOL-1 ..... p 833 N87-28552 * #
PWA-5869-88-VOL-2 ..... p 833 N87-28556 * #

RAE-TM-FS(B)-637 ..... p 829 N87-28547 #
RAE-TM-FS(B)-638 ..... p 829 N87-28548 #

REPT-85150 ..... p 826 N87-28546 * #
REPT-85266 ..... p 827 N87-29496 * #
REPT-85333 ..... p 816 N87-29431 * #

RF-7035 ..... p 839 N87-28572 #

R81AEG484 ..... p 860 N87-29315 * #
R83AEB122-3 ..... p 834 N87-29534 * #
R83AEB566 ..... p 834 N87-29539 * #
R83AEB592 ..... p 833 N87-28553 * #
R87-916527-1 ..... p 850 N87-28869 * #

SAND-86-2875C ..... p 814 N87-29414 #
SAND-86-7182 ..... p 813 N87-28524 #
SAND-86-7183 ..... p 850 N87-28866 #
SAND-87-1648C ..... p 814 N87-29415 #
SAND-87-1649C ..... p 815 N87-29416 #

TELAC-86-14A ..... p 825 N87-28543 #

US-PATENT-APPL-SN-079316 ..... p 846 N87-29650 * #
US-PATENT-APPL-SN-641152 ..... p 844 N87-28605 *
US-PATENT-APPL-SN-739792 ..... p 849 N87-28833 *

US-PATENT-CLASS-244-134-D ... p 849 N87-28833 *
US-PATENT-CLASS-318-116 ..... p 849 N87-28833 *
US-PATENT-CLASS-558-145 ..... p 844 N87-28605 *
US-PATENT-CLASS-558-190 ..... p 844 N87-28605 *
US-PATENT-CLASS-558-193 ..... p 844 N87-28605 *

US-PATENT-4,689,421 ..... p 844 N87-28605 *
US-PATENT-4,690,353 ..... p 849 N87-28833 *

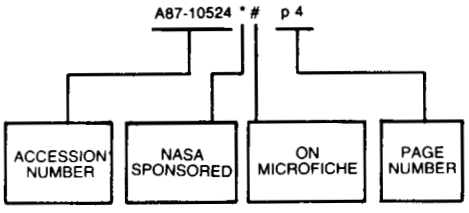
USAAEFA-84-25 ..... p 825 N87-28541 #
USAAEFA-84-28 ..... p 827 N87-29495 #

USAAVSCOM-TR-87-A-8 ..... p 815 N87-29421 * #

USAFOEHL-87-068E0118ENA ..... p 860 N87-29308 #
USAFOEHL-87-073C00253FOC .. p 819 N87-29472 #

VTH-LR-475 ..... p 860 N87-30150 #
VTH-LR-484 ..... p 815 N87-29417 #

Typical Accession Number Index Listing



Listings in this index are arranged alphanumerically 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.

A87-50872 p 847
A87-50876 p 803
A87-50880 p 803
A87-50890 p 803
A87-50915 p 859
A87-50949 p 855
A87-50972 p 803
A87-50974 p 847
A87-51007 p 803
A87-51158 p 847
A87-51177 # p 840
A87-51195 p 853
A87-51213 p 837
A87-51214 p 823
A87-51215 p 859
A87-51221 p 803
A87-51231 p 820
A87-51232 p 853
A87-51301 p 840
A87-51322 p 820
A87-51325 p 820
A87-51347 p 823
A87-51351 p 840
A87-51353 p 830
A87-51400 p 840
A87-51454 p 804
A87-51469 p 847
A87-51471 p 847
A87-51472 p 847
A87-51473 p 804
A87-51474 p 830
A87-51475 p 847
A87-51477 p 861
A87-51483 p 859
A87-51614 p 848
A87-51634 p 841
A87-51648 p 841
A87-51651 p 804
A87-51653 p 804
A87-51654 p 804
A87-51659 p 804
A87-51663 p 804
A87-51664 p 805
A87-51669 p 805
A87-51671 p 805
A87-51672 p 805
A87-51757 p 841
A87-51792 p 841
A87-51807 p 841
A87-51808 # p 830
A87-51809 # p 805
A87-51810 # p 830
A87-51811 # p 805
A87-51812 # p 859
A87-51813 # p 805
A87-51941 # p 828
A87-51968 p 837
A87-51981 # p 835
A87-52056 p 806
A87-52064 * p 853
A87-52069 * p 859
A87-52171 p 861
A87-52172 p 861
A87-52189 # p 848
A87-52233 p 856
A87-52245 * # p 830
A87-52246 * # p 830
A87-52251 * # p 806
A87-52290 # p 838
A87-52291 * # p 806
A87-52304 p 806
A87-52306 p 806
A87-52314 p 848
A87-52322 p 806
A87-52324 p 806
A87-52334 p 848
A87-52348 * p 806
A87-52355 p 807
A87-52357 * p 807
A87-52359 p 807
A87-52360 p 807
A87-52370 p 848
A87-52371 p 807
A87-52386 * p 807
A87-52393 p 848
A87-52403 p 841
A87-52494 * p 838
A87-52517 p 848
A87-52522 p 824
A87-52534 * # p 856
A87-52658 p 842
A87-52661 p 842
A87-52673 p 842
A87-52678 p 848
A87-52683 p 842
A87-52765 p 820
A87-52796 * p 857
A87-52823 p 857
A87-52832 p 857
A87-52844 # p 824
A87-52846 p 859
A87-52876 # p 859
A87-52877 # p 859
A87-52878 * # p 807
A87-52879 * # p 838
A87-52880 # p 835
A87-52881 # p 824
A87-52882 # p 807
A87-52883 # p 808
A87-52884 # p 808
A87-52885 * # p 808
A87-52886 # p 808
A87-52887 * # p 824
A87-52888 # p 808
A87-52889 # p 808
A87-52890 * # p 808
A87-52900 p 861
A87-52960 * # p 857
A87-52962 * # p 828
A87-52963 * # p 828
A87-52964 # p 835
A87-53062 # p 857
A87-53066 # p 857
A87-53069 # p 857
A87-53075 # p 857
A87-53079 * p 835
A87-53115 * p 853
A87-53159 * p 853
A87-53206 * p 853
A87-53231 * p 858
A87-53269 p 853
A87-53352 * p 842
A87-53354 p 842
A87-53373 p 842
A87-53412 # p 808
A87-53413 p 801
A87-53414 p 801
A87-53415 p 801
A87-53416 p 849
A87-53417 p 861
A87-53418 p 849
A87-53419 p 849
A87-53420 * p 849
A87-53423 p 831
A87-53424 p 831
A87-53425 p 801
A87-53426 p 831
A87-53427 p 831
A87-53428 * p 831
A87-53429 p 831
A87-53430 p 831
A87-53431 p 832
A87-53441 p 843
A87-53442 p 832
A87-53520 p 808
A87-53522 p 808
A87-53526 p 808
A87-53544 p 809
A87-53552 p 801
A87-53553 p 801
A87-53562 p 809
A87-53563 p 809
A87-53564 p 824
A87-53569 p 838
A87-53573 p 824
A87-53574 p 809
A87-53575 p 832
A87-53576 p 849
A87-53578 p 820
A87-53580 p 820
A87-53581 p 840
A87-53582 p 820
A87-53583 p 835
A87-53585 p 849
A87-53623 * p 843
A87-53744 p 824
A87-53776 # p 824
A87-53777 # p 809
A87-53778 * # p 809
A87-53779 * # p 838
A87-53780 * # p 818
A87-53781 # p 824
A87-53782 # p 824
A87-53783 * # p 818
A87-53784 * # p 809
A87-53785 # p 843
A87-53798 p 824
A87-53800 p 821
A87-53802 p 829
A87-53823 p 843
A87-53888 p 843
A87-53892 p 843
A87-53893 p 843
A87-53894 p 844
A87-53901 * p 825
A87-53903 p 860
A87-53957 p 858
A87-53969 p 854
A87-53986 # p 832
A87-54139 p 835
A87-54140 p 835
A87-54189 # p 838
A87-54190 # p 836
A87-54191 # p 818
A87-54195 p 840
A87-54201 p 825
A87-54239 p 860
A87-54252 # p 801
A87-54315 p 818
A87-54316 p 844
A87-54361 p 809
A87-54363 p 809
A87-54364 p 810
A87-54367 * p 821
N87-28500 # p 802
N87-28501 * # p 802
N87-28502 * # p 802
N87-28503 # p 810
N87-28504 # p 810
N87-28505 # p 810
N87-28506 # p 810
N87-28507 # p 810
N87-28508 # p 811
N87-28509 p 811
N87-28510 p 811
N87-28511 p 811
N87-28513 p 811
N87-28514 * # p 811
N87-28518 # p 812
N87-28520 # p 812
N87-28521 * # p 812
N87-28522 * # p 812
N87-28523 * # p 812
N87-28524 # p 813
N87-28525 * # p 813
N87-28526 * # p 813
N87-28527 * # p 813
N87-28528 # p 818
N87-28529 # p 819
N87-28530 # p 821
N87-28531 # p 821
N87-28532 # p 836
N87-28533 # p 821
N87-28534 # p 821
N87-28535 # p 821
N87-28536 # p 822
N87-28537 # p 822
N87-28538 # p 822
N87-28539 # p 822
N87-28540 # p 822
N87-28541 # p 825
N87-28542 # p 825
N87-28543 # p 825
N87-28544 p 825
N87-28545 * # p 826
N87-28546 * # p 826
N87-28547 # p 829
N87-28548 # p 829
N87-28549 # p 832
N87-28550 # p 832
N87-28551 * # p 832
N87-28552 * # p 833
N87-28553 * # p 833
N87-28554 * # p 833
N87-28555 * # p 833
N87-28556 * # p 833
N87-28557 * # p 833
N87-28558 * # p 834
N87-28559 # p 836
N87-28561 # p 836
N87-28562 * # p 836
N87-28563 * # p 836
N87-28564 * # p 837
N87-28565 * # p 837
N87-28566 # p 838
N87-28567 # p 839
N87-28570 * # p 839
N87-28571 * # p 839
N87-28572 # p 839
N87-28605 * p 844
N87-28606 # p 844
N87-28607 # p 844
N87-28613 * # p 844
N87-28614 * # p 844
N87-28615 * # p 845
N87-28616 * # p 845
N87-28617 * # p 845
N87-28618 * # p 845
N87-28619 * # p 845
N87-28643 * # p 845
N87-28658 # p 845
N87-28833 * p 849
N87-28835 # p 850
N87-28845 # p 850
N87-28866 # p 850
N87-28869 * # p 850
N87-28883 * # p 850
N87-28923 # p 851
N87-28950 # p 854
N87-29057 # p 854
N87-29060 # p 854
N87-29065 # p 854
N87-29068 * # p 854
N87-29115 # p 855
N87-29140 * # p 858
N87-29174 # p 858
N87-29186 * # p 858
N87-29227 # p 846
N87-29297 # p 826
N87-29308 # p 860
N87-29311 p 860
N87-29315 * # p 860
N87-29364 # p 861
N87-29404 # p 802
N87-29405 # p 802
N87-29406 # p 802
N87-29407 # p 802
N87-29409 p 813
N87-29410 p 813
N87-29411 * # p 814
N87-29412 * # p 814
N87-29413 * # p 814
N87-29414 # p 814
N87-29415 # p 814
N87-29416 # p 815
N87-29417 # p 815
N87-29418 * # p 815
N87-29419 * # p 815
N87-29420 * # p 815
N87-29421 * # p 815
N87-29422 * # p 816
N87-29425 # p 816
N87-29426 # p 816
N87-29427 # p 816
N87-29428 # p 816
N87-29429 * # p 816
N87-29431 * # p 816
N87-29434 * # p 851
N87-29435 * # p 851
N87-29436 * # p 851
N87-29445 * # p 817
N87-29447 * # p 851
N87-29451 * # p 851
N87-29452 * # p 851
N87-29454 * # p 852
N87-29461 * # p 817
N87-29462 * # p 817
N87-29464 p 817
N87-29465 p 817
N87-29466 p 818
N87-29467 p 818
N87-29468 # p 819
N87-29469 * # p 819
N87-29470 * # p 819
N87-29471 * # p 819
N87-29472 # p 819
N87-29473 # p 819
N87-29474 # p 822

N87-29477 # p 822
N87-29479 # p 852
N87-29480 # p 823
N87-29481 # p 823
N87-29487 # p 823
N87-29488 # p 823
N87-29490 p 826
N87-29491 * # p 826
N87-29493 # p 826
N87-29494 # p 826
N87-29495 # p 827
N87-29496 * # p 827
N87-29497 * # p 827
N87-29498 * # p 827
N87-29499 * # p 827
N87-29500 * # p 827
N87-29501 * # p 828
N87-29502 * # p 828
N87-29504 # p 855
N87-29507 # p 855
N87-29510 # p 856
N87-29512 # p 861
N87-29516 # p 856
N87-29526 # p 837
N87-29527 # p 829
N87-29531 * # p 829
N87-29532 # p 829
N87-29534 * # p 834
N87-29536 * # p 834
N87-29537 * # p 834
N87-29538 * # p 834
N87-29539 * # p 834
N87-29543 * # p 839
N87-29544 * # p 839
N87-29545 # p 839
N87-29604 * # p 846
N87-29609 * # p 846
N87-29612 * # p 846
N87-29629 # p 846
N87-29646 # p 852
N87-29650 * # p 846
N87-29842 # p 852
N87-29893 # p 852
N87-29956 * # p 855
N87-30051 # p 856
N87-30072 # p 856
N87-30099 * # p 858
N87-30102 * # p 858
N87-30150 # p 860
N87-30155 * # p 860
N87-30224 # p 862

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