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A Continuing Bibliography with Indexes

NASA SP-7037(192)
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National Aeronautics and Space Administration

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Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering

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Accession numbers cited in this Supplement fall within the following ranges.

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NASA SP-7037(192)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 192)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in September 1985 in

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

NASA Scientific and Technical Information Branch 1985
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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 626 reports, journal articles, and other documents originally announced in September 1985 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

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

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

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

An annual cumulative index will be published.

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All publications abstracted in this bibliography are available to the public through the sources as indicated in the *STAR Entries* and *IAA Entries* sections It is suggested that the bibliography user contact his own library or other local libraries prior to ordering any publication inasmuch as many of the documents have been widely distributed by the issuing agencies, especially NASA

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A17	376-400	29 50	59 00
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TABLE OF CONTENTS

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NASA ACCESSION NUMBER — CORPORATE SOURCE

TITLE — PUBLICATION DATE

AUTHORS — AVAILABILITY SOURCE

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REPORT NUMBER

N85-10007*# Boeing Commercial Airplane Co , Seattle, Wash
DEVELOPMENT AND APPLICATIONS OF ALGORITHMS FOR CALCULATING THE TRANSONIC FLOW ABOUT HARMONICALLY OSCILLATING WINGS
F E EHLERS, W. H WEATHERILL, and E L YIP Oct 1984 152 p refs
(Contract NAS1-16297)
(NASA-CR-172376, NAS 1 26 172376) Avail NTIS HC A08/MF A01 CSCL 01A

A finite difference method to solve the unsteady transonic flow about harmonically oscillating wings was investigated The procedure is based on separating the velocity potential into steady and unsteady parts and linearizing the resulting unsteady differential equation for small disturbances. The differential equation for the unsteady velocity potential is linear with spatially varying coefficients and with the time variable eliminated by assuming harmonic motion An alternating direction implicit procedure was investigated, and a pilot program was developed for both two and three dimensional wings This program provides a relatively efficient relaxation solution without previously encountered solution instability problems Pressure distributions for two rectangular wings are calculated Conjugate gradient techniques were developed for the asymmetric, indefinite problem. The conjugate gradient procedure is evaluated for applications to the unsteady transonic problem Different equations for the alternating direction procedure are derived using a coordinate transformation for swept and tapered wing planforms Pressure distributions for swept, untaped wings of vanishing thickness are correlated with linear results for sweep angles up to 45 degrees. E A.K

TYPICAL CITATION AND ABSTRACT FROM *IAA*

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AUTHORS — AUTHOR'S AFFILIATION

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A85-18511*# Virginia Polytechnic Inst and State Univ Blacksburg
A VORTEX-LATTICE METHOD FOR GENERAL, UNSTEADY AERODYNAMICS
P KONSTADINOPOULOS, D F THRASHER, D T MOOK A H NAYFEH, and L WATSON (Virginia Polytechnic Institute and State University Blacksburg VA) Journal of Aircraft (ISSN 0021-8669) vol 22 Jan 1985, p 43-49 refs
(Contract N00014-79-C-0103, NSG-1262)

A general method of calculating unsteady, incompressible inviscid, three-dimensional flows around arbitrary planforms has been developed The method is an extension of the vortex-lattice technique It is not limited by aspect ratio, camber, or angle of attack, as long as vortex breakdown does not occur above the surface of the wing and separation occurs only along sharp edges As the wing performs arbitrary maneuvers the position of the wake and the distribution of circulation on the wing and in the wake are obtained as functions of time One desirable feature of the present method is its ability to treat steady lifting flows very efficiently Several examples of steady and unsteady flows are presented These include rectangular wings, with and without flaps, delta, and cropped delta wings *Author*

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 192)

OCTOBER 1985

01

AERONAUTICS (GENERAL)

A85-37176

ISRAEL ANNUAL CONFERENCE ON AVIATION AND ASTRONAUTICS, 26TH, HAIFA, ISRAEL, FEBRUARY 8, 9, 1984, COLLECTION OF PAPERS

Conference supported by Technion - Israel Institute of Technology, Tel Aviv University, Ministry of Defence of Israel, et al Haifa, Israel, Technion - Israel Institute of Technology, 1984, 358 p For individual items see A85-37177 to A85-37213.

The experimental determination of the effect of nonlinear stiffness on the vibration of elastic structures is considered along with an unsteady wake model of the aerodynamic behavior of a rotor in forward flight, the influence of fighter aircraft load spectrum variations on fatigue crack initiation and growth, a fatigue life evaluation program for the Kfir aircraft, computer-aided tube routing design in aircraft, and a pursuit evasion game with a limited detection range Attention is given to a crack growth analysis in multiple load path structure, the crack propagation analysis of longitudinal skin cracks in a pressurized cabin, a supersonic panel method based on the triplet singularity, a method to estimate the service life of a case bonded rocket engine, and computational aerodynamics and supercomputers. Other topics explored are related to the concepts and application of aircraft damage tolerance analysis, the influence of initial imperfections on nonlinear free vibration of elastic bars, and wing optimization and fuselage intergration for future generations of supersonic aircraft. G R

A85-37183#

COMPUTER AIDED TUBE ROUTING DESIGN IN AIRCRAFTS

A. MINKOV (Israel Aircraft Industries, Ltd., Tel Aviv, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 41-47.

The routing design process in the case of the tubes and harnesses of an aircraft is different from the design procedures which are followed for mechanical parts and structures. Thus, problems not foreseen in the design stage at the drawing board can arise later, and time-consuming adjustment procedures become necessary. It is, therefore, highly desirable to develop more efficient procedures for tube routing design in aircraft manufacture. The present investigation is concerned with the development of such procedures. The employment of better tools for handling aircraft tubing is discussed, taking into account production tools and design tools. Particularly useful appears to be an approach which is based on the utilization of a computer. Attention is given to the CATS (Computer Aided Tube data storage) software which was developed for the required computer operations. Author

A85-38236

DEVELOPMENT IN UK ROTOR BLADE TECHNOLOGY

R. W WHITE (Westland Helicopters, Ltd , Yeovil, Somerset, England) Future, Spring 1985, p 31-40. Research supported by the Ministry of Defence.

An account is given of the development history of the British Experimental Rotor Program (BERP), which has been concerned with the production of an aerodynamically innovative composite rotor blade for helicopters of Lynx and W30 type The BERP rotor is distinguished by a paddle-like tip which furnishes aerodynamic efficiency benefits in the advancing and retreating blade regimes, while decoupling advancing and rotating blade dynamic behavior. The blade also provides more than 30 percent greater thrust than conventional designs, and extends the forward speed potential of the edgewise rotor to more than 200 kts. Attention is given to the development of a glass-carbon fiber hybrid reinforcement for the composite blade, and to its laminate's prepreg layup and molding methodology, which is highly automated O.C.

A85-38301

SCIENTIFIC BALLOONING - IX; PROCEEDINGS OF THE SEVENTH SYMPOSIUM, GRAZ, AUSTRIA, JUNE 25-JULY 7, 1984

W. RIEDLER, ED and K TORKAR, ED. (Oesterreichische Akademie der Wissenschaften, Institut fuer Weltraumforschung, Graz, Austria) Symposium sponsored by COSPAR. Advances in Space Research (ISSN 0273-1177), vol 5, no 1, 1985, 135 p In English and French For individual items see A85-38302 to A85-38326.

Selected topics pertaining to scientific ballooning are discussed. Papers are presented on recent materials problems relating to catastrophic balloon failures, stratospheric flights with large polyethylene balloons from equatorial latitudes, a new reeling technique for very long extension scanning system for X-ray astronomy. Consideration is given to attitude determination in a limb-scanning balloon radiometer, balloon-borne high-altitude gravimetry, solar and cosmic X-ray and gamma-ray studies with long-duration balloon flighs, and the role of scientific ballooning for the exploration of the magnetosphere. M.D.

A85-38353#

MAN-POWERED AIRCRAFT

H. KIMURA and A. NAITO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 32, no 360, 1984, p. 15-22. In Japanese. refs

A historical review on the developments in man-powered aircraft in Japan is presented The first man-powered aircraft, Linnet I, was developed by Nihon University in 1966, and Storke B of Nihon University achieved a 2093-m straight line flight in 1977. In 1980 the main wing of Ibis also of Nihon University was built with carbon fiber composites and an aluminum alloy. The Gossamer series are analyzed and compared with Milan 82, Ibis, and Storke B of Nihon University. S H

A85-38439

ULTRALIGHTS BREAK THE RULES

I. GOOLD Flight International (ISSN 0015-3710), vol. 127, June 1, 1985, p. 175-177.

In the 1980-1983 period, general aviation aircraft deliveries fell significantly while purchase prices and operating costs increased.

The growth of ultralight aircraft purchases for that period, by contrast, are noted by an FAA report to have been exceptionally high, with 60 manufacturers in the U.S. alone producing a total of 25,000 ultralights to date at the rate of 7000 units/year. While the average price of an ultralight in the U.S. is $4500-6500, with averge hourly operating costs of about $4, single piston-engined aircraft sell for $60,000 and typically cost $30-60/hr to operate. O.C.

A85-38641

METHODS FOR THE ASSEMBLY OF AIRCRAFT STRUCTURES [METODY SBORKI SAMOLETNYKH KONSTRUKTSII]

A. I BABUSHKIN Moscow, Izdatel'stvo Mashinostroenie, 1985, 248 p. In Russian. refs

The book presents a systematic review of the engineering and organizational problems involved in the aircraft assembly process in relation to a specific method of assembly. Attention is given to the analytical evaluation of the accuracy of components for various methods of assembly; the effect of inaccuracies at the different stages of the assembly process on the final dimensions of components; and the correlation of the shapes and dimensions of components in various assembly processes. The discussion also covers approaches to the optimization of the assembly process and a cost-effectiveness analysis of assembly methods. V.L.

A85-38776

LIGHTER-THAN-AIR SYSTEMS CONFERENCE, 6TH, NORFOLK, VA, JUNE 26-28, 1985, TECHNICAL PAPERS

Conference sponsored by the American Institute of Aeronautics and Astronautics. New York, American Institute of Aeronautics and Astronautics, 1985, 163 p. For individual items see A85-38777 to A85-38798.

The topics discussed cover the feasibility of airship-borne warning systems, the operation of tethered aerostats in a marine environment, an aerodynamic performance model for hybrid airship heavy lift systems, an experimental investigation of aerodynamic effects on a body of revolution in turning flight, the design and development of the GAC-20 airship, airship certification programs, the use of hydrogen as a lifting gas, and the use of source panel and vortex methods for aerodynamic solutions of airship configurations. Also covered are a wind tunnel investigation of airship configuration-lifting rotor interaction, the development status of the LTA 20-1 airship, thrust-vectored takeoff, landing and ground handling of an airship, the dynamic characteristics of the STARS aerostat, and Skyship-500 control response measurements. O.C.

A85-38797#

THE TETHERED AEROSTAT ANTENNA PROGRAM (TAAP) DEMONSTRATION PHASE

A. S. CARTEN, JR. (USAF, Geophysics Laboratory, Bedford, MA) and T. F. STOMPS (TCOM, Columbia, MD) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 142-152. Research sponsored by the U S. Defense Communications Agency. refs

(AIAA PAPER 85-0883)

The U.S. Air Force's Tethered Aerostat Antenna Program (TAAP) has designed, built, and tested a highly mobile, self-contained and quickly deployable demonstration model configured around the existing, 25,000-cu ft capacity STARS aerostat and mooring system. The TAAP aerostat's 3000-ft tether can be used as the antenna of a VLF transmitter to establish emergency communications with national security forces. Attention is given to the physical and electrical links between the tether/antenna and transmitter/tuner assembly, as well as the telemetry subsystem used for monitoring of aerostat 'housekeeping' functions. The impact of corona effects on tether design and aerostat protection measures are noted. O.C.

A85-39068

REPAIRING COMMERCIAL AIRCRAFT JET ENGINE NACELLE COMPOSITE STRUCTURES

L. A HUGHES (Rohr Industries, Inc., Chula Vista, CA) IN: Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 121-133.

(SAE PAPER 841567)

Composite structures used in jet engine nacelle applications and advantages of this type of construction are briefly reviewed. Composite structures are designed to be durable components having a long service life, but damage from outside sources can occur on a random basis during operational service, necessitating repair or disposition of the damage. Sources of damage, types of damage, and inspection methods used for detecting damage are discussed. Specific repairs and elements of the repair process such as materials, tools and equipment, procedures and techniques are discussed in detail. Author

A85-39201

V/STOL: AN UPDATE AND OVERVIEW; PROCEEDINGS OF THE AEROSPACE CONGRESS AND EXPOSITION, LONG BEACH, CA, OCTOBER 15-18, 1984

Congress and Exposition sponsored by the Society of Automotive Engineers. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-591), 1984, 114 p. For individual items see A85-39202 to A85-39209

(SAE SP-591)

Among the topics covered are a computer study of a jet flap-equipped Advanced Supersonic Short Takeoff and Vertical Landing aircraft, model test results of the 'split-fan' cross-ducted propulsion system concept for medium-speed V/STOL aircraft, the application of circulation control technology to propulsive high lift systems, and recent developments in the design of ejectors for V/STOL aircraft Also discussed are the estimation of hot gas reingestion for a VTOL aircraft at the conceptual design stage, a twin-tilt nacelle V/STOL configuration, the altitude testing of a flight-weight, self-cooled, two-dimensional vectoring exhaust nozzle, and the development of a pneumatic thrust deflector. O.C.

A85-39214#

PILOT PRODUCTION OF SUPERPLASTICALLY FORMED/DIFFUSION BONDED T-38 MAIN LANDING GEAR DOORS

W. LEODOLTER (McDonnell Douglas Corp., Airframe Research and Technology Div., Long Beach, CA) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 568-572

(Contract F33615-80-C-5045)

(AIAA PAPER 84-0933)

This paper discusses the engineering development effort, the preliminary and final airworthiness qualification of a test door, and the manufacture of 30 titanium main landing gear strut doors for the T-38 aircraft using superplastic forming and concurrent diffusion bonding (SPF/DB) as the principal fabrication method. The structural concept of the new door is a variable thickness sandwich panel having an internal core structure with rectangular cells. The tooling concept and fabrication steps, from sheet preparation to final assembly and nondestructive testing, are described, with particular emphasis on those elements that contribute most to the process reliability. Cost analyses indicated that fabrication costs are sensitive to the cost and utilization of the titanium material. Although acquisition costs for the SPF/DB doors are higher than those for the currently used aluminum honeycomb doors, significant life-cycle cost savings can be achieved. The discussion on costs deviates from the standard and highlights the implications from the time lag between front-end investments and later benefit accrual as a potential barrier for technology implementation. Since 1983, the titanium doors have been used on U.S. Air Force aircraft. Author

A85-39621#
ADVANCED TECHNIQUES FOR HEALTH AND USAGE MONITORING OF HELICOPTER TRANSMISSIONS
D. G. ASTRIDGE (Westland Helicopters, Ltd., Yeovil, Somerset, England) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 8 p. refs
(AIAA PAPER-85-1142)

Recent advances in diagnostics and monitoring technology, particularly in quantitative debris monitoring and vibration analysis of helicopter transmissions in service with commercial airlines, are summarized. It is shown that the combination of the techniques with transmission usage monitoring, and health, performance, status, and usage monitoring of engines and rotor systems in a comprehensive on-board analysis system offers significant benefits in improved flight safety and reduced operating costs. The monitoring requirements of development testing and of production quality assurance testing are considered and the relevance of the technology to the emerging propeller-fan engine applications is indicated M.D.

N85-28912*# McLean (F. Edward), Yorktown, Va.
SUPERSONIC CRUISE TECHNOLOGY
F. E. MCLEAN Feb. 1985 194 p refs Original contains color illustrations
(Contract NASW-3531)
(NASA-SP-472; NAS 1.21:472, LC-83-26912) Avail: NTIS HC A09/MF A01; SOD HC $6.50 as 033-000-00944-5 CSCL 01B

The history and status of supersonic cruise research is covered. The early research efforts of the National Advisory Committee for Aeronautics and efforts during the B-70 and SST phase are included. Technological progress made during the NASA Supersonic Cruise Research and Variable Cycle Engine programs are presented. While emphasis is on NASA's contributions to supersonic cruise research in the U.S., also noted are developments in England, France, and Russia. Written in nontechnical language, this book presents the most critical technology issues and research findings. Author

N85-28913# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
HELICOPTER AEROMECHANICS
Loughton, England Apr 1985 329 p refs Lectures held in Brunswick, 2-3 May 1985, in Rome, 6-7 May 1985, and in St. Louis, 21-22 May 1985
(AGARD-LS-139; ISBN-92-835-1499-8) Avail: NTIS HC A15/MF A01

A variety of information relevant to helicopters is presented. Topics range from actual aerodynamic studies to computerized simulation as employed in flight simulators

02

AERODYNAMICS

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

A85-36996*#
ROTARY-WING AERODYNAMICS. VOLUME 1 - BASIC THEORIES OF ROTOR AERODYNAMICS (WITH APPLICATION TO HELICOPTERS). VOLUME 2 PERFORMANCE PREDICTION OF HELICOPTERS (2ND REVISED AND ENLARGED EDITION)
W. Z. STEPNIEWSKI and C. N. KEYS Research supported by the U.S. Army and NASA. New York, Dover Publications, Inc., 1984, 258 p. refs

Basic theories of rotor aerodynamics are presented and applied to the performance prediction of helicopters. The very simple physicomathematical model of the rotor offered by momentum theory is addressed first, followed by the combined blade-element and momentum theory. Vortex theory is discussed, and a rotor blade is modeled by means of a vortex filament or vorticity surface. Considerations of airfoil sections suitable for rotors are examined. Detailed performance techniques for a single-rotor helicopter in hover, vertical ascent, and forward flight are described, and winged and tandem-rotor helicopter performance calculations are presented as extensions and modifications of single-rotor methodology. Computer data based on the vortex theory are compared with approximate results obtained from the simplified momentum theory and the blade element solution. C.D

A85-37049#
INTERACTION OF TWIN TURBULENT CIRCULAR JET
M. YAGITA (Tokyo Institute of Technology, Tokyo, Japan), A. WATANABE (Japan Aircraft Manufacturing Co., Ltd, Yokohama, Japan), K. KAWAMURA (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan), and T. OKAMOTO JSME, Bulletin (ISSN 0021-3764), vol. 28, April 1985, p. 617-622.

An experimental study of the interaction of a twin turbulent circular jet is presented The velocity and the static pressure of the jets were measured by varying the distance between two nozzles. The results of the twin-jet were compared with those of a jet parallel to a plane wall on the basis of the principle of reflected image The main results are as follows: (1) the twin-jet interacts and joins in the form of an ellipse at the downstream distance, becoming close to a circular jet at far downstream distances; (2) the position of maximum velocity of the twin-jet shifts from the axis of nozzle to the mid-point between the jets, (3) the positions of maximum velocity of the twin-jet and the jet parallel to a plane wall are expressed by similar curves for various nozzle distances, and (4) the difference between the characteristics of the twin-jet and those of the jet parallel to a plane wall is due to their different boundary conditions Author

A85-37178#
A NEW UNSTEADY PRESCRIBED WAKE MODEL OF THE AERODYNAMIC BEHAVIOR OF A ROTOR IN FORWARD FLIGHT
O RAND and A. ROSEN (Technion - Israel Institute of Technology, Haifa, Israel) IN Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 8-21. refs

A derivation of an unsteady prescribed wake model of the aerodynamics of an helicopter rotor in forward flight is presented. At the begining, expressions for the velocity which is induced at the 1st blade by all the wake elements and the bound vortices, is obtained The wake includes the free trailing vortices and shed vortices of all the blades. The bound vortices of the other blades ae modeled as lifting lines while the bound vortices of the 1st blade are described in more detail Chordwise bound vortices are also taken into account By applying the condition of non-penetration through the blade surface, a system of equations in the unknowns is obtained. The unknowns are the harmonics which compose the total circulations at the blade cross sections. In order to simplify the analysis, the velocity which is induced by the wake and the bound vortices of the other blades is calculated at a representative chordwise location. The model which is obtained is very general and contains new features compared with other models which have been reported in the literature. Example of using the model is presented and the theoretical results are compared with existing experimental results. Good agreement is obtained in most of the cases Author

A85-37191#
A SUPERSONIC PANEL METHOD BASED ON THE TRIPLET SINGULARITY
B. L. COLEMAN (Israel Aircraft Industries, Ltd., Tel Aviv, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 109-114 refs

Supersonic panel methods in general use employ sources or vortices to describe body panels. The piecewise nature of such distributions prevents complete cancellation of internal radiation, and mutual interference occurs between panels on opposite sides of the body In consequence calculated wing pressures show spurious spatial oscillations. The triplet singularity proposed by Woodward and Landrum combines sources and vortices in proportions which greatly reduce the internal leakage. In their treatment the vortices are closed through ring triplets on the body. In this note trailing vortices are used, paralleling standard wing analysis, enabling complex configurations to be modeled. Author

A85-37194#

THE STABILITY OF SYMMETRICAL VORTICES IN THE WAKE OF ELLIPTICAL CYLINDERS IN CONFINED FLOW

A. KAROU and D. WEIHS (Technion - Israel Institute of Technology, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 140-145. refs

A theoretical investigation of the stability of symmetrical vortex pairs in the wake of elliptical bodies in confined potential flow is presented. The stability around points of zero induced velocity was analyzed by the small perturbations method. It was found that a symmetrical vortex pair has four natural modes of oscillation. Two are constant amplitude symmetrical harmonic oscillations and two are diverging and converging asymmetrical oscillations, respectively These natural modes are independent of the body shape and wall distance. The frequency of the symmetrical oscillations decreases as the vortex strength increases and it moves downstream from the body. This frequency increases with the widening of the elliptical body and with the reduction in wall distance The rate of divergence of one asymmetrical oscillation is equal to the rate of convergence of the other and both decrease with increasing vortex strength in unconfined flow. In confined flow this rate remains unchanged when the vortices are close to the body, but as they move downstream and closer to the walls it becomes much larger relative to its values in unconfined flow. Author

A85-37197#

NONEQUILIBRIUM SUPERSONIC FLOWS PAST OSCILLATING 2-D LIFTING SURFACES AND THIN ELASTIC BODIES

L. LIBRESCU (Tel Aviv University, Tel Aviv, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 159-164. refs

The present study is concerned with the determination of the 2-D unsteady pressure field on lifting surfaces and thin elastic bodies harmonically oscillating in a non-equilibrium supersonic gas flow. The analysis assumes that a single relaxation process characterizes the flow and that transport phenomena are disregarded. By accounting for the finite-reaction-rate processes, two closed form solutions of the unsteady pressure field are obtained Their classical counterparts (for non-reactive flows) referred to as quasi-static and piston-theory aerodynamics are widely used in flutter analyses. The peculiarities of the obtained results involving qualitative and quantitative differences with respect to their frozen and equilibrium counterparts are pointed out. The work is intended to constitute a basis for a consistent evaluation of aeroelastic phenomena of lifting surfaces and panels placed in a supersonic reactive flow-environment. Author

A85-37200#

LIFT AND DRAG OF AIRFOILS IN NONUNIFORM SUPERSONIC STREAM

A BARSONY-NAGY and M. HANIN (Technion - Israel Institute of Technology, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 195-204. refs

A method is developed for calculating the aerodynamic forces on a two-dimensional airfoil set at an angle of attack in a nonuniform parallel supersonic stream whose velocity and temperature vary in the vertical direction. Explicit analytic expressions for the lift and inviscid drag are deduced from linearized equations of flow by using the concept of fundamental solutions. Numerical results are presented, showing the effects of stream nonuniformity on the lift and drag forces of a rhombic airfoil in a sheared stream, a jet stream and a wake stream. Comparisons with computations using the method of characteristics indicate that the fundamental-solution method is efficient and accurate. Author

A85-37203#

THE EVALUATION OF AERODYNAMIC COEFFICIENTS FOR PROJECTILES FIRED FROM A HOVERING HELICOPTER

R ARIELI, A. SIGAL (Technion - Israel Institute of Technology, Haifa, Israel), and D BRUCKER IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p 231-234. refs

An approximate method is presented aiming at the evaluation of the aerodynamic coefficients of a projectile fired from a helicopter in hover The analysis uses a prescribed downwash field due to the helicopter rotor namely a fixed, a priori known wake model. The aerodynamic coefficients are evaluated assuming that the configuration is slender. The method proposed is an extension of methods used for slender bodies at high angles of attack, to nonuniform flows. It is a hybrid method that uses experimental data, and analytically corrects them for the nonuniform flow field. The theoretical influence of the rotor flow field on the projectile aerodynamics has been examined for a wide range of angles of attack, concluding that the variation of flow properties along the projectile axis significantly affects the aerodynamic force and moment coefficients Author

A85-37212#

WING OPTIMIZATION AND FUSELAGE INTEGRATION FOR FUTURE GENERATION OF SUPERSONIC AIRCRAFT

A NASTASE (Aachen, Rheinisch-Westfaelische Technische Hochschule, Aachen, West Germany) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 318-325. refs

A graphic-analytical method of the author is here presented for the design of fully optimized integrated wings for which the fuselage is located inside the thickness of the wing and the geometrical characteristics of this integrated wing, i.e., camber, twist, thickness and also the shape of the plan projection are simultaneously optimized in order to obtain a minimum drag by cruising Mach number. Author

A85-37330

A SYSTEM OF SHOCK AND RAREFACTION WAVES IN FLOWS PAST BODIES WITH COMPLEX SHAPES [SISTEMA SKACHKOV UPLOTNENIIA I VOLN RAZREZHENIIA PRI OBTEKANII TEL SLOZHNOI FORMY]

G. I. PETROV IN: Hydroaeromechanics and space research . Moscow, Izdatel'stvo Nauka, 1985, p. 32-35. In Russian.

A description of a model and the results of computations of an inhomogeneous supersonic gas flow around an obstruction on a flat surface are presented. A summary of available information is also included for Mach numbers of 2 5, 3, 4, and 6. It is pointed out that the theoretically predicted pressure distribution at the walls is in qualitative agreement with experiments. Computations of the flow around an axisymmetric obstruction confirm that the pressure ratio of two specified regions is independent of the shape of the obstruction. It is concluded that the model presented can yield satisfactory quantitative agreement with experimental data for Mach numbers larger than 2. L.T.

A85-37333
A NUMERICAL INVESTIGATION OF A VISCOUS HYPERSONIC AIR FLOW AROUND ELONGATED BLUNTED BODIES AT LARGE ANGLES OF ATTACK [CHISLENNOE ISSLEDOVANIE VIAZKOGO OBTEKANIIA UDLINENNYKH ZATUPLENNYKH TEL POD BOL'SHIMI UGLAMI ATAKI GIPERZVUKOVYM POTOKOM VOZDUKHA]
N. E. AFONINA, A. IU. VLASOV, and V. G. GROMOV IN: Hydroaeromechanics and space research . Moscow, Izdatel'stvo Nauka, 1985, p 53-65. In Russian. refs

A method for calculating a supersonic flow of a chemically nonequilibrium gas around an elongated blunted body at a large angle of attack is presented, which relies on the equations of a three-dimensional viscous shock layer that include all components of Euler and Prandtl equations. The region of the shock layer adjacent to the windward side of the body is considered. A numerical model is applied to the case of a flat triangular plate with cylindrical edges, oriented at angles of attack of 40 and 60 deg for a Reynolds number of 8500 and a Mach number of 24.1. In all cases, the maximum temperature is expected to appear near the critical point. L.T.

A85-37335
A SUPERSONIC INHOMOGENEOUS FLOW OF AN IDEAL GAS AROUND BLUNTED BODIES [OBTEKANIE ZATUPLENNYKH TEL SVERKHZVUKOVYM NERAVNOMERNYM POTOKOM IDEAL'NOGO GAZA]
L. I. ARKHIPOVA and M. G. LEBEDEV IN: Hydroaeromechanics and space research . Moscow, Izdatel'stvo Nauka, 1985, p 85-91. In Russian.

A supersonic gas flow, inhomogeneous both in its magnitude and direction, around a spherically blunted body is investigated numerically The solution relies on the finite difference nonstationary method of Babenko-Rusakov (1965). The geometrical pattern of the flow and the distribution of parameters in the shock layer are analyzed and expressed in terms of the dimensions and shape of the body, its location in the stream, and the adiabatic curve of the gas. The results are compared with solutions for a homogeneous flow and for a flow generated by a spatial source L.T.

A85-37336
A NONSTATIONARY TRANSITION PROCESS CAUSED BY INJECTION OF A GAS INTO THE NEAR WAKE OF A BODY IN A SUPERSONIC FLOW [NESTATSIONARNYI PEREKHODNYI PROTSESS, VYZVANNYI VDUVOM GAZA V BLIZHNII SLED ZA TELOM, OBTEKAEMYM SVERKHZVUKOVYM POTOKOM]
V. M. PASKONOV, T P. PETUKHOVA, and S. V. RUSAKOV IN Hydroaeromechanics and space research . Moscow, Izdatel'stvo Nauka, 1985, p. 91-102. In Russian. refs

A nonstationary axisymmetric flow of a viscous gas in the near wake of a spherically blunted cylinder, moving at a supersonic velocity, is numerically modeled on the basis of full Navier-Stokes equations for a viscous ideal heat-conducting gas. The computations are performed for a freestream Mach number of M = 3 and a Reynolds number of 200 and describe the decay or variations of the reverse-circulation current and the formation of a shock-wave structure in the flow. L.T.

A85-37337
GAS FLOW IN NOZZLES AND JETS [TECHENIE GAZA V SOPLAKH I STRUIAKH]
E. A ASHRATOV, T. G VOLKONSKAIA, and G S. ROSLIAKOV IN: Hydroaeromechanics and space research Moscow, Izdatel'stvo Nauka, 1985, p. 116-136. In Russian refs

Selected results of studies of gas flow in nozzles and jets are outlined The methods employed by the investigations include solutions to the inverse problem of nozzle theory, finite difference method, difference method, classic and layered methods of characteristics, and low-perturbation method Consideration is given to the flow in conical nozzles, flows with a pressure differential in circular nozzles, the influence of spatial effects on the nozzle characteristics, and the nonstationary starting of the nozzle The interaction of jets with a slipstream is also studied L.T.

A85-37338
INVESTIGATION OF THREE-DIMENSIONAL SEPARATED FLOWS [ISSLEDOVANIE TREKHMERNYKH OTRYVNYKH TECHENII]
G. N ANDREEV, A. I. GLAGOLEV, A. I ZUBKOV, B. E LIAGUSHIN, and V B. MINOSTSEV IN Hydroaeromechanics and space research . Moscow, Izdatel'stvo Nauka, 1985, p. 136-151 In Russian. refs

Results of experimental studies of supersonic and hypersonic flows around sharp and blunted bodies are presented. The shapes include a spherically blunted cone with a half-angle of divergence of 2 to 15 deg, cylinders whose front part is a spherical segment, segmentally conical bodies consisting of combinations of a spherical segment and a straight circular cone with a half-angle of divergence of 5 to 20 deg, and bodies similar to the latter but with an elliptic (semiaxis ratio of 2:1) cross section. The experiments were conducted for Mach numbers of the unperturbed flow ranging from 3 to 10, for angles of attack from 0 to 25 deg, and for Reynolds numbers (unperturbed flow) ranging from 5 x 10 to the 5th to 1 5 x 10 to the 7th. Pressure distributions, heat flux distributions, and flow characteristics in the separation zones are determined L T

A85-37340
THE SEPARATION OF A TURBULENT BOUNDARY LAYER WITHIN A TWO-FACE ANGLE BEFORE AN OBSTRUCTION [OTRYV TURBULENTNOGO POGRANICHNOGO SLOIA V DVUGRANNOM UGLE PERED PREPIATSTVIEM]
A. I. GLAGOLEV, A. I. ZUBKOV, and IU. A PANOV IN Hydroaeromechanics and space research . Moscow, Izdatel'stvo Nauka, 1985, p. 157-162 In Russian.

Supersonic flow at M = 3 around a cylinder aligned perpendicularly to the edge of a biplanar angle in the bisector plane is studied experimentally for angle openings of 45 and 135 deg. Pressure distributions and flow structure are determined near the cylinder in the presence of a turbulent boundary layer. Furthermore, the internal separation lines are defined for the region near the spatial separated flow before the cylinder The interaction of the density increment with the boundary layer near the edge is also described. It is concluded that the length of the separated flow zone for the case considered is larger than that for a cylinder on a plate. L.T

A85-37341
DETERMINATION OF AERODYNAMIC CHARACTERISTICS OF BODIES IN WEAKLY PERTURBED GAS FLOWS [OPREDELENIE AERODINAMICHESKIKH KHARAKTERISTIK TEL V SLABOVOZMUSHCHENNYKH POTOKAKH GAZA]
V. V EREMIN, IU. M LIPNITSKII, and IU. B. NEGOMETIANOV IN: Hydroaeromechanics and space research . Moscow, Izdatel'stvo Nauka, 1985, p. 163-170. In Russian.

A linear theory for computing the propagation of weak perturbations is used in conjunction with formulas for supersonic external problems of gas dynamics to assess the influence of inhomogeneities in flow fields on aerodynamic characteristics of a body Calculations are applied to examples of flow around cones in flat and axisymmetric supersonic tunnels, with consideration of some inhomogeneities of the model Numerical simulations performed for cones with angles of diverence ranging from 7.5 to 10 deg show that the magnitudes of balancing angles during the establishing of the oscillation center are quite different even for cones with identical midsections. L.T.

A85-37580*# North Carolina State Univ., Raleigh.
A REVIEW OF SOME APPROXIMATE METHODS USED IN AERODYNAMIC HEATING ANALYSES
F. R. DEJARNETTE (North Carolina State University, Raleigh, NC), H. H. HAMILTON, K. J. WEILMUENSTER (NASA, Langley Research Center, Space Systems Div., Hampton, VA), and F. M. CHEATWOOD American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 11 p. refs
(AIAA PAPER 85-0906)

It is pointed out that preliminary design and optimization studies for new aerospace vehicles require techniques which can calculate aerodynamic heating rates accurately and efficiently. The method employed to calculate the flow field depends to a large extent on the shape of the vehicle, Mach number, Reynolds number, and Knudsen number In the case of the aero-assisted orbital transfer vehicle (AOTV), a substantial portion of the flight will be in the transitional regime between continuum and free molecule flow. The present paper discusses some approximate methods which have been used to calculate heating rates on high-speed vehicles. Attention is given to the stagnation point and leading edges, the downstream region, the axisymmetric analog, laminar and turbulent heating rates, transition heating rates, gas models, and three-dimensional applications. G.R.

A85-37593#
NUMERICAL SIMULATION OF HYPERSONIC VISCOUS FORE- AND AFTERBODY FLOWS OVER CAPSULE-TYPE VEHICLES AT ANGLES OF ATTACK
Y. YAMAMOTO (National Aerospace Laboratory, Chofu, Tokyo, Japan) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 16 p. refs
(AIAA PAPER 85-0924)

The thin-layer, three-dimensional Navier-Stokes equations are solved for hypersonic fore- and afterbody flowfields over capsule-type reentry vehicles. An implicit approximate factorization algorithm proposed by Beam and Warming has been used to obtain laminar numerical solutions at the following free stream condition. free stream Mach number of 7.0 with Reynolds number of 4.5 x 10 to the 5th. Body configurations are composed of a blunt nosed forebody and 20 deg conical afterbody followed by a cylinder Calculations proceed in two parts. Initially, solutions of the forebody flowfields are obtained. Then, remaining afterbody portion has been computed using previous solution as an upstream boundary. The results demonstrate the capability of the present numerical procedure for investigating the severe aerodynamic heating on the forebody and the detailed structure of three-dimensional separations around the afterbody. Author

A85-37594*# National Aeronautics and Space Administration. Johnson (Lyndon B.) Space Center,
COMPUTATIONAL METHODS FOR HYPERSONIC VISCOUS FLOW OVER FINITE ELLIPSOID-CONES AT INCIDENCE
C. P LI (NASA, Johnson Space Center, Aerosciences Branch, Houston, TX) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 13 p. refs
(AIAA PAPER 85-0925)

A numerical method, which is simpler than others currently in use, is proposed for determining the full viscous flow over a finite body in hypersonic stream at high altitude It treats the shock layer surrounding the blunt foebody and the near wake behind the base simultaneously by formulating the Navier-Stokes equations in conformal and azimuthal-angle coordinates. The computational domain is confined to the body wall, outflow surface and the bow shock, which is adjusted along the coordinate normal to the wall in the course of iterations. Because of the optimal grid and a well developed alternating direction implicit factorization technique for the governing equations, reasonably accurate results can be obtained on a 30 by 36 by 6 grid with 400 time-marching iterations. Results for body shapes belonging to the ellipsoid-cone family are compared with the experimental data for the Apollo command module and the Viking aeroshell. Validation of the method based on self-consistency is also discussed. Author

A85-37621#
THE EFFECTS OF SURFACE DISCONTINUITIES ON CONVECTIVE HEAR TRANSFER IN HYPERSONIC FLOW
D. E. NESTLER (General Electric Co., Philadelphia, PA) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 13 p. refs
(AIAA PAPER 85-0971)

This paper presents a survey of recent experimental data, prediction methods, and correlations for the effects of surface discontinuities on convective heat transfer. Types of surface discontinuities include: steps, cavities, gaps, and protuberances. Emphasis is placed on the hypersonic flow regime, including both laminar and turbulent boundary layer conditions. In addition to the survey aspects of the paper, an assessment of critical technology needs in this field is presented. Author

A85-37623#
STAGNATION POINT HEAT TRANSFER IN HYPERSONIC HIGH ENTHALPY FLOW
S. L. GAI, J. P. BAIRD (New South Wales, University, Duntroon, Australia), P. R. A. LYONS, and R. J. SANDEMAN (Australian National University, Canberra, Australia) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 6 p refs
(AIAA PAPER 85-0973)

Stagnation-point heat-transfer measurements obtained under hypervelocity high-enthalpy reacting flows generated in a free piston-driven shock tunnel with a contoured nozzle are presented. A description of the facility, model, and instrumentation is given. The tests are conducted with either air or CO2 as the test gas and helium as the driver gas. It is shown that the range of stagnation enthalpies and temperatures is much higher than similar measurements by Miller et al. (1985). The results show that pronounced nonequilibrium flow effects result in reduced convective heat-transfer rates M.D.

A85-37626#
DENSITY AND VELOCITY PROFILES IN NON-EQUILIBRIUM LAMINAR BOUNDARY LAYERS IN AIR
J P. BAIRD, S. L. GAI (New South Wales, University, Duntroon, Australia), and P R. A. LYONS (Australian National University, Acton, Australia) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 7 p. refs
(AIAA PAPER 85-0976)

A series of experiments were conducted in a free piston shock tunnel on a 456 mm long flat plate at zero incidence. The free stream velocities were varied from 1.78 to 7.3 km/s with a variation in free stream density between 0.0012 and 0.012 kg/cu m. Pitot pressure and profiles were measured and interferograms were taken from which the density profiles were deduced. From the Pitot and density profiles the velocity profiles were calculated. It is shown that the ratio of density boundary layer thickness to velocity boundary layer thickness varies with enthalpy. This effect is related to the Prandtl number and possible reasons for the behavior are discussed. Author

A85-37640#
LOW DENSITY AEROTHERMODYNAMICS
G. A. BIRD (Sydney, University, Sydney, New South Wales, Australia) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 10 p. refs
(AIAA PAPER 85-0994)

A review is made of the low density gas flows that are associated with the operation of current and projected spacecraft. Typical applications are related to orbital contamination studies, the early stages of reentry, high altitude aerobraking, plume-vehicle and plume-atmosphere interactions, and the orbital drag problem.

Cnteria are established for determining whether a continuum or particle model is appropriate in particular cases. It is shown that satisfactory procedures now exist for the application of the Direct Simulation Monte Carlo (DSMC) method to real gas flwos involving nonequilibrium of the translational and internal modes, chemical reactions and thermal radiation. On the other hand, the necessary physical database is seriously deficient, particularly in regard to gas-surface interactions under orbital conditions, and chemical reaction cross-sections in the 8-10 e.v. energy range. It is concluded that both laboratory and in-orbit measurements will be needed if these deficiencies are to be remedied. Author

A85-37642#

THE DRAG OF SIMPLE SHAPED BODIES IN THE RAREFIED HYPERSONIC FLOW REGIME

G. KOPPENWALLNER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer experimentelle Stroemungsmechanik, Goettingen, West Germany) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 7 p. refs

(AIAA PAPER 85-0998)

The drag behavior of simple shaped two-dimensional and axisymmetric bodies in hypersonic rarefied flow is summarized. The experimental data used was mainly obtained in the DFVLR hypersonic low density tunnels during the past 15 years. The body shapes analyzed include sphere, disk, cones cylinders and flat plates parallel to the flow. These shapes include bodies which have only pressure- and only friction drag Special attention is given to the frictional drag overshoot of flat plates in the near free molecular flow regime. Simple qualitative explanations for this overshoot and for the different behavior of two- and three-dimensional bodies are given. Author

A85-37643#

HYPERSONIC GAS DYNAMICS

H. T. NAGAMATSU (Rensselaer Polytechnic Institute, Troy, NY) and R. E SHEER, JR. (GE Research and Development Center, Schenectady, NY) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 12 p. refs

(AIAA PAPER 85-0999)

Basic aerodynamic, heat transfer, and gasdynamic phenomena observed at flight Mach numbers from 5 to 35 with a maximum stagnation temperature of 11,000 K are studied experimentally in a combustion-driven 24-inch diameter hypersonic shock tunnel. The effects of vibrational relaxation and recombination of high-temperature nitrogen and air are investigated for reflected temperatures of up to 7000 K and maximum pressure of 500 psi. The experiments cover real gas flow over sharp and blunt bodies with smooth and rough surface and viscous flow over a flat plate Moreover, rarefied hypersonic flow effects on the flat plate heat transfer rates are studied in air at Mach numbers of 19.2 and 25.4 and in helium at Mach numbers of 22.8 to 86.8. MHD results for highly dissociated and ionized air plasma produced by shock Mach numbers from 10 to 32 with equilibrium plasma temperatures from 3600 to 11,000 K are obtained with transverse field strength of 2300 and 6500 gauss across the 4-inch diameter shock tube. L.T.

A85-37645#

TRANSITION MEASUREMENTS VIA HEAT-TRANSFER INSTRUMENTATION ON A 0.5 BLUNTNESS 9.75-DEG CONE AT MACH 7 WITH AND WITHOUT MASS ADDITION

A. H. BOUDREAU (USAF, Arnold Engineering Development Center, Air Force Station, TN) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 8 p. refs

(AIAA PAPER 85-1004)

Wind tunnel tests have been conducted at Mach 7 on a blunt 9.75-deg half-angle cone equipped with heat-transfer instrumentation and a porous skin to determine the effects of mass addition on boundary-layer transition. Mass flow rates of 0.008 lbm/sec or greater were required to produce significant effects on transition Analysis suggests that the movement of transition could be caused, at least in part, by the tripping effect of microscopic surface jets. Author

A85-37661*# Vanderbilt Univ, Nashville, Tenn

TRANSITIONAL, HYPERVELOCITY AERODYNAMIC SIMULATION AND SCALING IN LIGHT OF RECENT FLIGHT DATA

J. L. POTTER (Vanderbilt University, Nashville, TN) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 10 p. refs

(Contract NAG1-549)

(AIAA PAPER 85-1028)

Simulation and scaling procedures applicable to maneuvering vehicles for the transitional hypervelocity flow regime are discussed with reference to certain discrepancies between lifting reentry flight data and predicted results. Low-density hypervelocity wind-tunnel data are compared with CFD and in-flight measurements. A general correlation parameter for transitional flow is produced by incorporation of a new geometric term into a form of Reynolds number. It is shown that normalized drag coefficients of a variety of shapes, including spheres, blunt-nosed cones, lifting bodies, and an STS orbiter are correlated by the parameter A provisional bridging formula for the coefficients is presented. M.D.

A85-37675*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

MEASURED AND PREDICTED VORTEX-INDUCED LEEWARD HEATING ON A BICONIC AT MACH 6 AND 10

C. G MILLER, S. E WILDER, P. A. GNOFFO (NASA, Langley Research Center, Space Systems Div., Hampton, VA), and S. A WRIGHT (NASA, Langley Research Center; System Development Corp., Hampton, VA) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985 16 p. refs

(AIAA PAPER 85-1061)

Detailed longitudinal and circumferential heating distributions were measured on a spherically blunted, 13 deg/7 deg biconic at angles of attack from 0 deg to 27 deg. The measurements were made in the Langley 20-inch Mach 6 tunnel and 31-inch Mach 10 tunnel to provide heating distributions at Mach 6 and 10 in air. The free-stream Reynolds number based on model length varied from 0.4 to 4.8 million at Mach 6 and 0.3 to 1.3 million at Mach 10. The basic trends in leeward heating are found to be described by a single parameter, the viscous interaction parameter. A decrease in this parameter results in a decrease in leeward heating for attached flow, an increase in heating for separated flow, and a forward movement of the separation region The parabolized Navier-Stokes code for laminar flow qualitatively predicted the longitudinal and circumferential heating distributions C D.

A85-37879

THE FINITE ELEMENT FORMULATION OF AIRFLOW AROUND A DEFORMABLE WING BY USING THE INCREMENTAL FINITE ELEMENT METHOD

M. JOSIFOVIC and J. JANKOVIC (Beograd, Univerzitet, Belgrade, Yugoslavia) (Gesellschaft fuer angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Regensburg, West Germany, Apr. 16-19, 1984) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 65, no. 5, 1985, p. T 271, T 272.

A special procedure for determining the control surface deflection which stabilizes the system of interaction between the fluid and the elastic body structure around a deformable wing is presented The finite element method is used to describe the physical phenomena occurring in this problem. A nonstationary matrix of the mathematical model of the system is obtained which is dependent on the angle of the control surface deflection. Using the presented dynamical model of the interaction airflow-deformable wing, the deflection of the control surface which stabilizes the whole system is determined C.D.

A85-37927#
FLOW-FIELD MATRIX SOLUTION FOR FLOW ALONG ARBITRARILY TWISTED S1 SURFACE EMPLOYING NON-ORTHOGONAL CURVILINEAR COORDINATES
W. WU and H. YU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 6, Feb. 1985, p. 21-26. In Chinese, with abstract in English. refs

Based upon a set of given discrete points on several stream lines, a method of fitting an arbitrarily twisted S1 stream surface was developed. The fitted surface obtained with this method is compared with that obtained with the analytic method, and the accuracy is about 0 004 percent, which is satisfactory for engineering applications. Employing nonorthogonal curvilinear coordinates and corresponding nonorthogonal velocity components, the stream-function equation governing flow along the arbitrarily twisted S1 stream surface was solved with the matrix method, and some numerical examples are presented. This method can also be used for S2 stream surfaces and other applications. Author

A85-37928#
QUASI-THREE-DIMENSIONAL BLADE DESIGN CODE
Q. WANG, G. ZHU, Y. ZHANG, and B WANG (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 6, Feb. 1985, p 27-32. In Chinese, with abstract in English. refs

Based on Wu's general theory of 3-D flow in turbomachine, an automatic code system for blade design of a subsonic axial-flow turbomachine has been developed. Using the code system, the things a user has to do are discussed, specifying the input data and investigating the calculation results. The code system, which includes several individual codes, is executed automatically without any personal interference The code system can substantially reduce the time and personnel needed for a design work, and provides the possibility to choose among a large number of design schemes. Author

A85-37929#
THE SOLUTION OF TRANSONIC FLOW THROUGH THREE-DIMENSIONAL TURBINE BLADE
S JIANG and Z. JIANG (Qinghua University, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol 6, Feb. 1985, p. 33-36. In Chinese, with abstract in English. refs

A numerical technique with artificial viscosity is presented for the calculation of transonic flow through three-dimensional turbine blade. The problem is posed in the time-dependent form. In order to make the analysis manageable, the stream surfaces are assumed to be axisymmetric. Two examples are given. The solutions exhibit the position of shocks and static pressure distribution on the blade surface Author

A85-37930#
FAMILIES OF VARIATIONAL PRINCIPLES FOR THE SEMI-INVERSE AND TYPE-A HYBRID PROBLEMS ON A S2-STREAMSHEET IN MIXED-FLOW TURBOMACHINES
R. CAI and G. LIU (Shanghai Institute of Mechanical Engineering, Shanghai, People's Republic of China) Journal of Engineering Thermophysics, vol. 6, Feb. 1985, p. 37-39. In Chinese, with abstract in English. refs

In this paper, two families of variational principles (VPs) for the semiinverse and type-A hybrid problem on S2-steamsheet in mixed-flow turbomachines are developed The momentum equation in an arbitrary quasi-orthogonal direction-y is chosen as the primary equation, and a corresponding image plane is introduced. Taking advantage of natural boundary conditions and artificial interfaces, these VPs provide a reliable theoretical basis for the F E. M. or other direct variational methods. Author

A85-37931#
A GENERAL THEORY OF HYBRID PROBLEMS OF FULLY 3-D COMPRESSIBLE POTENTIAL FLOW IN TURBO-ROTORS. I - AXIAL FLOW, STREAM FUNCTION FORMULATION
G. LIU (Shanghai Institute of Mechanical Engineering, Shanghai, People's Republic of China) Journal of Engineering Thermophysics, vol. 6, Feb. 1985, p. 40-45. In Chinese, with abstract in English. refs

A85-37932#
COMPUTATION OF THE THRUST PERFORMANCE OF AXISYMMETRIC NOZZLES
Z. JIANG (Quinghua University, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 6, Feb. 1985, p. 46-48 In Chinese, with abstract in English

A time marching method is used to compute the transonic nonviscous flow field and a finite difference method to compute the boundary layer of axisymmetric nozzles. The influence of the boundary layer on the nonviscous flow has been considered along with the calculated displacement thickness, using an iteration procedure. The thrust of the nozzle is then computed from the flow field parameters. The computed results are compared with experimental data, and the average relative error is about 2 percent, satisfying engineering needs Author

A85-38355#
A STUDY ON THE METHOD FOR SOLVING THE EQUATION OF SUBSONIC OSCILLATORY LIFTING-SURFACE THEORY. IV - COMPUTER PROGRAM SOLST 1
T. ICHIKAWA, K HIRAOKA, S. SUEMATSU, and A. DAITOKU Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol 32, no. 360, 1984, p. 34-45. In Japanese, with abstract in English. refs

A computer program SOLST 1 for calculating the lift distribution of oscillating wings has been developed based on a previous investigation It is shown by numerical results that the method needs less spanwise integration points than other methods in order to obtain the same degree of accuracy. Author

A85-38362#
WIND TUNNEL EXPERIMENTS OF THE HIGH-PERFORMANCE ROTOR BLADES
T. TAKENAWA, Y. YOSHITAKE, S. IMAHASHI, and I. TAKANASHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 32, no. 361, 1984, p. 89-93 In Japanese.

Experimental results of wind tunnel tests of helicopter composite blades are reported. The rotor blades used for testing consist of glass and Kevlar fibers, and new wing models, DKR-120B and -105B, are developed. It was found that the blades in combination with the new wings and the stool type wing edge reduced significantly the required torques Experimental results are given. S.H.

A85-38367#
EXPERIMENT OF TURBULENT ROUND JET PARALLEL TO GROUND PLANE
T OKAMOTO and M. YAGITA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 32, no 361, 1984, p. 122-125. In Japanese, with abstract in English.

An experimental study on the effect of the plane on a round jet issued parallel to a ground plane is presented. The velocity and static pressure of the jet flow and the surface pressure of the ground plane were measured for various distances between jet and ground plane. The results show that: (1) the decay of the maximum velocity becomes slower than that of a round free jet with decreasing distance, (2) the spread perpendicular to the ground decreases with decreasing distance, and the position of maximum velocity is shifted from the axis of nozzle to the neighborhood of ground plane, and (3) the spread parallel to the ground increases more sharply than that of a round free jet. Author

A85-38370#

AERODYNAMIC CHARACTERISTICS OF THE WEIS-FOGH MECHANISM

M. TSUTAHARA and T KIMURA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol 32, no. 362, 1984, p. 154-162. In Japanese, with abstract in English. refs

Lighthill's two-dimensional inviscid-flow model (1973) for the Weis-Fogh mechanism is investigated For the 'fling' (or opening) stage, the lift and the moment acting on the wing are calculated from the Lighthill solution. The effect of the angular acceleration due to wing rotation is also accounted for For the separating stage, a doubly-connected region of the flow-field is analyzed by transforming it into a circular ring. The circulation around the wing is determined by assuming that Kutta's condition is satisfied at the trailing edge, and the unsteady lift, drag, and moment are also calculated. It is found that the circulation can be made constant by taking the acceleration of the wing motion properly Author

A85-38371#

CL BETA OF UNSWEPT FLAT WINGS IN SIDESLIP. II

A. ICHIKAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 32, no. 362, 1984, p. 163-170. In Japanese, with abstract in English. refs

The paper deals with a numerical method for calculating the Cl Beta of rectangular flat wings. The computational system is based on a discrete vortex method in order to take account of separated flow at the side edges. Two kinds of wings, one with sharp side edges and the other with conventional blunt ones, are used to examine the effect of side edge thickness on the flowfield around the edges and on the Cl Beta. Comparison of the results of this method and experiment indicate good agreement of the Cl Beta for a moderate range of C(L) The wings having sharp side edges show a substantial decrease in the Cl Beta. Author

A85-38430

LOCAL INSTABILITY CHARACTERISTICS AND FREQUENCY DETERMINATION OF SELF-EXCITED WAKE FLOWS

W KOCH (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer theoretische Stroemungsmechanik, Gottingen, West Germany) Journal of Sound and Vibration (ISSN 0022-460X), vol. 99, March 8, 1985, p 53-83. refs

The proposal that a resonance-like mechanism controls the downstream discrete frequency self-excited vortex shedding process is discussed. It is shown that for symmetric blunt body wakes the quasi-parallel flow assumption together with the proposed resonance hypothesis leads to a bifurcation condition (a direct resonance condition) for the local instability eigenvalue. The same condition is found to separate a linearly absolute instability from a linearly convective instability and the critical basic wake profile corresponding to the resonance condition is found to be near the end of the potential core If the steady basic wake flow is modeled realistically, the pertinent frequency is close to experimentally found values For asymmetrical basic wakes there exists a limiting asymmetry beyond which no time-harmonic resonance appears possible, thus providing a link to mixing layers for which only time-attenuated resonances occur. M.D.

A85-38481

CONFIGURATION OF SHOCK WAVES CLOSING A LOCAL SUPERSONIC ZONE [O KONFIGURATSII SKACHKOV UPLOTNENIIA, ZAMYKAIUSHCHIKH MESTNUIU SVERKHZVUKOVUIU ZONU]

A. N. KRAIKO Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 49, Mar-Apr. 1985, p. 236-243. In Russian. refs

The problem of shock waves closing a local supersonic zone is analyzed, and the possibility of a reverse-lambda configuration is demonstrated. The first shock in this configuration occurs inside the local supersonic zone; an infinite discontinuity of second derivatives corresponding to the sonic line is then seem propagating along the c(+) characteristic from the shock nucleation point. This, in turn, can give rise to a second shock forming, together with the first shock, the above configuration. V L

A85-38483

DIFFRACTION OF A SINGLE PLANE WAVE BY A CONICAL WING [DIFRAKTSIIA PLOSKOI EDINICHNOI VOLNY NA V-OBRAZNOM KRYLE]

P. V. TRETIAKOV Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 49, Mar.-Apr. 1985, p 251-257. In Russian.

The problem of the diffraction of a single plane wave by a conical wing moving at a supersonic velocity is solved using a linear formulation. The solution is based on an analysis of eigenfunctions for a class of self-similar solutions to a three-dimensional wave equation. A boundary value integral is obtained using a method similar to that discussed in an earlier study (Tretiakov, 1976) V.L.

A85-38488

THE ISOLATED NATURE OF SOLUTIONS WITH A STRONG ATTACHED SHOCK WAVE AT THE EDGES OF A CONICAL WING AND A WEDGE [OB IZOLIROVANNOM KHARAKTERE RESHENII S SIL'NYM PRISOEDINENNYM SKACHKOM UPLOTNENIIA NA KROMKAKH V-OBRAZNOGO KRYLA I KLINA]

A. V. GRISHIN Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 49, Mar.-Apr. 1985, p. 330-334. In Russian. refs

The problems of supersonic flow past an infinite wedge and a conical wing with subsonic flow behind an attached shock wave are analyzed using a subsonic approximation. In particular, the possibility of the existence of flow with a strong discontinuity in a plane perpendicular to the edge of the wing or the wedge is investigated In this connection, a linear analysis is made of boundary value problems for perturbations with respect to exact solutions with a plane shock. It is shown that the boundary value problems have a solution if the plane shock wave corresponding to an exact solution is weak (in the plane perpendicular to the edge) and have no solution if the shock wave is strong. V.L

A85-38551

INSTABILITY OF PLANE-PARALLEL SUPERSONIC GAS FLOWS IN THE LINEAR APPROXIMATION [NEUSTOICHIVOST' PLOSKOPARALLEL'NYKH SVERKHZVUKOVYKH POTOKOV GAZA V LINEINOM PRIBLIZHENII]

P. I. KOLYKHALOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar.-Apr. 1985, p 10-16 In Russian. refs

It is shown that plane-parallel supersonic gas flows are linearly unstable The rise time of instability is found to be proportional to the time required for sonic perturbations to cover a distance of the order of the characteristic scale of the flow. It is also shown that the unstable perturbations are actually acoustic waves within the flow. V.L.

A85-38555

STABILITY OF A STATIONARY SOLUTION TO THE ABLATION EQUATION [OB USTOICHIVOSTI STATSIONARNOGO RESHENIIA URAVNENIIA OBGARA]

V V LUNEV and I N. POLIAKOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar.-Apr. 1985, p. 96-103. In Russian. refs

The problem of the stability of bodies of stationary shape during aerodynamic heating is reduced to that of solving a linearized equation of ablation. In the plane case, the Cauchy problem for this equation has multiple solutions depending on the arbitrary distribution of the unknown functions with respect to the axis However, a physically meaningful regular solution is unique and can be found by solving an integral equation. For this case, symmetrical and nonsymmetrical perturbations are considered, and the damping of perturbations, initially localized in the front part of the body, is discussed. V.L.

A85-38559

SHADING AND INTERFERENCE EFFECTS DURING THE ROTATION OF A PLATE [EFFEKTY ZATENENIIA I INTERFERENTSII OT VRASHCHENIIA PLASTINY]

S. G. IVANOV and A. M. IANSHIN Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar.-Apr. 1985, p. 140-148. In Russian. refs

The shading and interference effects resulting from the tumbling of a plate in a free-molecular stream are investigated analytically. The particle fluxes, pressure, and tangential stresses acting on the plate are determined with allowance for these effects. For a purely diffusive scheme of interaction of a gas with the plate surface, estimates are made of the relative contributions of shading and interference to the head resistance and the damping moment of the plate. V.L.

A85-38562

A STUDY OF THE CRITICAL FLOW RATE THROUGH CASCADES OF THIN SLIGHTLY BENT AIRFOILS USING THE LARGE-PARTICLE METHOD [ISSLEDOVANIE KRITICHESKOGO RASKHODA CHEREZ RESHETKI TONKIKH SLABOIZOGNUTYKH PROFILEI METODOM KRUPNYKH CHASTITS]

IU. M. DAVYDOV, V. D. KULIKOV, and E V. MAIORSKII Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar -Apr. 1985, p. 182-185 In Russian. refs

The critical flow rate past plane cascades of wing profiles is investigated experimentally and analytically using the large-particle method. The analysis is carried out for subsonic velocities and varying angles at the entrance and high supersonic velocities at the exit. The critical flow rate is calculated as a function of the entrance angle for various types of cascades. V.L.

A85-38563

APPROXIMATE RELATIONSHIPS FOR DETERMINING PRESSURE AT THE SURFACE OF A SPHERE OR A CYLINDER FOR ARBITRARY FREE-STREAM MACH NUMBERS [PRIBLIZHENNYE ZAVISIMOSTI DLIA OPREDELENIIA DAVLENIIA NA POVERKHNOSTI SFERY ILI TSILINDRA PRI PROIZVOL'NOM CHISLE MAKHA NABEGAIUSHCHEGO POTOKA]

A. N. POKROVSKII and L. G. FROLOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar.-Apr. 1985, p. 185-188. In Russian. refs

Simple analytical formulas are proposed for determining pressure at the surface of spheres or cylinders for any free-stream Mach number. The formulas are based on reported numerical data concerning pressure distribution on the surface of a sphere or a cylinder in transverse flow for theta = 0 pi/2, where theta is the angle relative to the critical point along the meridional plane. A comparison is made between the results obtained and experimental data. V.L.

A85-38564

THE EFFECT OF THE BLUNTNESS SHAPE ON THE DRAG COEFFICIENT OF A BODY IN HYPERSONIC FLOW OF A RAREFIED GAS [VLIIANIE FORMY ZATUPLENIIA NA KOEFFITSIENT SOPROTIVLENIIA TELA V GIPERZVUKOVOM POTOKE RAZREZHENNOGO GAZA]

I. N. LARINA Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar.-Apr 1985, p. 190-192. In Russian.

The effect of the bluntness shape of a body in hypersonic flow of a rarefied gas on the flow field and aerodynamic characteristics is investigated analytically by considering flow past ellipsoids of revolution at zero angle of attack. The problem of flow in the transition mode is solved on the basis of a numerical analysis of the BGK kinetic model equation for a monoatomic gas. The results are found to be in good agreement with experimental data. V.L.

A85-38780#

BASIC AEROSTATICS - A TUTORIAL

D. M. LAYTON (U.S Naval Postgraduate School, Monterey, CA) IN: *Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers* . New York, American Institute of Aeronautics and Astronautics, 1985, p. 20-25.

(AIAA PAPER 85-0864)

A discussion is presented concerning the most fundamental aspects of aerostatic behavior in ambient temperature and hot gases which generate sufficient lift for use in lighter-than-air vehicles. Attention is given to the most beneficial relationships between such aerostatic lift and both aerodynamic and powered lift possibilities, as well as such secondary aerostatic phenomena as lift enhancement through solar heating of aerostat vehicle gas volumes, and the effects of varying atmospheric pressure and temperature conditions. O C.

A85-38782#

AN EXPERIMENTAL INVESTIGATION OF THE AERODYNAMIC EFFECTS ON A BODY OF REVOLUTION IN TURNING FLIGHT

A. KING and J. DELAURIER (Toronto, University, Toronto, Canada) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 40-43. refs

(AIAA PAPER 85-0866)

An investigation was made of the side forces acting on a streamlined body of revolution in steady turning flight. A rotating-arm water tank was built and instrumented to measure the radial force on the model and the angular velocity of the arm. A series of tests were run using a body of revolution with a fineness ratio of 5.2. The results are presented as a value for the nondimensional side force coefficient, K. Author

A85-38783#

AERODYNAMICS OF A NEW AEROSTAT DESIGN WITH INVERTED-Y FINS

S. P. JONES (TCOM, Columbia, MD) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers New York, American Institute of Aeronautics and Astronautics, 1985, p. 44-52 refs

(Contract F19628-83-C-0152)

(AIAA PAPER 85-0867)

The 365Y design combines the much-used TCOM 365 aerostat hull with an inverted-Y empennage, which has several advantages in handling, manufacture and the shedding of precipitation. Wind tunnel tests on a 1/72 scale model show the aerostat to be well-behaved with attached flow at low angles of pitch and yaw At yaw angles above 6 deg with pitch greater than 5 deg the onset of separation can be detected with the 'tufted' model and in the roll moment data. The experimental results have been fit to a theoretical model with empirical efficiency factors and a function to duplicate separation effects. A segmented theoretical model was used for stability analyses and nonlinear dynamic simulations. The results predict a stable aerostat capable of surviving in heavy turbulence. Author

A85-38789#

AN APPLICATION OF SOURCE-PANEL AND VORTEX METHODS FOR AERODYNAMIC SOLUTIONS OF AIRSHIP CONFIGURATIONS

K. Y. WONG, J. DELAURIER (Toronto, University, Toronto, Canada), and L. ZHIYUNG (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China; Toronto, University, Toronto, Canada) IN Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 78-83. refs

(AIAA PAPER 85-0874)

A potential flow computational method is used to calculate the flow around traditional airship configurations. In this method, the basic building blocks of the singularity distribution consist of constant strength source-panels for the hull, and horseshoe vortices for the fins. The resulting Neumann boundary-value problem is solved as a system of linear algebraic equations to yield the pressure distribution, forces, and moments on the configuration. A number of examples are treated and the results are in general agreement with wind tunnel data, showing this to be a useful tool in the aerodynamic analysis of airship configurations. Author

A85-38790#

WIND TUNNEL INVESTIGATION OF THE INTERACTION OF AN AIRSHIP CONFIGURATION WITH LIFTING ROTORS

T. S. WONG, W. D. MCKINNEY, and J. D. DELAURIER (Toronto, University, Toronto, Canada) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 84-89. Research supported by Transport Canada and Natural Sciences and Engineering Research Council of Canada. refs

(AIAA PAPER 85-0875)

This article describes a series of wind-tunnel tests conducted on a 'generic' airship configuration with lifting rotors. In particular, the phenomena studied included hull/rotor interaction and the combined hull and rotor-interference effects on the fins. These interaction studies were conducted for both the still-air hover and translational flight modes In general, the test results show that (1) a quad-rotor configuration heavy-lift airship in the still-air hover mode may incur problematic pitching oscillations when subjected to longitudinal gusts, (2) tail fin loads due to the lifting rotors are significant, and (3) side gusts may give rise to unexpected loads on the leeward fin and rotor. Author

A85-38922

A SECOND-ORDER APPROXIMATE METHOD FOR TRANSONIC SMALL-DISTURBANCE POTENTIAL FLOW AND ITS APPLICATION TO THE ANALYSIS OF FLOWS OVER AIRFOILS

K.-Y. SHEN (Shanghai Aviation Industrial Corp., Shanghai, People's Republic of China) and S.-J. LUO (Northwestern Polytechnical University, Xian, People's Republic of China) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 49, June 1985, p. 149-161. refs

A transonic small-disturbance equation retaining all secondand some higher-order terms (i.e., the TSDH equation) is proposed for computing transonic flows over blunt leading edge airfoils in subsonic and supersonic free streams Three difference schemes and relaxation techniques are studied numerically for obtained converged solutions, of which two succeed for both subsonic and supersonic free streams; the other can only be applied to subsonic free streams. Comparisons with reported results and experiments are made for the DSMA 523 and NACA 0012 airfoils. The agreements are generally satisfactory. Author

A85-38963#

THE COMPUTATION OF TRANSONIC NOZZLE FLOW-FIELD BY A TIME-DEPENDENT METHOD

D. FANG (National University of Defence Technology, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 10-18. In Chinese, with abstract in English. refs

The steady inviscid transonic nozzle flow is computed based on the time-dependent method The Boundary-Fitted-Coordinates (BFC) system is adopted for generating a natural grid. The second-order MacCormack finite difference scheme is adopted for solution of the governing equations The wall boundary condition is computed from characteristics formulation The reflection boundary condition is used to evaluate the physical flow variables at the centerline. The results from this study agree very well with the test data. Author

A85-38965#

NUMERICAL SIMULATION OF THREE-DIMENSIONAL TRANSONIC FLOW IN A TURBOMACHINERY

Y. ZHANG (Chinese Academy of Sciences, Computing Centre, People's Republic of China) and M. SHEN (Qinghua University, Beijing, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 29-36. In Chinese, with abstract in English. refs

Three-dimensional transonic flow in turbomachinery is simulated using the correct raddial momentum equation in integral form. The unsteady adiabatic energy equation for an inviscid perfect gas is used instead of conservation of enthalpy. The results are compared with those from Denton's computational scheme. The numerical solutions obtained with the present scheme show a correct trend and good convergence. C.D.

A85-38966#

THE NUMERICAL CALCULATION OF THE PRESSURE DISTRIBUTION OF SHARP EDGE SLENDER WINGS WITH LEADING OR SIDE EDGE VORTEX SEPARATION

Y. XIANG Acta Aerodynamica Sinica, no. 2, 1985, p. 37-43. In Chinese, with abstract in English. refs

In this paper, a convenient method is developed to calculate the aerodynamic characteristics and pressure distribution of slender wings with leading or side edge vortex separation in incompressible flow By use of a vortex lattice method, the leading edge Kutta conditions is employed to determine the strength of the vortex sheet, and an equivalent concentrated vortex line is adopted to simulate the leading edge vortex. Various kinds of slender wings are calculated using the method, and the results show good agreement with other methods and tests up to vortex breakdown. Author

A85-38967#

THE CHARACTERISTICS COMPATIBILITY CONDITIONS ON THE BOUNDARY POINTS ARE APPLIED TO TIME-MARCHING METHODS FOR TRANSONIC FLOW PAST PLANE CASCADES

B LIN (Chinese Academy of Space Technology, Beijing, People's Republic of China), M. SHEN (Qinghua University, Beijing, People's Republic of China), and S. ZHOU (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 44-50. In Chinese, with abstract in English. refs

In this paper, the characteristic compatibility system that is applied to the boundary points is derived under universal form. Methods of giving the boundary conditions for flow past plane cascades are discussed using characteristic theory. Numerical tests of the boundary conditions are done with some different approaches, and comparisons of their numerical results are presented. Author

A85-38969#

INVESTIGATION ON CONFIGURATIONS IN LONGITUDINAL DIRECTION WIND-TUNNEL TESTING OF FORWARD SWEPT WINGS

W. YE and R. XIAO (Nanjing Aeronautical Institute, Nanjing, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 61-68. In Chinese, with abstract in English. refs

Based on a test of a low speed wind tunnel and the computation of aerodynamic load and transonic-supersonic area rule the aerodynamic characteristics of configurations with FSW are analyzed in this paper. The measures for improving aerodynamic performance of FSW are presented. By a symmetry principle, the calculations on the panel method and the area rule are applied to FSW. The results indicate that the configurations with FSW have better aerodynamic performance. The winglet is able to raise lift-drag ratio. The canard-FSW configuration and a small fairing panel inserted in the wing root apparently improve the flow field on the wing root. The spanwise lift distribution of FSW approaches the optimum form. As the area distribution of FSW more easily approaches the optimum form than that of ASW, the configuration with FSW is able to reduce the wave drag. Author

A85-38972#

AN EXTENSION OF THE GENERALIZED VORTEX-LATTICE METHOD OF SUPERSONIC SIDESLIPPING WINGS

R. CHEN and M. HUANG (Nanjing Aeronautical Institute, Nanjing, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 83-87. In Chinese, with abstract in English. refs

One of the authors previously suggested a transformation which can be used to obtain the velocity components induced by a sideslipping lifting element from the formulas for calculating the components induced by a nonsideslipping one, so that Woodward's (1968) panel method can be extended to include sideslip cases. In this paper, the same transformation rule is applied to a skewed-horseshoe vortex in supersonic flows, and the generalized vortex-lattice method developed by Miranda et al. (1977) is extended to the case of sideslip. The advantages of the new method are that the panelizing of the wing and the arrangement of the element vortices and the control points are in the same manner as in nonsideslip cases The aerodynamic derivatives of the rolling moment are calculated for plate delta and arrow wings. Comparison with exact results shows that the accuracy of the numerical results meets the needs of engineering use C.D.

A85-38981#

COMPUTATIONS OF PROJECTILE MAGNUS EFFECT AT TRANSONIC VELOCITIES

C. J. NIETUBICZ, W B. STUREK, and K. R. HEAVEY (U.S Army, Ballistics Research Laboratories, Aberdeen Proving Ground, MD) AIAA Journal (ISSN 0001-1452), vol. 23, July 1985, p. 998-1004. refs

A combined computational and experimental research program has been ongoing to develop a predictive capability for the Magnus effect that develops on spinning projectiles at angle of attack. This effort has been very successful in the supersonic regime and has now been extended to the transonic regime Utilizing the time-marching, thin-layer, Navier-Stokes computational technique, flowfield solutions have been obtained for a spinning 6-caliber-long, ogive-cylinder-boattail shape at Mach 0.91 and 2-deg angle of attack The computed results predict the correct development of the Magnus force along the body; and comparisons between the computational results and experiment are encouraging. Details of the flowfield solution, such as turbulent boundary-layer velocity profiles and surface pressure distributions, are presented. The surface pressure and viscous shear components of the Magnus effect are presented as a function of axial position. A complete set of aerodynamic coefficients has been determined from the flowfield solutions. The computations for this research effort were obtained using a CDC 7600 and a Cray 1S computer. Author

A85-38984*# Pennsylvania State Univ., University Park.

CONICAL SIMILARITY OF SHOCK/BOUNDARY-LAYER INTERACTIONS GENERATED BY SWEPT AND UNSWEPT FINS

G. S. SETTLES (Pennsylvania State University, University Park, PA) and F. K. LU AIAA Journal (ISSN 0001-1452), vol 23, July 1985, p. 1021-1027. refs

(Contract NAG2-109; F49620-81-K-0018)

A parametric experimental investigation has been made of the class of three-dimensional shock wave/turbulent boundary layer interactions generated by swept and unswept leading-edge fins. The fin sweepback angles were 0-65 deg at 5, 9, and 15 deg angles of attack. Two equilibrium two-dimensional turbulent boundary layers with a freestream Mach number of 2.95 and a Reynolds number of 6.3 x 10 to the 7th/m were used as incoming flow conditions. All of the resulting interactions were found to possess conical symmetry of the surface flow patterns and pressures outside of an initial inception zone. Further, these interactions were found to obey a simple conical similarity rule based on inviscid shock wave strength, irrespective of fin sweepback or angle of attack. This is one of the first demonstrations of similarity among three-dimensional interactions produced by geometrically dissimilar shock generators. Author

A85-38989#

NUMERICAL SOLUTION OF TWO- AND THREE-DIMENSIONAL ROTOR TIP LEAKAGE MODELS

A. R. WADIA (General Electric Co., Evendale, OH; General Motors Corp., Detroit Diesel Allison Div, Indianapolis, IN) AIAA Journal (ISSN 0001-1452), vol. 23, July 1985, p. 1061-1069. Previously cited in issue 16, p. 2294, Accession no A83-36258. refs

A85-38997#

STABILITY OF THE THIN-JET MODEL OF THE UNSTEADY JET FLAP

D. I. PULLIN and J. M. SIMMONS (Queensland, University, Brisbane, Australia) AIAA Journal (ISSN 0001-1452), vol. 23, July 1985, p 1118-1120. refs

A 'jet flap' is generated by the ejection of air from a spanwise slot at the trailing edge of an airfoil. In view of the success of numerical vortex sheet models of unsteady wakes, it has been useful to investigate the vortex sheet formulation of the thin jet in order to study its nonlinear behavior in a simple configuration; attention is given to the case of the periodic plunging motion of a wing-jet flap combination treated as an initial value problem, in order to avoid difficulties associated with downstream boundary conditions. The present finding of violent instability in the thin jet model is consistent with the severe instability problems discussed by Potter (1972), and indicates that the model is too unstable for practical use. O.C.

A85-39001#

TRANSONIC FLOW IN THE THROAT REGION OF RADIAL OR NEARLY RADIAL SUPERSONIC NOZZLES

B. F. CARROLL and J. C. DUTTON (Texas A & M University, College Station, TX) AIAA Journal (ISSN 0001-1452), vol. 23, July 1985, p. 1127-1129 refs

A transonic solution is presented that is applicable to annular nozzles whose throat flow is inclined at arbitrary, but large, angles to the nozzle axis-of-symmetry. This solution is a computationally efficient means of establishing a supersonic initial value line for space-marching supersonic calculations, and is applicable to the analysis of radial inflow and outflow, as well as planar geometries. A parametric study using the computer program of Carroll and Dutton (1984) was performed to establish guidelines for use of the transonic analysis. O.C.

A85-39021

THE FREE INTERACTION IN A SUPERSONIC FLOW OVER A POROUS WALL

M. A. PAGE (Monash University, Melbourne, Australia) and N RILEY (East Anglia, University, Norwich, England) Quarterly Journal of Mechanics and Applied Mathematics (ISSN 0033-5614), vol. 38, Feb. 1985, p. 79-92. refs

The present study is concerned with the free interaction which takes place when a supersonic stream flows past a plane wall, part of which is the surface of a bed of porous material. It is known that a polyurethane duct lining in a shock tunnel is extremely effective in reducing the strength of unwanted shock reflections. Clarke (1984) has considered the transient response of a bed of porous material to pressure changes at its upper surface due to the passage of a weak plane shock wave in the gas above it. In the current study, attention is given to the steady supersonic flow past a plane boundary, part of which is the surface of a bed of isotropic porous material. It is assumed that the flow in the porous medium is governed by Darcy's law. The results obtained are evaluated. The presence of a porous bed in a wall in the considered case is found to modify the flow to the extent that the distribution of pressure gradient is altered with a concomitant change in the position of flow separation, but the overall pressure rise is little changed. G.R.

A85-39058
ENGINE INLET INTERACTION WITH A PROP-FAN PROPULSION SYSTEM
D. D TANNER and T. A WYNOSKY (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) IN. Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc, 1984, p. 11-17.
(SAE PAPER 841478)

Pratt & Whitney participated in a cooperative model test program with NASA Lewis, Lockheed-Georgia and Hamilton Standard to evaluate chin inlet/propeller interactions using an advanced technology Prop-Fan model The tests were conducted at the United Technologies Research Center's main wind tunnel using its propeller test rig and NASA Lewis's 2-ft diameter SR3 Prop-Fan model. The tests were done at several forward flight speeds, up to Mach 0.8, simulating both cruise and reverse thrust operation. Interaction effects with and without boundary layer diverters are discussed in terms of inlet recovery and installed thrust minus drag. These interaction effects are presented as a function of parameters such as power coefficient, advance ratio, mass flow ratio and Mach number Author

A85-39060* Douglas Aircraft Co., Inc., Long Beach, Calif
AERODYNAMIC TEST RESULTS FOR A WING-MOUNTED TURBOPROP PROPULSION INSTALLATION
G. S. PAGE, H R WELGE (Douglas Aircraft Co., Long Beach, CA), and R. C. SMITH (NASA, Ames Research Center, Moffett Field, CA) IN: Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 27-33
(SAE PAPER 841480)

The paper provides an overview of the renewed interest in turboprop propulsion systems for future commercial transport designs. The potential operating cost advantage of advanced turbofan designs. Critical technology items for the aerodynamic installation of turboprop propulsion systems are presented, along with experimental results addressing the main technology issue for wing-mounted turboprop installations Nacelle installation effects are presented for overwing and underwing nacelles. The drag reduction for nacelle contouring is also shown. Wing/nacelle/power data are presented for the baseline wing geometry and for a wing modified to reduce the propeller power effects Author

A85-39063
INVESTIGATION OF TRANSONIC INLET DRAG CHARACTERISTICS
D. K. KRIVEC, R. T LING (Lockheed-California Co., Burbank, CA), and J. VADYAK (Lockheed-Georgia Co., Marietta, GA) IN: Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc, 1984, p. 69-80. refs
(SAE PAPER 841539)

Fourteen subsonic axisymmetric inlet models with various forebody contours and geometry parameters were tested in the NASA-Langley Research Center 16-foot transonic wind tunnel Test Mach numbers ranged from 0.59 to 0 96 A mass flow control throttle (translating plug) allowed mass flow ratios from 0.23 to 0.92. Force and pressure data were acquired for all fourteen inlets, with and without external boundary layer transition strips (grit). The force balance was found to be defective after completion of the test However, drag data were calculated from wake pressure rake data. Various inlet geometry effects on drag characteristics were analyzed. In particular, drag divergence Mach number was found to correlate with inlet thickness ratio. Experimental pressure and drag data were also compared with predictions from full potential transonic flow codes to verify their reliability and accuracy. The computer codes were found to be useful design tools that can help significantly reduce the number of inlet configurations to be examined experimentally. Author

A85-39064
DYNAMIC PRESSURE FLUCTUATIONS IN THE INTERNOZZLE REGION OF A TWIN-JET NACELLE
D E. BERNDT (Rockwell International Corp, North American Aircraft Operations, Los Angeles, CA) IN: Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p 81-87
(SAE PAPER 841540)

The current trend of flying aircraft in a severe environment, i e., high Mach numbers at low altitudes, has created interest in the impact of dynamic pressure fluctuations on nozzle hardware durability. Because of this interest, methods have been developed to obtain dynamic pressure data in the internozzle region of twin-jet aircraft models during wind tunnel testing Results from the wind tunnel tests have been analyzed to establish trends, such as the effect of flight variables and engine operating variables, on the dynamic pressure fluctuations. Comparisons have also been made between wind tunnel test results and flight test data. Author

A85-39200
COMPUTATION OF THREE-DIMENSIONAL FLOW USING THE EULER EQUATIONS AND A MULTIPLE-GRID SCHEME
C. KOECK (Matra S A., Velizy-Villacoublay, Yvelines, France) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 5, May 1985, p. 483-500 Research supported by the Direction des Recherches, Etudes et Techniques. refs

The unsteady Euler equations are numerically solved using the finite volume one-step scheme recently developed by Ni (1981). The multiple-grid procedure of Ni is also implemented The flows are assumed to be homo-enthalpic; the energy equation is eliminated and the static pressure is determined by the steady Bernoulli equation; a local time-step technique is used. Inflow and outflow boundaries are treated with the compatibility relations method of ONERA The efficiency of the multiple-grid scheme is demonstrated by a two-dimensional calculation (transonic flow past the NACA 12 aerofoil) and also by a three-dimensional one (transonic lifting flow past the M6 wing). The third application presented shows the ability of the method to compute the vortical flow around a delta wing with leading-edge separation. No condition is applied at the leading-edge, the vortex sheets are captured in the same sense as shock waves. Results indicate that the Euler equations method is well suited for the prediction of flows with shock waves and contact discontinuities, the multiple-grid procedure allowing a substantial reduction of the computational time. Author

A85-39205* Naval Ship Research and Development Center, Bethesda, Md
CIRCULATION CONTROL TECHNOLOGY APPLIED TO PROPULSIVE HIGH LIFT SYSTEMS
R. J. ENGLAR, J. H. NICHOLS, JR., M. J. HARRIS (David Taylor Naval Ship Research and Development Center, Bethesda, MD), J. C EPPEL, and M. D. SHOVLIN (NASA, Ames Research Center, Moffett Field, CA) IN: V/STOL An update and overview; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p 31-43. refs
(SAE PAPER 841497)

Technology developed for the Circulation Control Wing high-lift system has been extended to augment lift by entraining and redirecting engine thrust. Ejecting a thin jet sheet tangentially over a small curved deflecting surface adjacent to the slipstream of a turbofan engine causes the slipstream to flow around that deflecting surface. The angle of deflection is controlled pneumatically by varying the momentum of the thin jet sheet. The downward momentum of the slipstream enhances wing lift. This concept of pneumatically deflecting the slipstream has been applied to an upper surface blowing high-lift system and to a thrust deflecting system The capability of the pneumatic upper surface blowing system was demonstrated in a series of investigations using a wind tunnel model and the NASA Quiet Short-haul Research Aircraft (QSRA). Full-scale thrust deflections greater than 90 deg were achieved. This mechanically simple system can provide increased maneuverability, heavy lift or overload capability, or short takeoff and landing performance. Author

A85-39210*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

COMPUTATIONAL/EXPERIMENTAL PRESSURE DISTRIBUTIONS ON A TRANSONIC, LOW-ASPECT-RATIO WING

E. R. KEENER (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 545, 546; Abridged. Previously cited in issue 20, p. 2847, Accession no. A84-42345.

A85-39216#

MULTIGRID CALCULATION OF TRANSONIC FLOW PAST WING-TAIL-FUSELAGE COMBINATIONS

A. SHMILOVICH (Douglas Aircraft Co., Long Beach, CA; Cornell University, Ithaca, NY) and D. A. CAUGHEY (Cornell University, Ithaca, NY) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 581-586. refs

(Contract N00014-77-C-0033)

A computer program for calculating transonic potential flowfields about three-dimensional wing-tail-fuselage combinations has been developed. The transonic potential equation is approximated and solved numerically using a finite volume method on a boundary-conforming coordinate system. The multigrid technique is utilized to accelerate convergence of the relaxation scheme and, thus, allow computations about multiple-component airplanes with reasonable expenditure of computer resources. The wing-tail flow interaction is investigated and results indicate that the tail exerts a noticeable effect on the wing loading when the tail is located near the wing trailing edge. Author

A85-39219*# North Carolina State Univ., Raleigh.

NUMERICAL AND EXPERIMENTAL DETERMINATION OF SECONDARY SEPARATION ON DELTA WINGS IN SUBSONIC FLOW

F. R. DEJARNETTE (North Carolina State University, Raleigh, NC) and S. H. WOODSON Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 602-608. Previously cited in issue 20, p. 2844, Accession no. A84-41340. refs

(Contract NCC1-22; NCC1-46)

A85-39223#

AERODYNAMICS OF AN ASPECT RATIO 8 WING AT LOW REYNOLDS NUMBERS

J. F. MARCHMAN, III and A. A. ABTAHI (Virginia Polytechnic Institute and State University, Blacksburg, VA) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 628-634. Previously cited in issue 07, p. 842, Accession no. A85-19630. refs

(Contract N00014-84-K-0093)

A85-39224#

THEORETICAL CONSIDERATIONS IN THE AERODYNAMIC EFFECTIVENESS OF WINGLETS

K. ASAI (National Aerospace Laboratory, Tokyo, Japan) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 635-637. refs

An attempt is made to identify and explain the relative advantages of planar and nonplanar wings, by means of simple theoretical analyses taking into account such structural constraints as the wing root bending moment, which is presently used as an index of the structural weight of a wing. In addition, the influence of parasite drag has been included in a tradeoff study which employs empirical methodology. The parasite drag penalty was found to be crucial to the discussion of the relative advantages of a winglet and a tip extension, although most of the previous theoretical studies have not taken this into account. O.C.

A85-39225#

DYNAMIC OVERSHOOT OF THE STATIC STALL ANGLE

L. E. ERICSSON and J. P. REDING (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 637, 638. refs

The extensive set of experimental results for an airfoil in pitch-up motion presented by Daley and Jumper (1984) is compared with Ericsson and Reding's (1976) analytic prediction of the dynamic overshoot of the static stall angle. Attention is given to the 'infinite Reynolds number limit' reached when the pitch-up rate exceeds a certain value. It is noted that, at high pitch-up rates, the dynamic overshoot of static stall is primarily due to the Karman-Sears (1983) wake effect. O.C.

A85-39226*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

DYNAMIC GROUND EFFECTS ON A TWO-DIMENSIONAL FLAT PLATE

Y.-S. CHEN (NASA, Marshall Space Flight Center, Huntsville, AL) and W. G. SCHWEIKHARD (Kohlman System Research, Inc., Lawrence, KS) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 638-640. refs

(Contract NAS8-35918)

The effect of time-variant vortex shedding is simulated by a sequence of discrete vortices convecting downstream in the wake of a two-dimensional flat plate whose lifting condition is modeled by means of the quasi-vortex lattice method. The boundary condition of this problem is specified in such a way that the tangency condition on the surface of the flat plate is satisfied; the boundary condition also takes into account the effect of airfoil motion relative to the ground Significant lift changes are shown to occur, due to the dynamic ground effect, that are crucial in aircraft takeoff and landing transitions. O.C.

A85-39241* Royal Aircraft Establishment, Bedford (England).

COMPUTER STUDIES OF HYBRID SLOTTED WORKING SECTIONS WITH MINIMUM STEADY INTERFERENCE AT SUBSONIC SPEEDS

D G. MABEY (Royal Aircraft Establishment, Bedford, England) and F. W. STEINLE (NASA, Ames Research Center, Moffett Field, CA) Aeronautical Journal (ISSN 0001-9240), vol. 89, April 1985, p. 135-148. refs

Currently there is renewed interest in the evaluation and reduction of steady wind tunnel wall interference, especially for large models. Evaluation of previous predictions for perforated and slotted tunnels suggests that a hybrid slotted tunnel (i.e., a slotted tunnel with closed slats and perforated slots) should offer minimum corrections for upwash, flow curvature and solid blockage. This suggestion is confirmed by the present computer studies of a range of rectangular hybrid slotted tunnels. The computer studies are for tunnel working section height to breadth ratios of 0.835 and 0.600 over the Mach number range from 0 to 0.85. Wings swept at 28 deg and 50 deg, with ratios of model span to tunnel breadth varying from 0 to 0.7, are considered. An idealized fuselage shape is used to predict solid and wake blockage corrections for the wall configurations selected on the basis of minimum upwash and curvature interference. Author

A85-39242

MODELLING VORTEX FLOWFIELDS BY SUPERCOMPUTERS WITH SUPER-SIZE MEMORY

A. RIZZI (Flygtekniska Forsoksanstalten, Bromma; Kungl. Tekniska Hogskolan, Stockholm, Sweden) Aeronautical Journal (ISSN 0001-9240), vol. 89, April 1985, p. 149-161. Research supported by the Control Data Corp. refs

The possibilities for studying fluid flow on the basis of mathematical models are considered. Fluid motion is governed by the Navier-Stokes equations. However, present day methods are unable to provide solutions to general three-dimensional problems, and modeling simplifications are needed. One step along the way to a computer solution involves the transformation of the continuum problem posed by the Navier-Stokes equation to a discrete one. A network of grid points is laid out, and a large dynamical system of nonlinear algebraic equations is to be solved. As the size of this system increases, the discrete model becomes an increasingly higher-order approximation to the asymptotic limit of the founding continuum model. This size is restricted by the capacity of the computer, and the utilization of a computer with a larger memory, in the considered case 16 million words of 64-bit precision, can lead to very significant advances regarding the obtainable solutions. Attention is given to classical leading-edge flows, leading-edge vorticity and turbulence, and the importance of supercomputers G R.

A85-39245#

CORRELATION AND PREDICTION OF ROTATING STALL INCEPTION BY DIVERGENCE METHOD

V. J. ZIKA ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 107, June 1985, p. 191-196. refs

An empirical correlation of rotating stall inception points of elementary compressors, modeled as equivalent diffusers, is presented. From it, two inception criteria for self-induced rotating stall are derived. Compressor blade rows are classified according to a geometric form parameter into two groups, subcritical and supercritical. The subcritical geometries stall at a constant kinematic area ratio, in what appears to be a pure rotating stall mode, which occurs before the airfoil stalls. In supercritical geometries, the rotating stall is delayed until it is triggered by the airfoil stall. Thus, for the latter geometries, the airfoil stall and rotating stall are coincident. In contrast to other diffuser-analog methods, the divergence method determines the stall angle and the stalled flow coefficient rather than the stalled pressure rise. Author

A85-39445

SIMILARITY PROPERTIES IN THE PROBLEM OF FLOW FROM A SUPERSONIC SOURCE PAST A SPHERICAL BLUNTNESS

IU. P GOLOVACHEV (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR) International Journal of Heat and Mass Transfer (ISSN 0017-9310), vol. 28, July 1985, p. 1165-1171. refs

The problem of steady-state perfect gas flow from a supersonic spherical source past a spherical bluntness is discussed. Numerical solutions for the nonviscous gas equations, the boundary-layer equations, and the Navier-Stokes equations are given. Universal relations for the heat transfer and drag parameters which apply to a wide range of Mach and Reynolds numbers for different free-stream uniformities, are constructed. The results presented are based on numerical solutions of the problem for a gas with a specific heat ratio of 1.4. M D.

A85-39578#

A COMPUTATIONAL STUDY OF THE UNSTEADY SHOCK-WAVE STRUCTURE IN A TWO-DIMENSIONAL TRANSONIC ROTOR

P. D. SPARIS (Thrace, University, Xanthi, Greece) Journal of Propulsion and Power (ISSN 0748-4658), vol 1, July-Aug. 1985, p. 261, 262; Abridged.

Some of the loss mechanisms associated with unsteady transonic flow in a two-dimensional cascade are discussed. For this purpose, the unsteady flowfield generated by a shifting inlet velocity profile modeling approximately the stator wake as a linear velocity profile is compared to the steady field created by a uniform inlet. Both flows are generated by a numerical solution of the Euler equations using the MacCormack difference scheme. The results indicate that there is considerable influence of the inlet flow unsteadiness on the location of the shock wave that moves upstream for a distance on the order of 15 percent of chord length. The shock also tends to oscillate with an amplitude 5 percent of chord length. These shock oscillations generate pressure waves propagating downstream of the rotor increasing the flow mixing losses They should also affect the boundary layer detrimentally. An overall effect of the shifting velocity deficit is 10 percent of steady-state lift. - Author

A85-39581#

EXTERNAL COMPRESSION SUPERSONIC INLET ANALYSIS USING A FINITE DIFFERENCE TWO-DIMENSIONAL NAVIER-STOKES CODE

A. F. CAMPBELL, J SYBERG, and C. K. FORESTER (Boeing Military Airplane Co, Seattle, WA) Journal of Propulsion and Power (ISSN 0748-4658), vol 1, July-Aug. 1985, p. 279-285. Previously cited in issue 17, p. 2420, Accession no. A84-37216.

A85-39582#

STUDY OF AN ASYMMETRIC FLAP NOZZLE AS A THRUST-VECTORING DEVICE

C. C. WU (California State University, Los Angeles, CA) and W. L. CHOW (Illinois, University, Urbana, IL) Journal of Propulsion and Power (ISSN 0748-4658), vol. 1, July-Aug. 1985, p 286-291. Previously cited in issue 16, p. 2278, Accession no A84-35190 refs

(Contract DAAG29-79-C-0184; DAAG29-83-K-0043)

A85-39589#

SIMULATION OF WAKE PASSING IN A STATIONARY TURBINE ROTOR CASCADE

D. J DOORLY (University College, London; Oxford University, Oxford, England) and M. L. G. OLDFIELD (Oxford University, Oxford, England) Journal of Propulsion and Power (ISSN 0748-4658), vol 1, July-Aug. 1985, p. 316-318. Research supported by the Science and Engineering Research Council and Rolls-Royce, Ltd. refs

The present experiment has permitted the generation of wake-passing flow in a stationary cascade of turbine rotor blades that are mounted in a short-duration wind tunnel. Schlieren flow visualization and unsteady heat flux data were obtained for the case of a typical turbine blade profile operating at full scale Reynolds and Mach numbers. Experimental design flexibility has allowed assessments to be made of the effects of wake size, spacing, and combinations of wake passing and freestream turbulence. By running the wake generator at subsonic and sonic flow-relative speeds, studies have been conducted of the effects of wake passing with and without associated shock waves. O.C.

A85-39613#

DEVELOPMENT OF AN ACTIVE LAMINAR FLOW NACELLE

J. S. MOUNT and V MILLMAN (Rohr Industries, Inc., Chula Vista, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 15 p. refs

(AIAA PAPER 85-1116)

The work being done to explore the concept of active laminar flow control (LFC) for nacelles is described. It is shown that there is a potential for drag reduction through suppressing transition of the laminar boundary layer. The associated pumping losses and weight gains for typical structure and suction systems are examined. A flight test program using the Citation III, believed to be a practical and low-cost way to demonstrate LFC for an engine nacelle, is outlined. Some of the problems along the road to successful development, such as surface contamination and cleaning, damage and repair, lightning strike, and liquid entry are considered. M D.

A85-39615#

SUBSTANTIATION OF THE APPLICABILITY OF VSAERO PANEL METHOD TO SUBSONIC INLET DESIGN

R. TINDELL and H POTONIDES (Grumman Corp, Bethpage, NY) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 15 p. refs

(AIAA PAPER 85-1119)

The results of application of the VSAERO panel code for inlet flowfield analysis of the Grumman design 698V/STOL aircraft are discussed. The code calculates the nonlinear aerodynamic characteristics of selected ducts in subsonic flow. Either Karman-Tsien or Prandtl-Meyer factors are used to approximate compressibility effects and velocity distributions are computed over the entire panel to derive streamlines. VSAERO also accommodates off-surface flowfield calculations. The V/STOL required a duct lip which does not experience separation over a wide range of angles of attack or during transition between horizontal and vertical flight modes. Additionally, flow distortion had to be minimized. The studies covered inlet-airframe integration effects, the inlet design and pressure distribution. Results are discussed for low-speed flight. M.S.K.

A85-39618#

UNSTEADY BLADE ROW INTERACTIONS IN A MULTI-STAGE COMPRESSOR

V. R. CAPECE, S. R. MANWARING, and S. FLEETER (Purdue University, West Lafayette, IN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 11 p. USAF-supported research. refs

(AIAA PAPER 85-1134)

A three-stage research compressor has been utilized to investigate the multi-stage blade row interaction gust aerodynamics for the first time. The aerodynamic forcing functions as well as the chordwise distributions of the steady surface pressures and the first harmonic unsteady pressure differences on the first and second stage stator vane rows were experimentally determined over a range of operating and geometric conditions. This series of experiments determined that the complex unsteady aerodynamic loading on downstream blade rows is directly related to the forcing function to that blade row, with this forcing function significantly affected by multi-stage blade row interactions. These results have an implication towards the modeling of unsteady aerodynamic blade row interaction phenomena. Namely, the variations of the second stage unsteady data with forcing function waveform cannot be predicted by harmonic gust models. Author

A85-39658#

NUMERICAL SIMULATION OF A SUPERCRITICAL INLET FLOW

M.-S. LIOU (National Cheng Kung University, Tainan, Republic of China; Michigan, University, Ann Arbor, MI), W. L. HANKEY (Wright State University, Dayton, OH), and J. L. MACE (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 8 p refs

(Contract F49620-82-C-0035; AF-AFOSR-84-0327)

(AIAA PAPER 85-1214)

The Reynolds-averaged, unsteady Navier-Stokes equations were solved numerically to predict flow-fields in a two-dimensional supersonic inlet. First, a brief description of numerical procedures, as well as boundary conditions is given. The discussion of calculated results follows. A flow at supercritical conditions was calculated and found to be unsteady. Hence, detailed spectral information for the computed data is given and the boundary-layer parameters, e.g., skin friction coefficients, are shown. Several physically interesting phenomena are discussed. The distribution of the entropy change indicating the performance of the inlet under the chosen set of conditions is given also. Author

A85-39659#

APPLICATION OF 3-D FLOW COMPUTATIONS TO GAS TURBINE AERODYNAMIC DESIGN

F. W. HUBER, R. J. ROWEY (United Technologies Corp., Engineering Div., West Palm Beach, FL), and R. R. NI (United Technologies Corp, Engineering Div., East Hartford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 8 p. refs

(AIAA PAPER 85-1216)

The application of three-dimensional flow modeling techniques to the aerodynamic design of high performance gas turbines is given. The general approach to three-dimensional flow computations, and formulation of equations and boundary conditions is included. In recent years these computational methods have been developed into valid and useful design tools, capable of iterative/interactive utilization in the turbine design process. Pratt and Whitney Aircraft has applied these advanced design tools to several new turbine configurations to provide improved performance and reduced risk relative to that achievable using conventional 2-D or quasi 3-D analyses. Significant performance benefits have been shown using 3-D design methodology, which provides an increased degree of control over the gas flow. The increased control results from the capability to utilize the radial body forces generated by the turbine airfoil and endwall contours in addition to conventional forces produced in the circumferential plane. Author

A85-39661#

INVESTIGATION OF THE EFFECT OF TWO ENDWALL CONTOURS ON THE PERFORMANCE OF AN ANNULAR NOZZLE CASCADE

S. H. MOUSTAPHA (Pratt and Whitney Canada, Longueuil, Quebec, Canada) and R. G. WILLIAMSON (National Research Council of Canada, Gas Dynamics Laboratory, Ottawa, Canada) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 11 p. refs

(AIAA PAPER 85-1218)

An annular nozzle cascade, of low aspect ratio and high flow turning, was tested with two different endwall contours over a range of exit flow conditions from subsonic to supersonic. Measurements were made of the distributions of exit total pressure and flow angle. Significant performance degradation occurred with increasing Mach number, particularly in the vicinity of the hub. Observed differences in radial loss distribution between the two nozzle builds were correlated with predicted static pressure differences on the endwalls. Author

A85-39685#

ON THE MODELLING OF A FULLY-RELAXED PROPELLER SLIPSTREAM

M. P. METCALFE (British Aerospace, PLC, Woodford, Ches., England) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 16 p refs

(AIAA PAPER 85-1262)

A method for the solution of complete induced velocity equations is presented, in order to predict the effects of propeller airframe interference for an advanced turboprop. The method does not require simplification and permits the development of a model that provides the position of and velocities in self-consistent fully relaxed slipstream. Results are presented defining the induced swirl, and axial and radial velocities for a number of cases that can be validated using the General Momentum theory. The induced velocities and position of the slipstream can be determined within five iterations using the slipstream program proposed. L.T.

A85-39686*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

COMPARISON OF ADVANCED TURBOPROP INSTALLATION ON SWEPT AND UNSWEPT SUPERCRITICAL WINGS AT TRANSONIC SPEEDS

J. R. CARLSON, O C PENDERGRAFT, JR. (NASA, Langley Research Center, Propulsion Aerodynamics Branch, Hampton, VA), and G R. BARTLETT (NASA, Langley Research Center; Vigyan Research Associates, Inc., Hampton, VA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 7 p.

(AIAA PAPER 85-1264)

A series of wind-tunnel investigations were conducted to determine the aerodynamic interference associated with the over wing and under wing installation of a turboprop nacelle on 20 deg swept and unswept supercritical wings. The purpose of the investigations was to increase the understanding of the flow interactions involved with the nacelle turboprop integration and to obtain experimental data for the verification of computational prediction techniques. The models were tested in the Langley 16-Foot Transonic Tunnel at Mach numbers from 0.50 to 0.80 and at angles-of-attack from 0 to 5 deg. In addition, data at several propeller pitch angles and advance ratio settings were obtained. This paper which presents only the results of the over-the-wing nacelle installations shows that wing sweep had considerable influence on the installation interference. Large scale flow separation was observed on the swept wing at M = 0 8 Less severe effects were observed at M = 0.7 on the swept wing and for both M = 0.7 and 0.8 on the unswept wing. Author

A85-39689#
NUMERICAL SOLUTIONS OF RAMJET NOZZLE FLOWS
J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg, VA), F. S. BILLIG, and S. FAVIN (Johns Hopkins University, Laurel, MD) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 11 p Navy-supported research. refs
(AIAA PAPER 85-1270)

Unsplit explicit McCormack unsteady/finite difference method is used to solve the equations of motion for nozzle flows in ramjets and scramjets. A turbulent kinetic energy model is employed to treat the turbulent transport taking place during the expansion process in scramjets with no throat at the end of the combustor. Consideration is given to the treatment of the chemistry by either frozen, equilibrium, or simple global finite rate model. Numerical methods for calculating the flowfield and performance of scramjet nozzles is presented, treating the nozzle core flow and the nozzle boundary layer separately. The method yields high computational capacity, making it possible to design efficient nozzles which operate with strongly nonuniform inflow profiles. L.T

A85-39697#
LOSS IN TURBOFAN THRUST CAUSED BY BOUNDARY LAYER GROWTH IN A NACELLE'S INLET AND EXHAUST DUCTS
W. M DOUGLASS AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 4 p.
(AIAA PAPER 85-1281)

A different approach to the evaluation of the losses in a nacelle's inlet and exhaust ducts and how they effect the performance and operation of a turbofan engine is presented The approach of this report is to evaluate the skin friction loss in the duct as a growth in boundary layer as opposed to the conventional method which evaluates the loss in terms of a pressure drop across the entire duct. Author

A85-39700*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECT OF A WING-TIP MOUNTED PUSHER TURBOPROP ON THE AERODYNAMIC CHARACTERISTICS OF A SEMI-SPAN WING
J. C. PATTERSON, JR. (NASA, Langley Research Center, Hampton, VA) and G. R. BARTLETT (Vigyan Research Associates, Inc., Hampton, VA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 9 p. refs
(AIAA PAPER 85-1286)

An exploratory investigation has been conducted at the NASA Langley Research Center to determine the installed performance of a wing tip-mounted pusher turboprop. Tests were conducted using a semispan model having an unswept, untapered wing with a air-driven motor located on the tip of the wing, with an SR-2 design high speed propeller installed on the rear shaft of the motor All tests were conducted at a Mach number of 0 70, at angles of attack of approximately -2 to +4 deg, and at a Reynolds number of 3.82 million based on the wing chord of 13 inches. The data indicate that, as a result of locating the propeller behind the wing trailing edge, at the wingtip, in the cross flow of the tip vortex, it is possible to recover part of the vortex energy as an increase in propeller thrust and, therefore, a reduction in the lift-induced drag as well. Author

A85-39728*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
APPLICATION OF RUNGE KUTTA TIME MARCHING SCHEME FOR THE COMPUTATION OF TRANSONIC FLOWS IN TURBOMACHINES
S. V. SUBRAMANIAN (NASA, Lewis Research Center, Cleveland, OH, Avco Corp., Avco Lycoming Div., Stratford, CT) and R. BOZZOLA (Avco Corp , Avco Lycoming Div., Stratford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 8 p. refs
(AIAA PAPER 85-1332)

Numerical solutions of the unsteady Euler equations are obtained using the classical fourth order Runge Kutta time marching scheme This method is fully explicit and is applied to the governing equations in the finite volume, conservation law form. In order to determine the efficiency of this scheme for solving turbomachinery flows, steady blade-to-blade solutions are obtained for compressor and turbine cascades under subsonic and transonic flow conditions. Computed results are compared with other numerical methods and wind tunnel measurements. The present study also focuses on other important numerical aspects influencing the performance of the algorithm and the solution accuracy such as grid types, boundary conditions, and artificial viscosity. For this purpose, H, O, and C type computational grids as well as characteristic and extrapolation type boundary conditions are included in the solution procedure. Author

A85-39729#
ACCURATE AND EFFICIENT SOLUTIONS OF TRANSONIC INTERNAL FLOWS
A. DADONE (Bari, Universita, Bari, Italy) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p. Research supported by the Ministero della Pubblica Istruzione and Consiglio Nazionale delle Ricerche. refs
(AIAA PAPER 85-1334)

The present paper provides a 'Modified Perturbative Lambda Formulation' for solving inviscid transonic flows. The proposed method takes correctly into account the transition from supersonic to subsonic flow conditions through a shock, thus allowing the coupling of these two regions and, therefore, the upstream movement of the shock. The modifications of the lambda formulation are derived from an analysis of a flux difference splitting methodology so that the proposed formulation and such methodologies perform very similarly in the shock transition region The accuracy and efficiency of the present formulation are demonstrated by computing both one-dimensional and arbitrary two-dimensional transonic flows. Author

A85-39736#
PERFORMANCE CHARACTERISTICS OF RECTANGULAR AND CIRCULAR THRUST AUGMENTING EJECTORS
M. E. FRANKE (USAF, Institute of Technology, Wright-Patterson AFB, OH) and G. UNNEVER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 8 p. refs
(AIAA PAPER 85-1344)

Effects of various parameters on the thrust augmentation of rectangular and axisymmetric circular cross section ejectors are studied. Ejector performance is shown to depend on primary nozzle area ratio and diffuser area ratio. Primary nozzle configuration, inlet position, and fluid injection angle are shown to affect thrust augmentation Continuous slot primary nozzles are compared with discrete slot primary nozzles in both the rectangular and circular ejectors. The effect of mixing plates on exit velocity profile and thrust agumentation is studied Results and trends are compared with the literature Author

A85-39738*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

CIRCULAR-TO-RECTANGULAR TRANSITION DUCTS FOR HIGH-ASPECT RATIO NONAXISYMMETRIC NOZZLES

J. R. BURLEY, II (NASA, Langley Research Center, Hampton, VA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 7 p. refs
(AIAA PAPER 85-1346)

The next generation fighter aircraft will be equipped with nonaxisymmetric multifunction jet engine exhaust systems. The circular-to-rectangular transition duct employed in these systems has been made longer with the objective to maintain uniform flow The weight of the exhaust system increases with increasing nozzle aspect ratio. The new design is to provide enhanced maneuvering and STOL performance. It is attempted to reduce the increase in weight as much as possible by new design strategies. The present paper has the objective to show through experimental data that the current design guidelines for transition ducts can be expanded so that shorter transitions are possible thereby reducing the nonaxisymmetric exhaust system weight penalty. G.R.

A85-39740#

STALL TRANSIENTS OF AXIAL COMPRESSION SYSTEMS WITH INLET DISTORTION

F. K MOORE (Cornell University, Ithaca, NY) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 13 p. refs
(AIAA PAPER 85-1348)

A previously-derived system of differential equations, based on fluid mechanics, are extended to provide a theory to predict how rotating stall or surge will develop in an axial compression system under combined influences of inlet distortion and throttle ramping. Results are relevant to the problem of stagnation stall or gas turbines It is found that stall margin is improved by large aerodynamic lag in the compressor. Both stall and recovery transients are considered. A distinction between axisymmetric and in-rotating-stall compressor performance characteristics leads to a concept of rotating-stall stability that explains the appearance of classic stall at low stage loading and the hysteresis associated with rotating stall. The influences of various system parameters are systematically explored, and it is found that large B parameter, tall compressor characteristic diagram, and rapid throttle closure all favor surge, while large distortion and small shut-off head relative to peak pressure rise both favor rotating stall When surge occurs, rotating stall is usually also present. Author

A85-39741#

AXIAL-FLOW COMPRESSOR STAGE POST-STALL ANALYSIS

W. T. COUSINS (Garrett Turbine Engine Co., Phoenix, AZ) and W. F. OBRIEN (Virginia Polytechnic Institute and State University, Blacksburg, VA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 9 p. USAF-supported research. refs
(AIAA PAPER 85-1349)

Rotating stall in a compressor stage is simulated by the numerical solution of a fluid dynamic model of an inlet guide vane and rotor row. The mathematical formulation of the model is described. Solutions for the flow upstream and downstream of the modeled stage are obtained for normal unstalled operation and for a simulation of stable rotating stall. Examples of the predicted velocity and pressure fields are shown, and conclusions are developed regarding recovery from rotating stall. The influence of the rotor row loss coefficient curve and other blade row design variables on model predictions are studied. Author

A85-39766#

PNS PREDICTED SHOCK LOCATION AND JUMP CONDITIONS AT SUPERSONIC AND HYPERSONIC SPEEDS

D. W. MAYER and J. Y. BALTAR (Boeing Military Airplane Co., Seattle, WA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p. refs
(AIAA PAPER 85-1407)

Progress has been made toward preparing a parabolized Navier-Stokes (PNS) code to support design of supersonic and hypersonic vehicles. Code preparation work includes both development and testing of the code, and as part of this, a study on the effects of mesh resolution and smoothing on solution accuracy was completed. This paper reports on these effects and discusses the implications of using PNS methods for propulsion system analysis. In particular, the ability of the code to accurately predict induced shock and boundary layer characteristics has been tested. Important findings are: (1) PNS codes can accurately predict induced shocks for inviscid flow, (2) induced shock locations predicted for viscous flow are qualitatively correct, and (3) turbulent boundary layer development can be accurately predicted in the supersonic and low hypersonic speed regimes. At present, code stability becomes an increasing problem above Mach 8. Additional modifications to the differencing scheme and energy equation formulation are planned to facilitate the use of the PNS code in the hypersonic speed regime. Author

A85-39767*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CALCULATION OF THREE-DIMENSIONAL, VISCOUS FLOW THROUGH TURBOMACHINERY BLADE PASSAGES BY PARABOLIC MARCHING

T. KATSANIS (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 14 p. Previously announced in STAR as N85-23711. refs
(AIAA PAPER 85-1408)

The three-dimensional compressible Navier-Stokes equations are formulated in a rotating coordinate system, so as to include centrifugal and Coriolis forces The equations are parabolized by using a previously calculated inviscid static pressure field. The thin layer Navier-Stokes approximation, which neglects streamwise diffusion, is used. A body-fitted coordinate system is used The streamwise momentum equation is uncoupled from the cross-stream momentum equation by using contravariant momentum components, and then using the contravariant velocity components as primary unknowns. To reduce problems with small separating regions, the Reyhner and Flugge-Lotz approximation is used. The energy equation is included to allow for calculation of heat transfer. The flow may be laminar, or a simple eddy-viscosity turbulence may be used. A number of curved ducts and an axial stator were analyzed, including cases for which experimental data are available. Author

A85-39768*# United Technologies Research Center, East Hartford, Conn.

NUMERICAL INVESTIGATION OF INTERNAL HIGH-SPEED VISCOUS FLOWS USING A PARABOLIC TECHNIQUE

O. L. ANDERSON and G. D. POWER (United Technologies Research Center, East Hartford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p. refs
(Contract NAS1-17561)
(AIAA PAPER 85-1409)

A feasibility study has been conducted to assess the applicability of an existing parabolic analysis (ADD-Axisymmetric Diffuser Duct), developed previously for subsonic viscous internal flows, to mixed supersonic/subsonic flows with heat addition simulating a SCRAMJET combustor. A study was conducted with the ADD code modified to include additional convection effects in the normal momentum equation when supersonic expansion and compression waves are present. A set of test problems with weak shock and expansion waves have been analyzed with this modified ADD method and stable and accurate solutions were demonstrated provided the streamwise step size was maintained at levels larger than the boundary layer displacement thickness. Calculations made with further reductions in step size encountered departure solutions consistent with strong interaction theory. Calculations were also performed for a flow field with a flame front in which a specific heat release was imposed to simulate a SCRAMJET combustor. In this case the flame front generated relatively thick shear layers which aggravated the departure solution problem. Qualitatively correct results were obtained for these cases using a marching technique with the convective terms in the normal momentum equation suppressed. It is concluded from the present study that for the class of problems where strong viscous/inviscid interactions are present a global iteration procedure is required. Author

A85-39779#

A FURTHER ASSESSMENT OF NUMERICAL ANNULAR DUMP DIFFUSER FLOW CALCULATIONS

W. SHYY (GE Research and Development Center, Schenectady, NY) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 8 p. refs

(AIAA PAPER 85-1440)

A further study has been conducted for a model dump diffuser. The results obtained from several flow calculations using the standard k-epsilon turbulence model on two levels of grid distribution are presented. It is found that a coarser grid distribution may yield a better agreement between the numerical prediction and the experimental data. Also, a lower order finite difference scheme may produce a more favorable theory-data comparison than the higher order ones. The findings suggest that the standard k-epsilon two-equation turbulence model is inadequate for predicting the detailed features of the flow studied here. The zonal grid approach, which divides the whole flow domain into several subregions and generates the grid system in each subregion according to its own need, is also much needed. Both the physical modeling and the numerical grid generation needs require extensive research effort. However, it appears that the essential qualitative flow characteristics were present in the numerical simulation; hence, the present model should be useful for studying the global behavior of the flow field. Author

A85-39792#

A SIMULATION TECHNIQUE FOR JET TEMPERATURE EFFECTS ON NOZZLE-AFTERBODY DRAG AT TRANSONIC MACH NUMBERS

W. L. PETERS (Calspan Corp., Arnold Engineering Development Center, Arnold Air Force Station, TN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 11 p. refs

(AIAA PAPER 85-1463)

The objective of this investigation was to implement and demonstrate the performance of a technique for correcting nozzle/afterbody drag coefficient for jet temperature effects at transonic free-stream Mach numbers. The technique corrects axisymmetric nozzle afterbody drag coefficient for jet-temperature-related effects associated with inviscid jet plume shape and with jet mixing or entrainment Data were utilized from experiments conducted in the AEDC 1-ft and 16-ft transonic wind tunnels with two strut-mounted axisymmetric models incorporating a 15-deg afterbody boattail angle. The correction technique predicts jet temperature effects on afterbody drag coefficient (based on body diameter) within 50 drag counts at subsonic free-stream Mach numbers and 100 drag counts at supersonic free-stream Mach numbers. Author

A85-39793*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

RESULTS OF AGARD ASSESSMENT OF PREDICTION CAPABILITIES FOR NOZZLE AFTERBODY FLOWS

L. E. PUTNAM (NASA, Langley Research Center, Transonic Aerodynamics Div., Hampton, VA) and N. C BISSINGER (Messerschmitt Boelkow Blohm GmbH, Muenich, West Germany) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 13 p refs

(AIAA PAPER 85-1464)

This paper presents a brief review of an assessment conducted by AGARD Working Group 08 to determine the capabilities of theoretical methods for predicting the flow over nozzle afterbody configurations. A series of test cases were selected for which extensive experimental data were available. The assessment was limited to axisymmetric nozzle configurations with a jet simulated with high-pressure air. Contributions were solicited from researchers, identified by a literature search, who had developed methods for predicting such flows. Predictions made with methods that varied in complexity from multicomponent techniques to solutions of the Navier Stokes equations were received. The status of the theoretical methods for predicting nozzle afterbody flows is illustrated by comparison with the experimental measurements. Author

A85-39874#

TWO-DIMENSIONAL TURBULENT FLOW ANALYSIS IN TURBOMACHINERY BY THE FINITE ELEMENT METHOD

M. IKEGAWA, S. NAKANO, and Y SHIKANO (Hitachi, Ltd., Mechanical Engineering Research Laboratory, Tsuchiura, Ibaraki, Japan) American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec. 9-14, 1984. 7 p. refs

(ASME PAPER 84-WA/FM-2)

A new finite element technique based on the two equation turbulence model and combined with a body-fitted curvilinear coordinate system is presented for analyzing two-dimensional turbulent flow in turbomachinery. The governing equations are integrated within a small control volume to produce conservation law forms for the unknown variables. The finite element technique is applied to these equations, where quadrilateral elements with four nodes are used for its formulation Resulting sets of algebraic equations are solved by the use of a relaxation method It is shown that the present method gives encouraging results for turbulent flow analysis and provides an effective tool for estimating the performance of turbomachinery. Author

A85-39875#

AN INVESTIGATION OF LIFT AUGMENTATION OF TANDEM CASCADES

R. R. MANKBADI (Rutgers University, New Brunswick, NJ) American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec. 9-14, 1984. 7 p. refs

(ASME PAPER 84-WA/FM-3)

The role of the relative layout of tanndem cascades on the effective lift is considered. The metod of singularity is used to predict the effective life coefficient of two or three cascades of geometrically identical blades of different lengths placed relative to each other In the case of a double cascade system with one set of blades shorter than the other, a considerable enhancement in life is obtained as the short blades are placed at the middle of the long ones. In the case of a three-element cascade system, an increase of as much as 32 percent in the effective lift is obtained at ideal incidence conditions This lift augmentation was found to be basically due to optimizing the blade interference effect with no apparent increase in losses. Author

A85-39876#
FLOWFIELD AND PERFORMANCE MEASUREMENTS IN A VANED RADIAL DIFFUSER
P. PIEMSOMBOON, J C. DUTTON, and P. E JENKINS (Texas A&M University, College Station, TX) American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec 9-14, 1984. 6 p Research supported by the Texas A&M University refs
(ASME PAPER 84-WA/FM-7)
The flow characteristics of a vaned radial diffuser typical of those currently used in centrifugal compressors have been determined experimentally by using a static diffuser test rig. The vortex test vehicle (VTV) portion of this rig was used to simulate the essential features of the flow leaving the impeller of an actual compressor. The mean flow phenomena at the diffuser entrance and the static pressure recovery along the diffuser passage have been determined. In addition, the flow angle and Mach number distributions at several key locations throughout the diffuser channel have been obtained. The most notable feature of the diffuser flowfield is the degree of nonuniformity in the inlet/leading edge region. Author

N85-27822*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SUPERSONIC AERODYNAMIC CHARACTERISTICS OF CANARD, TAILLESS, AND AFT-TAIL CONFIGURATIONS FOR 2 WING PLANFORMS
P F. COVELL Jun. 1985 69 p refs
(NASA-TP-2434; L-15927; NAS 1.60:2434) Avail NTIS HC A04/MF A01 CSCL 01A
Aerodynamic characteristics of canard, tailless, and aft tail configurations were compared in tests on a general research model (generic fuselage without canopy, inlets, or vertical tails) at Mach 1.60 and 2.00 in the Langley Unitary Plan Wind Tunnel. Two uncambered wing planforms (trapezoidal with 44 deg leading edge sweep and delta with 60 deg leading edge sweep) were tested for each configuration. The relative merits of the configurations were also determined theoretically, to evaluate the capabilities of a linear theory code for such analyses. The canard and aft tail configurations have similar measured values for lift curve slope, maximum lift drag ratio, and zero lift drag. The stability decrease as Mach number increases is greatest for the tailless configuration and least for the canard configuration Because of very limited accuracy in predicting the aerodynamic parameter increments between configurations, the linear theory code is not adequate for determining the relative merits of canard, tailless, and aft tail configurations. Author

N85-27823*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STATIC AND DYNAMIC PRESSURE MEASUREMENTS ON A NACA 0012 AIRFOIL IN THE AMES HIGH REYNOLDS NUMBER FACILITY
J. B MCDEVITT and A. F. OKUNO Jun. 1985 78 p refs
(NASA-TP-2485; A-85100; NAS 1.60:2485) Avail: NTIS HC A05/MF A01 CSCL 02A
The supercritical flows at high subsonic speeds over a NACA 0012 airfoil were studied to acquire aerodynamic data suitable for evaluating numerical-flow codes. The measurements consisted primarily of static and dynamic pressures on the airfoil and test-channel walls. Shadowgraphs were also taken of the flow field near the airfoil The tests were performed at free-stream Mach numbers from approximately 0.7 to 0.8, at angles of attack sufficient to include the onset of buffet, and at Reynolds numbers from 1 million to 14 million. A test action was designed specifically to obtain two-dimensional airfoil data with a minimum of wall interference effects. Boundary-layer suction panels were used to minimize sidewall interference effects. Flexible upper and lower walls allow test-channel area-ruling to nullify Mach number changes induced by the mass removal, to correct for longitudinal boundary-layer growth, and to provide contouring compatible with the streamlines of the model in free air. E.A.K.

N85-27824*# Scientific Research Associates, Inc., Glastonbury, Conn
USERS MANUAL FOR COORDINATE GENERATION CODE CRDSRA
S. J SHAMROTH Jun. 1985 17 p refs
(Contract NAS1-15214)
(NASA-CR-172584, NAS 1.26:172584) Avail. NTIS HC A02/MF A01 CSCL 01A
Generation of a viable coordinate system represents an important component of an isolated airfoil Navier-Stokes calculation. The manual describes a computer code for generation of such a coordinate system. The coordinate system is a general nonorthogonal one in which high resolution normal to the airfoil is obtained in the vicinity of the airfoil surface, and high resolution along the airfoil surface is obtained in the vicinity of the airfoil leading edge. The method of generation is a constructive technique which leads to a C type coordinate grid. The method of construction as well as input and output definitions are contained herein. The computer code itself as well as a sample output is being submitted to COSMIC. Author

N85-27825*# Scientific Research Associates, Inc., Glastonbury, Conn.
USER'S MANUAL FOR AIRFOIL FLOW FIELD COMPUTER CODE SRAIR
S. J. SHAMROTH Jun. 1985 60 p refs
(Contract NAS1-15214)
(NASA-CR-172585; NAS 1.26:172585) Avail: NTIS HC A04/MF A01 CSCL 01A
A two dimensional unsteady Navier-Stokes calculation procedure with specific application to the isolated airfoil problem is presented. The procedure solves the full, ensemble averaged Navier-Stokes equations with turbulence represented by a mixing length model. The equations are solved in a general nonorthogonal coordinate system which is obtained via an external source. Specific Cartesian locations of grid points are required as input for this code. The method of solution is based upon the Briley-McDonald LBI procedure. The manual discusses the analysis, flow of the program, control steam, input and output Author

N85-27826# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
SOME EFFECTS OF SWEEP DIRECTION AND STRAKES FOR WINGS WITH SHARP LEADING EDGES
D. I. A POLL and C. H QIU (Peking Inst. of Aeronautics and Astronautics) May 1984 33 p refs
(CA-8421; ISBN-0-947767-088) Avail: NTIS HC A03/MF A01
An experimental investigation has been carried out to compare the effects of sweep direction upon the aerodynamic characteristics of three wing planforms, each with sharp leading edges The wings have biconvex aerofoil sections which allow them to be tested in both the forward-swept and backward-swept configurations without changing the section profile. Measurements of lift, drag and pitching moment have been made for angles of incidence in the range -5 deg to +50 deg at a mean chord Reynolds number of approximately 1 5 x 10 to the 5th power and Mach number of 0.1 To complement the force and moment data a comprehensive series of oil-flow visualizations are also presented. In addition the aerodynamic characteristics of simple strakes (wing root fillets) have been studied for both the swept-forward and swept-back configurations Author

N85-27827# Cranfield Inst. of Tech., Bedford (England) Aerodynamics Div.
ON THE EFFECT OF WING TAPER AND SWEEP DIRECTION ON LEADING EDGE TRANSITION
D. I. A. POLL and D. J. PAISLEY Dec. 1984 25 p refs
(CA-8435; ISBN-0-947767-096) Avail NTIS HC A02/MF A01
An experimental study has been made of the conditions necessary to produce transition in a swept attachment-line boundary layer which is subjected to disturbances from trip wires of various sizes The boundary layer considered is that formed on a long tapered cylinder which has been tested in both the backward

swept and forward swept configurations. Results from these tests are compared with previous work on an untapered model. Some important similarities and some puzzling differences have been found. Finally, consideration is given to the practical implications of this work. It is suggested that a forward swept wing may be capable of supporting a laminar attachment-line flow at a much higher free-stream Reynolds number than a corresponding swept back wing. Author

N85-27828*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
NUMERICAL STUDY OF POROUS AIRFOILS IN TRANSONIC FLOW
C. L. CHEN (Colorado Univ., Boulder), C. Y. CHOW (Colorado Univ., Boulder), T L HOLST, and W R. VANDALSEM May 1985 23 p refs
(NASA-TM-86713, REPT-85209, NAS 1 15.86713) Avail· NTIS HC A02/MF A01 CSCL 01A
A numerical study was made to examine the effect of a porous surface on the aerodynamic performance of a transonic airfoil. The pressure jump across the normal shock wave on the upper surface of the airfoil was reduced by making the surface below the shock porous. The weakened shock is preceded by an oblique shock at the upstream end of the porous surface where air is blown out of the cavity. The lambda shock structure shown in the numerical result qualitatively agrees with that observed in the wind tunnel. According to the present analysis, the porous airfoil has a smaller drag and a higher lift than the solid airfoil. Author

N85-27829# National Aeronautical Establishment, Ottawa (Ontario).
AN INTRODUCTION TO VORTEX BREAKDOWN AND VORTEX CORE BURSTING
J L HALL Mar 1985 29 p refs
(NAE-AN-28; NRC-24336; AD-A155324) Avail: NTIS HC A03/MF A01
The phenomenon of vortex breakdown, also known as vortex core bursting is introduced. The first part of the report presents some important elements of basic vortex theory The second part reviews the research that was done on vortex breakdown. An overview of the historical development of vortex breakdown research and a summary of the current state of knowledge on the subject are also included. Author

N85-27830# National Aeronautical Establishment, Ottawa (Ontario). Low Speed Aerodynamics Lab.
WING TUNNEL INVESTIGATION OF DYNAMIC STALL OF AN NACA 0018 AIRFOIL OSCILLATING IN PITCH
R. H. WICKENS Feb 1985 71 p refs
(NAE-AN-27; NRC-24262; AD-A154717) Avail: NTIS HC A04/MF A01
This report presents aerodynamic data on an NACA 0018 airfoil oscillating in pitch in the NAE 2m X 3m Low Speed Tunnel. The purpose of the test was to simulate the dynamic aerodynamic behavior of a Vertical Axis Wind Turbine blade section at the equatorial plane under the dynamic stall conditions which may occur at low ratios of tip speed to wind speed. Measurements were made of wing surface pressure time histories at various chordwise locations, during a complete cycle of oscillation. The dynamic effects on nose suction pressures were seen to increase their magnitude and to delay flow breakdown to a higher angle of attack. Integration of wing pressures furnished normal and chordwise forces during the angle of attack cycle. The behavior of these parameters showed that dynamic stall for wing angles of attack up to 30 degrees, occurred about 5 degrees later than for the equivalent steady flow case. This phenomenon resulted in an increase in normal force of about 20% and an increase in chordwise force of about 40% when the wing is pitching to 30 degrees. Author

N85-27831# Naval Postgraduate School, Monterey, Calif.
A METHOD TO CALCULATE THE PARAMETERS OF WINGS OF ARBITRARY PLANFORM M.S. Thesis
E. M. BARBER Dec. 1984 42 p
(AD-A152689) Avail: NTIS HC A03/MF A01 CSCL 20D
The computation method developed in this thesis proceeds from the theory developed by Jones (Ref. 1) His final equations are first rewritten in matrix format They are then organized into computational sequences that must be translated into computer programming language to calculate the aerodynamic parameters of wings of arbitrary planform. GRA

N85-27832# Air Force Inst. of Tech, Wright-Patterson AFB, Ohio. School of Engineering.
AERODYNAMIC PERFORMANCE OF A WING IN GROUND EFFECT USING THE PANAIR PROGRAM M.S. Thesis
A. R GOETZ Dec 1984 68 p
(AD-A153303; AFIT/GAE/AA/84D-7) Avail: NTIS HC A04/MF A01 CSCL 20D
The primary objective of this thesis is to correlate computed theoretical data with experimental data for wings in ground effect. This investigation uses the PANAIR computer program--a higher-order panel method to predict the lift and drag characteristics of an aspect ratio two wing, with and without endplates, operating at low speed in ground effect. The effects of altitude, trailing edge flap deflection and angle of attack are considered. Numerical results are compared with subsonic wind tunnel experimental data For both the numerical and experimental methods, the image model technique is used to simulate ground effect. Excellent agreement between numerical results and experimental data is achieved for the wing without endplates down to low (approximately 10% of wing chord) altitudes For the wing with endplates, numerical results are in good agreement with experimental data for altitudes greater than approximately 20% of the wing chord. PANAIR results diverged from experimental data at lower altitudes because the model did not attempt to account for spanwise flow between the bottom of the endplate and the ground, and other viscous effects which tend to become dominant These include a static pressure increase beneath the wing and wake distortions behind the configuration. GRA

N85-27833# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abt. Zellenaerodynamik.
DESIGN OF A BASIC PROFILE FOR A LOW SWEEP AIRFOIL. PART 2: EXPERIMENTAL INVESTIGATION ON THE DFVLR-W1 AIRFOIL PROFILE IN THE BRUNSWICK TRANSONIC WIND TUNNEL
G WICHMANN 1985 62 p refs In GERMAN, ENGLISH summary Report will also be announced as translation (ESA-TT-917)
(DFVLR-FB-85-01-PT-2; ISSN-0171-1342) Avail NTIS HC A04/MF A01, DFVLR, Cologne DM 19.50
The airfoil DFVLR-W1 was investigated in a transonic wind tunnel at free transition in the Mach number range between 0.5 and 0.81, at a Reynolds number 6 million. The influence of different locations of transition fixing was investigated. Results are presented as aerodynamic coefficients, airfoil performance boundaries, and pressure distributions. It is shown that the design requirements are met by the airfoil. A comparison with theoretical results indicates the applicability of the computer codes used in the design process. Author (ESA)

N85-27834# Technische Hogeschool, Delft (Netherlands) Dept. of Mathematics and Informatics
UPWIND-DIFFERENCE METHODS FOR AERODYNAMIC PROBLEMS GOVERNED BY THE EULER EQUATIONS
B VANLEER 1984 18 p refs Presented at 15th AMS/SIAM Summer Seminar on Large-Scale Computations in Fluid Mech., La Jolla, Calif, 27 Jun - 8 Jul. 1983
(REPT-84-23) Avail: NTIS HC A02/MF A01
Upwind-difference schemes for the solution of the steady Euler equations are interpreted as projection-evolution schemes, with a

numerical stage (interpolation of discrete initial values) and a physical stage (computation of fluxes). The schemes are compared with a central-difference scheme, stabilized by explicit dissipation. Upwind schemes are more robust, but take longer. Author (ESA)

N85-27835# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
TRANSONIC MACH NUMBER DETERMINATION IN A BLOW-DOWN WIND TUNNEL WITH SOLID WALLS AND A DOWNSTREAM THROAT
W. J. BANNINK and P. G. BAKKER Oct. 1983 34 p
(VTH-LR-402) Avail: NTIS HC A03/MF A01

Calibration measurements of the transonic flow in a wind tunnel (test section: 28 cm x 25 3 cm) with solid walls are described. Along the tunnel center line the static pressure distribution was measured, with and without a model in the test section. Using the static pressure distributions, the distribution of the ratio of the effective sonic cross-sectional area was determined. Far upstream of the model (14 chord lengths) the ratio is constant, meaning that no influence of the model is felt there. In that region reference positions in the tunnel side wall, where the pressures can be used to determine the free stream Mach number of the tunnel flow, were chosen. Author (ESA)

N85-27836# National Aerospace Lab., Amsterdam (Netherlands).
AERODYNAMIC RESEARCH IN PREPARATION FOR A NEW DUTCH TRANSPORT AIRCRAFT WITH SUPERCRITICAL WINGS
1983 13 p In DUTCH; ENGLISH summary Sponsored by Netherlands Agency for Aerospace Programs
(B8580077) Avail: NTIS HC A02/MF A01

An aerodynamic design procedure for a supercritical wing, based on the viewpoint that the pressure distribution determines its characteristics more then the geometry is developed. In the absence of a computer program for the calculation of three-dimensional transonic flow, a procedure is applied in which it is assumed that the difference between the transonic and the subsonic pressure distribution around a two-dimensional airfoil determines the same relation around the three dimensional wing. In order to limit the number of solutions, weight factors are applied in the calculations In an iterative process to find a geometry satisfying the geometrical constraint, a video terminal coupled to a CYBER-72 computer is utilized. Wind-tunnel experiments prove that the design procedure yields satisfactory results.
Author (ESA)

N85-27837# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Instationaere Aerodynamik.
ANALYSIS OF UNSTEADY PRESSURE MEASUREMENTS ON A SUPERCRITICAL AIRFOIL WITH A HARMONICALLY OSCILLATING TRAILING EDGE FLAP AT SUBSONIC AND TRANSONIC SPEEDS
H. S. MURTHY (National Aeronautical Lab., Bangalore, India) Jul 1984 79 p refs In GERMAN; ENGLISH summary Sponsored by German Academic Exchange Service (DAD)
(DFVLR-FB-84-49; ISSN-0171-1342) Avail: NTIS HC A05/MF A01; DFVLR, Cologne DM 26.50

Unsteady pressure distributions measured in a transonic wind tunnel on a supercritical airfoil of 13% maximum thickness with an oscillating trailing edge flap were analyzed. The influences of oscillation frequency, flap mean deflection, and incidence on the unsteady pressure distribution are discussed in the Mach number range of 0.3 to 0.85; the effects of the oscillation amplitude at M = 0.78 are also analyzed. Unsteady lift and moment coefficients obtained from unsteady pressure distributions are discussed.
Author (ESA)

N85-27838# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Inst fuer Theoretische Stroemungsmechanik.
METHODS FOR DESIGN AERODYNAMICS OF MODERN TRANSPORT AIRCRAFT
H. SOBIECZKY Dec. 1984 74 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-923)
(DFVLR-FB-85-05; ISSN-0171-1342) Avail: NTIS HC A04/MF A01, DFVLR, Cologne DM 23

A concept to obtain shock-free transonic flow for design aerodynamics of aircraft and turbomachinery is outlined. The method of elliptic continuation or method of fictitious gas represents a starting point for operational computational procedures to obtain supercritical airfoils and wings. Design examples illustrate the value of shock-free configurations for aerodynamic efficiency enhancement. The application of supercritical flow in aerodynamic concepts is mentioned. Author (ESA)

N85-28155# Joint Publications Research Service, Arlington, Va.
CHARACTERISTICS OF STEADY-STATE HYPERSONIC FLOW ABOUT BLUNTED BODIES WITH DISCONTINUITIES IN GENERATORS Abstract Only
V. D. SEROVA *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-85-004) p 80-81 15 May 1985 Transl. into ENGLISH from Vestn. Leningr. Univ.: Mat. Mekhan. Astron. (Leningrad), v. 13, no 3, Jun. 1984 p 80-85
Avail: NTIS HC A06/MF A01

The BVLR method is employed to calculate the multi-shock axisymmetrical problem of hypersonic flow. The processes occurring during axisymmetrical shock wave interactions are assessed qualitatively. Comparison of the pressure behavior as a function of the longitudinal coordinate at points on the surface of smooth and discontinuous cones indicate that even a small discontinuity results in a major qualitative and quantitative difference in the threshold distribution curves. Author

N85-28158# Joint Publications Research Service, Arlington, Va.
SUPERSONIC FLOW AROUND BLUNT WEDGE Abstract Only
S. V. MANUYLOVICH *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-85-004) p 82 15 May 1985 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Zhidkosti i Gaza (Moscow), no. 4, Jul. - Aug. 1984 p 137-140
Avail: NTIS HC A06/MF A01

Supersonic flow of a perfect gas around a semi-infinite body in the form of a plane wedge with blunt leading edge is analyzed. The problem is assumed to be asymptotic with respect tot he longitudinal coordinate and is solved by the method of asymptotic expansion. The gas is assumed to have a C sup p/ ratio independent of the temperature and its uniform unperturbed motion is assumed to satisfy the Euler equations. The oncoming stream is assumed to flow in the direction parallel to the plane of symmetry of the wedge and to split symmetrically along the faces of the latter Author

N85-28161# Joint Publications Research Service, Arlington, Va.
METHOD OF CALCULATING SEPARATION FLOW OF SUBSONIC GAS STREAM AROUND WINGS Abstract Only
S. M. BELOTSERKOVSKIY, V. N. KORZHNEV, and S. D. SHIPILOV *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-85-004) p 84 15 May 1985 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Zhidkosti i Gaza (Moscow), no. 4, Jul. - Aug. 1984 p 141-147
Avail: NTIS HC A06/MF A01

The nonlinear problem of steady subsonic flow of a gas around a wind was solved by discrete vortices for compressible fluids. The corresponding differential equation for the potential of perturbed velocities, with the boundary condition of an impermeable wing surface, is solved separately and differently for two regions. The velocity integrals for the semifinite corridor around the wing and containing the vortex trail are evaluated by a numerical iteration process, after the two subregions are subdivided into respectively finite and semi-infinitely long rectangular parallelepipeds. In the remaining space outside this region the potential of perturbed velocities is linearizable and, with the aid of a Prandlt-Glauert transformation, its differential equation is reduced to the Laplace equation in appropriate coordinates. The analytical solution for this region depends on the solution for the corridor. The method was validated on two test problems. A range of angles of attack which corresponds to stabilization of nosing vortex filaments are revealed. Two estimates are given for the critical angle of attack, namely a lower bound at which the iteration process ceases to converge relative to the aerodynamic load and an upper bound where the shape of the vortex sheet and the lift coefficient and the pitching moment coefficient begin to change from one iteration to the next. E.A K.

N85-28923*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

WIND-TUNNEL EVALUATION OF A 21-PERCENT-SCALE POWERED MODEL OF A PROTOTYPE ADVANCED SCOUT HELICOPTER

A. E. PHELPS, III and J. D. BERRY Washington NASA, Washington Jun. 1985 76 p refs Prepared in cooperation with Army Aviation Systems Command, St. Louis
(Contract DA PROJ. 1L1-62209-AH76)
(NASA-TP-2420; L-15895; NAS 1.60:2420; AVSCOM-TR-85-B-2) Avail NTIS HC A04/MF A01 CSCL 01A

An exploratory wind tunnel investigation of a 21 percent scale powered model of a prototype advanced scout helicopter was conducted in the Langley 4 by 7 Meter Tunnel The investigation was conducted to define the overall aerodynamic characteristics of the Army Helicopter Improvement Program (AHIP), to determine the effects of the rotor on the aerodynamic characteristics and to evaluate the effect of a mast mounted sight on the aircraft stability characteristics. Tests covered a range of thrust coefficients, advance ratios, angles of attack and angles of sideslip and were run for both rotor on and rotor off configurations. Results of the investigation showed that the prototype configuration was longitudinally unstable with angle of attack for all configurations tested. The instability was due to unfavorable interference effects between the horizontal tail and the wake shed from the engine pylon and rotor hub, which caused a loss of horizontal tail effectiveness. The addition of the mast mounted sight had little effect on the stability of the model, but it caused an alteration in the rotor lift distribution that resulted in substantial interference drag for the sight. Author

N85-28924*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

STATIC INVESTIGATION OF SEVERAL YAW VECTORING CONCEPTS ON NONAXISYMMETRIC NOZZLES

M L. MASON and B. L. BERRIER Jun. 1985 219 p refs
(NASA-TP-2432; L-15890; NAS 1.60:2432) Avail: NTIS HC A10/MF A01 CSCL 01A

A test has been conducted in the static test facility of the Langley 16-Foot Transonic Tunnel to determine the flow-turning capability and the effects on nozzle internal performance of several yaw vectoring concepts. Nonaxisymmetric convergent-divergent nozzles with throat areas simulating dry and afterburning power settings and single expansion ramp nozzles with a throat area simulating a dry power setting were modified for yaw thrust vectoring. Forward-thrust and pitch-vectored nozzle configurations were tested with each yaw vectoring concept Four basic yaw vectoring concepts were investigated on the nonaxisymmetric convergent-divergent nozzles: (1) translating sidewall, (2) downstream (of throat) flaps, (3) upstream (of throat) port/flap; and (4) powered rudder. Selected combinations of the rudder with downstream flaps or upstream port/flap were also tested. A single yaw vectoring concept, post-exit flaps, was investigated on the single expansion ramp nozzles. All testing was conducted at static (no external flow) conditions and nozzle pressure ratios varied from 2.0 up to 10.0. Author

N85-28925# National Aerospace Lab., Tokyo (Japan).

A METHOD OF DETERMINING THE SUCTION VELOCITY FOR LAMINAR FLOW CONTROL OF TWO-DIMENSIONAL AIRFOIL IN INCOMPRESSIBLE FLOW

Y. ISHIDA 1984 23 p refs In JAPANESE; ENGLISH summary
(NAL-TR-845; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

A design method for laminar flow control of two-dimensional airfoils in incompressible flows is described. The method can be used for determining the suction velocity required to keep the boundary layer on an airfoil surface laminar to a given velocity required to keep the boundary layer on an airfoil surface laminar to a given chordwise distance under given design conditions. The design method consists of two parts. The first deals with the direct problem, i.e., the calculation of the boundary layer characteristics for any given suction velocity by a new integral method and the application of Michel's criterion of transition point to determine if the transition occurs or not. The second part deals with the inverse problem, i e., the calculation of the suction velocity for any given R sub theta the Reynolds number based on the momentum thickness, which satisfies Michel's criterion. The results of the second part are used as initial input data of the required suction velocity in the first part. The method has been applied to two airfoils, NASA GA(W)-1 and NACA 64A010, and good results have been obtained. Author

N85-28926# Vrije Universiteit, Brussels (Belgium). Dept of Fluid Mechanics.

TURBULENCE STRUCTURE IN THE BOUNDARY LAYERS OF AN OSCILLATING AIRFOIL Final Technical Report, Jan. - Dec. 1983

J D. RUYCK and C. HIRSCH Dec. 1983 91 p
(Contract DAJA45-83-C-0021; DA PROJ. 1T1-61102-BH-57)
(AD-A153631, VUB-STR-14) Avail: NTIS HC A05/MF A01 CSCL 20D

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

N85-28927# Air Force Armament Lab., Eglin AFB, Fla.

SUBSONIC AND TRANSONIC AERODYNAMICS OF A WRAPAROUND FIN CONFIGURATION

R. H. WHITE, R. S BUFF, W. H. HATHAWAY, and G. L. WINCHENBACH 15 Jan. 1985 12 p
(AD-A153646, AFATL-TR-85-22) Avail NTIS HC A02/MF A01 CSCL 20D

Subsonic and transonic aerodynamic data for a wraparound fin configuration are presented. Free-flight aeroballistic tests to obtain these data were conducted at atmospheric pressure and over a Mach number range of 0.6 to 1.35. The aerodynamic coefficients and derivatives presented in this paper were extracted from the position-attitude-time histories of the experimentally measured trajectories using nonlinear numerical integration data reduction routines. Results of this analysis indicate that a dynamic instability exists above Mach 1.0 and is related to an out-of-plane side moment which is dependent of the pitch angle. The stability boundaries associated with this side moment are mapped. Designers should consider this moment whenever wraparound fins are used GRA

N85-28928# Analytical Methods, Inc., Redmond, Wash.
A STUDY OF AERODYNAMIC CONTROL IN STALLED FLIGHT LEADING-EDGE VORTEX FORMATION ANALYSIS Final Report, Dec. 1981 - Aug. 1984
J. K. NATHMAN Wright-Patterson AFB, Ohio AFWAL Feb. 1985 69 p refs
(Contract F33615-81-C-3626)
(AD-A153758; AFWAL-TR-84-3090) Avail: NTIS HC A04/MF A01 CSCL 20D

This report describes the theory and application of VORSEP, a wake preprocessor for panel methods that use an iterative procedure to determine the position of strongly interacting vortex sheets. The estimation of the wake geometry is based on slender body theory with separation. An unsteady, two-dimensional airfoil program was automated with the addition of routines to interpolate cross-sectional geometry from arbitrary three-dimensional bodies, generate multi-core wakes and synthesize a three-dimensional wake structure. Leading-edge wakes for a delta, straked wing and double delta are constructed and used in VSAERO, a three-dimensional panel method. The wake structures compare reasonably well to experimentally observed vortex core positions, while calculated pressures on the wings with the estimated wakes compare well near the nose but less well near the trailing edge. GRA

N85-28929# Naval Postgraduate School, Monterey, Calif.
A COMPUTATIONAL METHOD FOR WINGS OF ARBITRARY PLANFORM M.S. Thesis
C. S. JONES Dec. 1984 66 p
(AD-A153788) Avail: NTIS HC A04/MF A01 CSCL 20D

The computational method developed in this thesis permits the calculation of the aerodynamic performance of a wing of arbitrary planform. Both basic and additional lift are analyzed. This treatise is restricted to thin wings in steady, inviscid, incompressible flow. The method uses a grid system of control points over the wing semi-span. The circulation over the wing is considered variable with discrete values at the specified grid points. Finite difference equations are used to determine these discrete values. Control point indeterminacies are evaluated analytically. Matrix inversion is required for solution by the method presented A brief summary of the principal computational relations is included No numerical results are yet available but are expected during the next phase of this research. GRA

N85-28930# Analytical Methods, Inc., Redmond, Wash.
A STUDY OF AERODYNAMIC CONTROL IN STALLED FLIGHT LONG LAMINAR SEPARATION BUBBLE ANALYSIS Final Report, Dec. 1981 - Aug. 1984
F. A. DVORAK and D. H. CHOI Wright-Patterson AFB, Ohio AFWAL Feb. 1985 35 p refs
(Contract F33615-81-C-3626)
(AD-A153850; AFWAL-TR-84-3091) Avail: NTIS HC A03/MF A01 CSCL 20D

This report describes an analysis method for laminar separation bubbles (long or short) on two-dimensional airfoil sections at incidence A viscous/potential flow iterative procedure was chosen due to its simple and efficient nature. The boundary layer procedure is a finite-difference method, sometimes referred to as the Bosx Scheme, and uses the Cebeci-Smith two-layer, eddy viscosity model for turbulence closure. The potential flow is calculated in such a way that it gives constant pressure along the surface inside the bubble, The coupled calculation procedure has been applied to the NACA 64A006 airfoil and satisfactory results have been obtained. GRA

03

AIR TRANSPORTATION AND SAFETY

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

A85-37489
NUMERICAL SOLUTION OF THE MINIMUM-TIME FLIGHT OF A GLIDER THROUGH A THERMAL BY USE OF MULTIPLE SHOOTING METHODS
J. LORENZ (Fraunhofer-Institut fuer Festkoerpertechnologie, Munich, West Germany) Optimal Control Applications and Methods (ISSN 0143-2087), vol. 6, Apr.-June 1985, p. 125-140. refs

The problem of the time-optimal flight of a glider through a given thermal is treated with the calculus of variations. The resulting two-point boundary value problem is solved using the multiple shooting method. Solutions are obtained for various parameter values. For special values of these parameters, a branching of the solutions is observed. Additional solutions are obtained for which the control variable and the normal load factor are constrained by their maximum allowed values. Author

A85-37540
PROTECTION OF MATERIALS AND TECHNICAL EQUIPMENT AGAINST BIRDS [ZASHCHITA MATERIALOV I TEKHNICHESKIKH USTROISTV OT PTITS]
V. D. ILICHEV, ED (Akademiia Nauk SSSR, Nauchnyi Sovet po Biopovrezhdeniiam, USSR) Moscow, Izdatel'stvo Nauka, 1984, 240 p In Russian For individual items see A85-37541 to A85-37544.

Consideration is given to the forecasting of seasonal bird migrations in order to reduce the number of collisions between bird flocks and aircraft. Radar techniques to observe and track migrating bird flocks are described, and some practical techniques to reduce bird populations near airports are recommended. Particular attention is given to the use of chemical, acoustic, and optical repellants. I H.

A85-37541
CHEMICAL PREPARATIONS FOR PROTECTING AIRCRAFT AGAINST BIRDS [KHIMICHESKIE SREDSTVA ZASHCHITY LETATEL'NYKH APPARATOV OT PTITS]
B V. BOCHAROV IN: Protection of materials and technical equipment against birds Moscow, Izdatel'stvo Nauka, 1984, p. 72-81. In Russian refs

The use of chemical preparations to reduce the incidence of collisions between bird flocks and aircraft near airports is discussed. Consideration is given to a number of candidate compounds currently being tested in the Soviet Union and the West, including avitrol-100; alpha-chlorasol; and cholesterine derivatives. The possible ecological hazards involved in the large scale use of pesticides for bird repellant applications are described, and the possibility of developing an olfactory repellant which would be harmless to small mammals and man is considered I.H.

A85-37542
THE STUDY OF BIRD MIGRATION OVER A WATER AREA IN THE NORTHWESTERN PORTION OF THE BLACK SEA AND ADJACENT AREAS IN ORDER TO PREVENT BIRD-AIRCRAFT COLLISIONS [IZUCHENIE MIGRATSII PTITS NAD AKVATORIEI SEVERO-ZAPADNOI CHASTI CHERNOGO MORIA I SOPREDEL'NYKH TERRITORII S TSEL'IU PREDUPREZHDENIIA STOLKNOVENII IKH S SAMOLETAMI]
A. I. KORZIUKOV IN: Protection of materials and technical equipment against birds . Moscow, Izdatel'stvo Nauka, 1984, p 139-143. In Russian. refs

A85-37543

THE EFFECTIVENESS OF ACOUSTIC REPELLANTS IN FRIGHTENING BIRDS AWAY FROM AIRPORTS [EFFEKTIVNOST' AKUSTICHESKIKH REPELLENTOV PRI OTPUGIVANII PTITS V USLOVIIAKH AERODROMOV]

V. S SHEVIAKOV and A. V. TIKHONOV IN: Protection of materials and technical equipment against birds . Moscow, Izdatel'stvo Nauka, 1984, p. 176-188. In Russian. refs

The results of a Soviet program to investigate the possibility of repelling birds from airports by means of acoustic devices are reported. The devices examined in the program consisted of an amplifier, a microphone, and a cassette tape recorder The audible range of the devices (for humans) was 25-150 meters. Data are given for the effectiveness of different frequencies, power levels and device orientations in relation to the observed behavioral patterns of seagulls, doves, and starlings. Optimum pulse durations and frequencies are given in a table. I.H.

A85-37544

OBSERVATION OF BIRDS IN THE FLIGHT PATH OF AIRCRAFT - AN IMPORTANT STAGE IN THE PREVENTION OF BIRD STRIKES [OBNARUZHENIE PTITS NA PUTI SAMOLETOV - VAZHNYI ETAP PREDUPREZHDENIIA KONFLIKTNYKH SITUATSII]

V. E. IAKOBI IN: Protection of materials and technical equipment against birds Moscow, Izdatel'stvo Nauka, 1984, p. 189-199. In Russian. refs

It is shown that radar tracking of bird flocks can be an important factor in preventing collisions with aircraft near airports, or when aircraft visibility conditions are poor. The compilation of maps showing bird hazard areas in different seasons of the year is discussed, and some examples of bird hazard alert systems currently in use at airports in Belgium, Holland, West Germany, and the USSR are described. The methods used by the main airport of Talinn, Estonia to frighten birds away from aircraft runways during peak traffic hours are also discussed I.H

A85-37693

EXAMINATION OF FIRE SAFETY OF COMMERCIAL AIRCRAFT CABINS

W. L JOHNSTON and P. T. CAHALANE (Texas A & M University, College Station, TX) SAFE Journal, vol 15, Summer 1985, p 4-9 refs

Recommendations for raising the existing levels of aircraft cabin fire safety are presented which are based on safety analyses, research of published documents on the subject, and opinions of various aviation safety experts. The recommendations include setting standards for smoke or fire detectors in lavatories and requirements for installations on transports; installation of automatic thermal discharge-type fire extinguishers to sense and extinguish fires in and adjacent to lavatory waste receptacles, requiring protective breathing equipment, including smoke goggles, that meet new minimum performance standards; and rulemaking on fire-blocking materials and cabin emergency lighting. V.L.

A85-38304

STRATOSPHERIC FLIGHTS WITH LARGE POLYETHYLENE BALLOONS FROM EQUATORIAL LATITUDES

R. T. REDKAR (Tata Institute of Fundamental Research, Hyderabad, India) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol 5, no. 1, 1985, p. 13-16. refs

Starting with average 50 percent success for stratospheric balloon flights during 1959-1969 and attaining 100 percent success during 1972-1973, the success record dropped to 50 percent during 1974-1979 Through a critical analysis of 59 flights made from Hyderabad and 21 flights made from other equatorial bases, revised design criteria were proposed for balloons to be flown from equatorial latitudes, which were accepted by M/S Winzen International Inc. (WII), U.S.A. and have again raised the success record to 93 percent for 15 flights made since April 1980. A revised analysis for 71 flights made from 1965 to 1984 has been presented. Stratospheric circulation over Hyderabad indicating predominance of easterlies with mesospheric westerlies descending occasionally into stratosphere has been discussed. Author

A85-38307

LONG-DURATION FLIGHTS USING MIR (INFRARED BALLOON SYSTEM) [VOLS DE LONGUE DUREE SOUS MONTGOLFIERE INFRAROUGE MIR]

P MALATERE (Centre National d'Etudes Spatiales, Toulouse, France) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol 5, no. 1, 1985, p 23-26 In French

The scientific aspects of MIR, a long-duration balloon system are discussed. MIR is a hot air balloon which uses infrared radiation from the earth as a heat source and its volume of 36,000 cu m allows it to carry a payload of 50 kg. The results of various experimental flights involving measurements of stratospheric gravity waves in the Southern Hemisphere, are reported, and the balloon's performance is evaluated. Future applications of MIR are also considered. M.D

A85-38308

FIRST RESULTS OF A STRATOSPHERIC EXPERIMENT USING A MONTGOLFIERE INFRA-ROUGE (MIR)

J. P POMMEREAU, F DALAUDIER, J. BARAT, J. L. BERTAUX, F. GOUTAIL, and A. HAUCHECORNE (CNRS, Service d'Aeronomie, Verrieres-le-Buisson, Essonne, France) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no 1, 1985, p. 27-30. refs

An original stratospheric experiment performed in South Africa in December 1983 on board the new log-duration balloon system (MIR) developed by the Centre National d'Etudes Spatiales in France is described. The results of the experiment together with the performances reached in flight are presented It is shown that the thermal budget of MIR allows it to fly in the tropics even above the worst cloud conditions and that the balloon's CHACAL HF transmission system which consists of two receiving stations in South Africa and Brazil is adequate to cover the whole Southern Hemisphere if a third receiving station is set up in Australia. The measurements in flight show that temperatures lower than - 80 C can be observed in the tropics. M.D.

A85-38309* Wyoming Univ., Laramie.

THE UNIVERSITY OF WYOMING'S SMALL SCIENTIFIC BALLOON PROGRAM

D. J. HOFMANN, J. M ROSEN, N. T. KJOME, G L. OLSON, and D W MARTELL (Wyoming, University, Laramie, WY) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no. 1, 1985, p. 31-34 NASA-NSF-NOAA-Army-Navy-FAA-USAF-supported research. refs

Over 500 small scientific balloons have been launched by the University of Wyoming's Atmospheric Physics Group from 26 locations over the globe in a study of stratospheric aerosol physics and chemistry which began in 1971 These fllghs have led to a basic understanding of the evolution of sulfurous gases, injected into the stratosphere by major volcanic eruptions, into sulfuric acid aerosol droplets The recent use of new, thin film balloon technology, to reduce cost and simplify launch techniques, has been a major advantage to the program. Author

A85-38310

BALLOON SYSTEM AND BALLOON-BORNE EXPERIMENTS IN CHINA

Y.-D. GU (Chinese Academy of Sciences, Institute of High-Energy Physics, Beijing, People's Republic of China) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no 1, 1985, p. 35-38.

The Chinese scientific balloon project started in 1979, which consists of a 1500 sq m launching site complete with telecontrol, PCM and FM telemetry, and meteorological and communications equipment, is described. A series of 500 to 50,000 cu m zero-pressure natural-shape balloons which serve for scientific observations are found to have a maximum payload weight of 250 kg and a flight duration up to 18 hrs. Some properties of the balloons, as well as the typical static launching method, are discussed The balloon system is used to perform experiments on primary cosmic rays, high-energy nuclei-nuclei interactions, X-ray, gamma-ray, and infrared astronomy, atmospheric and space physics, and remote sensing. M.D.

A85-38311

DEVELOPMENT OF BALLOON-BORNE REEL-DOWN AND-UP WINCH SYSTEM

Y. MATSUZAKA, T. YAMAGAMI, J. NISHIMURA (Tokyo, University, Tokyo, Japan), and M D. YAMANAKA (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no 1, 1985, p. 41-44. refs

Balloon-borne winches, which can reel down and up scientific instruments repeatedly, have been developed since 1981 in order to observe stratospheric vertical microstructures The instrument is suspended by a kevler wire through a transverse-cum ropeguide, and its depth is accurately measured by counting numbers of spool rotations and ropeguide turns. Battery consumption is minimized by utilizing an efficient decelerator and a hysteresis brake. In 1983, a 12-kg payload was successfully reeled up and down through 1 km for three cycles at 24 km altitude. The capability of the winch is being improved, and in May 1984 a 22-kg payload was reeled down, up to 3 km from a balloon. Author

A85-38312* Harvard Univ., Cambridge, Mass.

A NEW REELING TECHNIQUE FOR VERY LONG EXTENSION SCANNING IN THE STRATOSPHERE

N. L. HAZEN and J. G. ANDERSON (Harvard University, Cambridge, MA) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no. 1, 1985, p. 45-48. NASA-supported research. refs

A balloon-borne winching system has been developed for extending a very long tether with payload down into the stratosphere and recovering it, this has been flight proven by being carried to an altitude of 40 km, lowering a 62-kg stratospheric photochemistry experiment 12 km at a descent velocity of about 6-8 m/sec and recovering it at comparable velocities. During the first flight, the data gave no evidence of dynamic instabilities due to the system or the stratospheric interactions. The future utility of this payload is discussed with attention to the design factors that bound the range of performance of this type of system. Author

A85-38315

ASSURING PAYLOAD SECURITY IN FLIGHT AND RECOVERY - DESIGN APPROACHES AND FLIGHT EXPERIENCE

N. L. HAZEN (Harvard University, Cambridge, MA) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no. 1, 1985, p. 57-60. refs

Maintaining the functional integrity of a scientific balloon payload must consider not only the landing shock, but also a number of other risks associated with launch, flight, landing, and recovery. In this paper, the major risks are described along with the design factors and approaches to protection represented in five payload examples ranging in mass from 60 kg to 1900 kg. Structural design for shock protection, packaging design, external protection and active development stow systems are considered, and effectiveness assessed in the light of over twenty flights and recoveries. Author

A85-38316

AN ALTERNATE APPROACH TO VERY LONG DURATION BALLOONING IN THE NORTHERN HEMISPHERE

D. R. J. BALL (National Scientific Balloon Facility, Palestine, TX) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol 5, no. 1, 1985, p. 61-64.

A plane to achieve balloon flights of 2 or more weeks in the northern hemisphere is outlined. The results of 21 separate simulations of this flight plan are presented and discussed. The simulations are based on rocketsonde wind observations which are compiled to arrive at a continuous time/altitude depiction of the wind regime over the flight path. Simulated flight durations vary from 3 to 31 days and exhibit a wide variety of trajectory types. Author

A85-38777#

NORTH WARNING SYSTEM AIRSHIP FEASIBILITY STUDY

W. S. MUELLER, R. E. ADAMS, D. B BAILEY (U.S Naval Material Command, Naval Air Development Center, Warminster, PA), and N. J. MAYER IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 1-6. (AIAA PAPER 85-0858)

A study was performed at the Naval Air Development Center to determine the feasibility of using nonrigid airships to transport maintenance teams to unmanned radar sites in northern Canada The investigation included a technology assessment of existing airships as well as a sizing study to determine airship volume and horsepower characteristics for logistics operations in an arctic environment. The results of this investigation show that airships uniquely satisfy the requirements of the arctic transport mission, however, developmental efforts, particularly in the areas of ground handling and payload transfer, are required to produce a viable airship transportation system Author

A85-38778#

TETHERED AEROSTAT OPERATIONS IN THE MARINE ENVIRONMENT

J. C. PERRY, R. VORTHMAN (U.S. Coast Guard, Washington, DC), and R. G. BURGIO (TCOM, Columbia, MD) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p 7-15. (AIAA PAPER 85-0860)

The present small, nonrigid aerostat, when tethered to a 194-ft U.S. Coast Guard vessel, constitutes an airborne radar platform which has been successfully used in surveillance for drug traffic interdiction. This system has lower operating costs than similarly equipped aircraft platforms, while furnishing surveillance coverage that is more extensive than that available from naval surface vessels. A two-month performance trial has demonstrated that the system can be effectively maintained at sea with a minimum of land-based support. O.C.

A85-38779#

HIGH ENDURANCE LIGHTER THAN AIR (HELTA) PROGRAM

J L. WEBSTER (U.S. Coast Guard, Office of Research and Development, Washington, DC) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers New York, American Institute of Aeronautics and Astronautics, 1985, p. 16-19. (AIAA PAPER 85-0861)

The U.S. Coast Guard's High Endurance Lighter-Than-Air (HELTA) program is based on the lease of an existing LTA vehicle of sufficient size and performance capabilities to perform a wide variety of representative mission scenarios for evaluation. The tasks to be evaluated encompass (1) coordinated operations with surface ships and aircraft; (2) command, control and communications functions; and (3) radar/IR sensor platform operations. Any future LTA vehicle will have to be larger and faster than existing types, however, and possess greater payload and endurance. The HELTA test program will help elucidate many questions concerning that future vehicle. O C.

A85-38785#
WHAT AN AIRSHIP MANUFACTURER FACES IN A CERTIFICATION PROGRAM TODAY
J H. PORTER and D. EVANS (Grace Aircraft Corp., Eugene, OR) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 58-62. refs
(AIAA PAPER 85-0870)

Certification requirements are noted to play a major role in the design, development and construction phases of new airships; an organization can accordingly expedite certification by anticipating FAA inspections' points of emphasis, as detailed by FAR 21's Advisory Circular AC 21.24-1. The certification requirements encompass airframe structural design, control systems, landing gear, personnel and cargo accommodations, fire protection, lightning protection, hull envelope construction, power-plant specifications, subsystems, and operating limitations. O.C.

A85-38792#
THRUST VECTORED TAKE-OFF, LANDING AND GROUND HANDLING OF AN AIRSHIP
B. L. NAGABHUSHAN and N. P. TOMLINSON (Goodyear Aerospace Corp., Defense Systems Div., Akron, OH) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 100-107. refs
(AIAA PAPER 85-0877)

Take-off, landing and ground level maneuverability characteristics of a modern airship having twin, vectorable thrustors were analyzed using an advanced airship flight simulation Effect of thrust tilting on tail clearance, angle of attack and ground distance were examined for several V/STOL modes in which the airship was light, heavy or in equilibrium. Significance of prevailing winds in these cases in improving the vehicle performance are illustrated. Airship response to control inputs and wind disturbances in near ground operations were simulated., It was found that ground plane excursions of the vehicle in the latter case could be reduced by selective use of thrust application rate and operator time lag. Consequences of thrust vectoring on the overall vehicle systems design and operation are discussed. Need for heading and altitude autopilots as well as a state of the art wind vector monitor at the pilot station are also presented. Author

A85-38793#
AN INVESTIGATION INTO THE HOVERING BEHAVIOUR OF THE LTA 20-1 AIRSHIP IN CALM AND TURBULENT AIR
J. D. LOWE (Toronto, University, Toronto, Canada) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 108-114. refs
(AIAA PAPER 85-0878)

A preliminary study has been made of the ability of the LTA 20-1 to hover in a turbulent environment close to the ground. It was found that translational velocity disturbances to the vehicle's state can easily be corrected with small displacements of the control devices. Author

N85-27839*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ICE SHAPES AND THE RESULTING DRAG INCREASE FOR A NACA 0012 AIRFOIL
W. OLSEN, R. SHAW, and J. NEWTON 12 Jan. 1984 31 p refs Presented at the 22nd Aerospace Sci. Meeting, Reno, Nev., 9-12 Jan. 1984; sponsored by AIAA
(NASA-TM-83556, E-1935; NAS 1.15:83556) Avail: NTIS HC A03/MF A01 CSCL 01C

Experimental measurements of the ice shapes and resulting drag increases were measured in the NASA-Lewis Icing Research Tunnel. The measurements were made over a large range of conditions (e.g., airspeed and temperature, drop size and liquid water content of the cloud, and the angle of attack of the airfoil). The measured drag increase did not agree with the existing correlation. Additional results were given which are helpful in understanding the ice structure and the way it forms, and in improving the ice accretion modeling theories. There are data on the ice surface roughness, on the effect of the ice shape on the local droplet catch, and on the relative importance of various parts of the ice shape on the drag increase. Experimental repeatability is also discussed. Auhor

N85-27840# Rotterdam Aviation Association (Netherlands).
ROTTERDAM AIRPORT AND THE COMMON MARKET
May 1984 32 p refs
Avail: NTIS HC A03/MF A01

The possibilities offered to airline companies to operate within the European Economic Community from Rotterdam airport, in light of Community directive 83/416/EEC, are presented. The routes must be within the Community, be at least 400 km long (except where natural barriers make air travel necessary), and use aircraft weighing 30 tons at takeoff, carrying up to 70 passengers plus freight. Author (ESA)

N85-27841 Joint Publications Research Service, Arlington, Va.
USSR REPORT: TRANSPORTATION
29 Aug. 1984 44 p Transl. into ENGLISH from various Russian articles
(JPRS-UTR-84-025) Avail: NTIS HC A03

This U.S.S R. report presents research and development data in the area of transportation. The test flight of IL-76TD long-range transport variant is reported.

N85-27842 Joint Publications Research Service, Arlington, Va.
TEST FLIGHT OF IL-76TD LONG-RANGE TRANSPORT VARIANT
V. BELIKOV *In its* USSR Rept.: Transportation (JPRS-UTR-84-025) p 1-3 29 Aug. 1984 Transl. into ENGLISH from Izvestiya (Moscow), 21 May 1984 p 1
Avail: NTIS HC A03

The unique uses of the IL-76TD long-range Transport Variant are addressed. Flight characteristics that contribute to the efficiency of the IL-76TD cargo aircraft are discussed. Flight tests carried out under emergency conditions are reported. B.W.

N85-28932 Deutsches Museum, Munich (West Germany)
AIR TRAFFIC: INSTRUMENTS, AIRPORTS, COMPANIES, POST, CARGO AND PASSENGERS [LUFTVERKEHR: GERAETE, HAEFEN, GESELLSCHAFTEN, POST, FRACHT, PASSAGIERE]
M. MATTHES 1984 92 p refs In GERMAN Sponsored by Bundesministers fuer Bildung und Wissenschaften
Avail: Issuing Activity

A historical review of air traffic is presented The first motorized aircraft, the beginning of air traffic; from bomber aircraft to long distance aircraft; jet aircraft replacing the propeller aircraft; supersonic air traffic; large aircraft; and outlook of air traffic are discussed. Author (ESA)

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A85-37803

NATCS - NAVIGATION AIDED TARGET CONTROL SYSTEM FOR MULTIPLE DRONE APPLICATIONS

D. G. MORGAN (Vega Precision Laboratories, Vienna, VA) IN: PLANS '84 - Position Location and Navigation Symposium, San Diego, CA, November 26-29, 1984, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1984, p 16-24.

Modern military target drone scenarios require control systems that communicate rapidly with multiple high speed drones, provide position location and are cost and space effective. This paper describes a system for communicating with multiple target drones using existing TACAN and/or IFF transponder RF links Demonstration flight test data and additional system capabilities such as ship location and over the horizon command control are also described Author

A85-37808

AUTOCALIBRATION OF A LASER GYRO STRAPDOWN INERTIAL REFERENCE/NAVIGATION SYSTEM

K. M. WEFALD and C R. MCCLARY (Honeywell, Inc., St. Louis Park, MN) IN: PLANS '84 - Position Location and Navigation Symposium, San Diego, CA, November 26-29, 1984, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1984, p. 66-74.

The inertial reference system considered in the present paper uses the stability of a laser gyro and state-of-the-art electronics to provide reliable performance. The units are flying in 126 aircraft operated by 19 airlines. In 1982, the manufacturer of the system recognized that the serviceability of the system would be enhanced by auto calibration and began development of auto calibration techniques for all three axes of the gyros and the level axes of the accelerometers Approaches for an implementation of automatic bias calibration (Autocal) were explored The Autocal configuration selected employs a three state filter using final position error as the measurement to estimate gyro biases. Attention is given to a Kalman filter overview, a gyro Autocal functional description, an accelerometer Autocal functional description, and test results. G.R.

A85-37810

INTEGRATED INERTIAL SENSOR ASSEMBLY PROGRAM STATUS

R. E. EBNER (Litton Systems, Inc., Woodland Hills, CA) IN: PLANS '84 - Position Location and Navigation Symposium, San Diego, CA, November 26-29, 1984, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1984, p. 91-98.

Litton has constructed an Advanced Development Model (ADM) of an Integrated Inertial Sensor Assembly (IISA), on contract to the U.S. Naval Air Development Center. IISA is designed to provide all sensor needs for modern military aircraft, including flight control and navigation, with reduced avionics cost through the use of redundant skewed inertial navigation sensors. Various design aspects of using six ring-laser gyros and six inertial-grade accelerometers in two, separated clusters are described. The redundancy management mechanization and the system design features for maximum flight safety are given. Navigation performance limits of strapdown INS, including the effects of skewed sensors, are presented Author

A85-37825* Jet Propulsion Lab, California Inst. of Tech, Pasadena.

GPS-BASED CERTIFICATION FOR THE MICROWAVE LANDING SYSTEM

C. L. THORNTON, L. E. YOUNG, S C. WU, and J. B. THOMAS (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IN: PLANS '84 - Position Location and Navigation Symposium, San Diego, CA, November 26-29, 1984, Record . New York, Institute of Electrical and Electronics Engineers, Inc, 1984, p. 256-263. NASA-supported research. refs

An MLS (microwave landing system) certification system based on the Global Positioning System (GPS) is described. To determine the position history of the flight inspection aircraft during runway approach, signals from the GPS satellites, together with on-board radar altimetry, are used. It is shown that the aircraft position relative to a fixed point on the runway at threshold can be determined to about 30 cm vertically and 1 m horizontally. A requirement of the system is that the GPS receivers be placed on each flight inspection aircraft and at selected ground sites. The effects of different error sources on the determination of aircraft instantaneous position and its dynamics are analyzed. M.D.

A85-37829

A COMPARISON OF SEVERAL DIGITAL MAP-AIDED NAVIGATION TECHNIQUES

C. A. BAIRD and M. R ABRAMSON (Harris Corp., Melbourne, FL) IN: PLANS '84 - Position Location and Navigation Symposium, San Diego, CA, November 26-29, 1984, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1984, p. 286-293. refs

Digital terrain maps can be used to provide position fixes for navigation systems using several different procedures. These methods include modifications to account for terrain nonlinearities and to extend performance to regions of lower signal-to-noise ratios. This paper utilizes simulations to evaluate the effectiveness of these modifications and compares the performance of the different procedures. The simulations used are based on both synthetically generated and Defense Mapping Agency maps. These maps are combined with statistically generated errors and measured flight test data to provide both a series of controlled experiments, as well as a realistic basis of comparison. The results of these simulations are compared to analytically developed performance predictions. Author

A85-37830

PASSIVE NAVIGATION BY TRIANGULATION AND TRACKING OF UNDISTINGUISHED FEATURES IN SUCCESSIVE HIGH-RESOLUTION IMAGES

J T. GALKOWSKI and P. J GALKOWSKI (IBM Corp., Federal Systems Div., Owego, NY) IN: PLANS '84 - Position Location and Navigation Symposium, San Diego, CA, November 26-29, 1984, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1984, p. 294-300. Research supported by the IBM Independent Research and Development Program refs

A passive navigation technique using the optical spectrum in an environment which provides good contrast (not desert, ocean, fog, or high haze) and good illumination is presented. The major difference between the technique proposed here and those based on landmark tracking is that it exploits features of opportunity rather than features corresponding to previously surveyed landmarks. Features of opportunity are selected from the pool of those discernable in a digitized image obtained from a camera. They are tracked as they move across the scene, by sampling it with successive high resolution images. This motion is induced by the motion of the airborne platform on which the camera is mounted. Coordinates of these features are transmitted for use by the navigation system. V.L.

A85-37831#

EVALUATION OF RADIONAVIGATION SYSTEMS

R. D. TILL (FAA Technical Center, Atlantic City, NJ) IN PLANS '84 - Position Location and Navigation Symposium, San Diego, CA, November 26-29, 1984, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1984, p. 301-305. refs

The Federal Aviation Administration (FAA) Technical Center has been evaluating various navigation systems for nonprecision approach application Loran C and the Global Positioning System (GPS) have been flight tested and evaluated in rotary and fixed wing aircraft. The results of some of these tests are presented in this paper Author

A85-37832

GLOBAL POSITIONING SYSTEM AS A SOLE MEANS FOR CIVIL AIR NAVIGATION

R. BRAFF (Mitre Corp., McLean, VA) and J BRADLEY (FAA, Washington, DC) IN: PLANS '84 - Position Location and Navigation Symposium, San Diego, CA, November 26-29, 1984, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1984, p. 306-311 refs

The Global Positioning System (GPS) is scheduled to be deployed in 1988 Discussions are now being held between DOD and DOT/FAA on whether the funded GPD constellation of 18 satellites plus 3 operating spare satellites, and its control segment, provide sufficient coverage redundancy and integrity to be approved by the FAA as a fully capable supplemental or sole means navigation system in the National Airspace System. The issues involved and the status of the joint DOD and DOT/FAA work to resolve them are summarized. A concept for disseminating the integrity information to user receivers, via geostationary satellites, is described The description illustrates the operational and technical considerations involved in providing the required integrity for a satellite based navigation system. Author

A85-38313

A BALLOON TRACKING SYSTEM THAT USES THE VHF OMIDIRECTIONAL RANGE (VOR) NETWORK

T L. THOMPSON (NOAA, Aeronomy Laboratory, Boulder, CO) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no 1, 1985, p 49-51

The development of an inexpensive balloon navigational package that uses the VHF omnidiiectional range (VOR) system is discussed The balloon system uses the principle of triangulation between stations to yield position information. It is shown that stations must be selected for good angles and signal integrity, and that it is necessary to mentally average the VOR radials for best results. Results from several flights in Palestine, Texas indicate that the system may be considered as a backup or substitute for the OMEGA system which is commonly used. The typical accuracy of the down point prediction is found to be + or - 1 mile M.D.

A85-38314

AN AUTOMATIC NAVIGATION AND ASPECT SENSING SYSTEM FOR X-RAY ASTRONOMY

J G. GREENHILL, B FRANKLIN, and A. SPRENT (Tasmania, University, Hobart, Australia) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no. 1, 1985, p. 53-56. Research supported by the Australian Research Grants Committee. refs

An automatic navigation and aspect sensing system is being developed for use in trans-Australia and possible globe circling balloon flights by the University of Tasmania stabilized platform for X-ray astronomy. This system comprises an Omega receiver, a three-axis magnetometer, alt-az. Mounted CID camera, and an on-board computer. The computer uses the Omega receiver output or other dead reckoning information together with the magnetometer data to calculate the approximate position of selected bright stars. It then drives the camera to each of these positions in turn and determines from the camera output the precise coordinates relative to the platform of each of these stars. From this information it fixes the geographic coordinates of he platform to within a few nautical miles and determines the true platform azimuth with a precision of approximately 0.1 deg. These data are passed to the platform aspect control computer via a serial link. Author

A85-38526

INSTITUTE OF NAVIGATION, NATIONAL TECHNICAL MEETING, SAN DIEGO, CA, JANUARY 17-19, 1984, PROCEEDINGS

Washington, DC, Institute of Navigation, 1984, 252 p. For individual items see A85-38527 to A85-38547.

A low-cost, multifunction strapdown inertial sensor for tactical applications is considered along with a ring laser gyro inertial reference system, the helicopter flight test of a ring laser gyro attitude and heading reference system, redundancy management in strapdown navigation systems, codeless GPS systems for positioning of offshore platforms and 3D seismic surveys, and marine positioning with a GPS-aided inertial navigation system Attention is given to the evolution of manned space avionics, coverage characteristics of the baseline Navstar GPS satellite constellation, Phase III GPS integration options for aircraft platforms, design and test evaluation of a marine integrated navigation system, ring laser gyro navigation for surface ships, fiber-optic gyroscopes, a high-accuracy strapped down accelerometer, and a hemispherical resonator gyro Other topics explored are related to commercial aviation GPS navigation set architecture, a radionavigation systems evaluation program for the 1990 census, and federal navigation planning G R.

A85-38528#

THE ARINC 704 RING LASER GYRO INERTIAL REFERENCE SYSTEM

R. R. SHOQUIST (Honeywell, Inc , St Louis Park, MN) IN Institute of Navigation, National Technical Meeting, San Diego, CA, January 17-19, 1984, Proceedings . Washington, DC, Institute of Navigation, 1984, p 11-19.

It is pointed out that the advent of the ring laser gyro (RLG) has caused a technological revolution in the design of aircraft inertial navigation and reference systems. This solid-state, precision, angular rate sensor is ideally suited for highly reliable strapdown system configurations. The RLG uses two beams of light counter-rotating within a closed triangular path The present investigation is concerned with an RLG system for airliners This system combines the solid-state strapdown properties of the laser gyro with advanced digital electronics. Attention is given to the RLG Inertial Reference System (IRS) in-service experience, RLG IRS designed-in reliability, aspects of testing, a RLG IRS system description, and future RLG navigation-related products. G R

A85-38529#

HELICOPTER FLIGHT TEST OF A RING LASER GYRO ATTITUDE AND HEADING REFERENCE SYSTEM

J. NIEMELA, V. DELGUERCIO (U.S Army, Aviation Systems Command, Colts Neck, NJ), J WELKER, and M S. KLEMES (Litton Industries, Guidance and Control Systems Div , Woodland Hills, CA) IN: Institute of Navigation, National Technical Meeting, San Diego, CA, January 17-19, 1984, Proceedings . Washington, DC, Institute of Navigation, 1984, p. 20-23.

In the case of helicopters, accurate data are needed on the vehicle's dynamic state for navigation, flight control, and, in the case of military application, weapon direction. Previous generation helicopter systems employed separate vertical and direction gyroscopes to perform this function. Current strapdown systems provide a large performance improvement over the older systems. However, future systems will probably require additional improvements. In 1980, an analysis was initiated with the aim to study the performance requirements of a ring laser gyro (RLG) Attitude and Heading Reference System (AHRS) operated with various navigation aids. The definition of performance requirements led to a preliminary system design A follow-on hardware demonstration program was also formulated. Attention is given to an RLG AHRS system description, a flight test plan devised for an instrumented UH-1H helicopter, and test results. G.R.

A85-38530#
REDUNDANCY MANAGEMENT IN STRAPDOWN NAVIGATION SYSTEMS
C. R. GIARDINA and E. G. LUXFORD (Singer Co., Kearfott Div., Wayne, NJ) IN: Institute of Navigation, National Technical Meeting, San Diego, CA, January 17-19, 1984, Proceedings . Washington, DC, Institute of Navigation, 1984, p. 24-28.

The evolution of ring laser gyros and improvements in their performance has made it possible to develop strapdown navigation systems which achieve the accuracy previously associated with gimballed systems (0.5 to 1.0 nmi/h error rates). The computational capability of computers used in these systems has been increased by the development of VHSIC technology. Attention is given to aspects of system specification, reasons for software enhancement of hardware in detecting failures, an optimum system configuration, the determination of failed components, the reliability of gyro and accelerometer subsystems, accelerometer reliability, computer reliability, numerical results, and significant conclusions. G.R.

A85-38538#
COMMERCIAL AVIATION GPS NAVIGATION SET ARCHITECTURE
M. A. STURZA (Litton Systems, Inc., Aero Products Div., Canoga Park, CA) IN: Institute of Navigation, National Technical Meeting, San Diego, CA, January 17-19, 1984, Proceedings . Washington, DC, Institute of Navigation, 1984, p. 149-153. refs

This paper describes a GPS Navigation Set specifically designed for commercial aviation applications The design philosophy for this set has been to minimize RF signal processing in favor of digital signal processing and to minimize hardware digital signal processing in favor of software digital signal processing. This philosophy has resulted in a unique architecture This architecture is described and its impact on performance and cost are discussed. Features of the set unique to the commercial aviation application are presented Author

A85-38541#
PROGRAM TO SUPPORT THE APPROVAL OF SUPPLEMENTAL NAVIGATION AIDS IN THE NATIONAL AIRSPACE SYSTEM
P. D. ABRAMSON (U.S. Department of Transportation, Transportation Systems Center, Cambridge, MA) IN: Institute of Navigation, National Technical Meeting, San Diego, CA, January 17-19, 1984, Proceedings Washington, DC, Institute of Navigation, 1984, p. 168-171.

The Federal Aviation Administration (FAA) has established a network of short range air navigation facilities based upon the VHF Omnidirectional Range (VOR) and Distance Measuring Equipment (DME). VOR/DME is an internationally accepted, widely used system of navigation which provides excellent high altitude coverage in the continental United States (CONUS). There are regions, however, in the CONUS and offshore which do not have adequate coverage to fully support users of the airspace. In these regions, supplemental navigation aids are being considered which can provide increased coverage to augment the more traditional VOR/DME system. The purpose of this paper is to suggest a program to investigate and ultimately approve the use of such supplemental navigational aids. Author

A85-38647
COMMUNICATION IN AUTOMATED AIR-TRAFFIC-CONTROL SYSTEMS [SVIAZ' V AVTOMATIZIROVANNYKH SISTEMAKH UPRAVLENIIA VOZDUSHNYM DVIZHENIEM]
O. S. NABATOV and N. S. VDOVICHENKO Moscow, Izdatel'stvo Transport, 1984, 288 p. In Russian. refs

Principles for the design of communication channels and networks in automated ATC systems are presented. Attention is given to the development of systems for digital signal processing and transmission, devices for the transmission of digital and analog signals, and integrated digital communication networks. Algorithms for the operation of these communication systems are presented, and their implementation through integrated-circuit devices and microcomputers is discussed. B.J.

A85-39458
ALGORITHMS FOR IMPROVED, HEADING ASSISTED, MANEUVER TRACKING
C. C. LEFAS (Nuclear Research Centre, Athens, Greece) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-21, May 1985, p. 351-359. Research supported by EUROCONTROL. refs

The evolution of the SSR mode S system makes it possible to receive airborne measurements at the ground station. The possibility of using data-linked heading measurements to assist present trackers to track maneuvering aircraft is investigated. The quality to be expected from heading measurements is investigated from available on-board recordings. Maneuver detection and false measurement rejection schemes are developed, and finally suitable maneuver tracking filters are constructed and evaluated. Author

N85-27843*# Textron Bell Helicopter, Fort Worth, Tex.
INVESTIGATION OF IMAGING AND FLIGHT GUIDANCE CONCEPTS FOR ROTORCRAFT ZERO VISIBILITY APPROACH AND LANDING
W. L. MCKEOWN Aug. 1984 172 p refs
(Contract NAS2-11364)
(NASA-CR-166571; T-3771; NAS 1.26:166571) Avail: NTIS HC A08/MF A01 CSCL 17G

A simulation experiment to explore the use of an augmented pictorial display to approach and land a helicopter in zero visibility conditions was conducted in a fixed base simulator. A literature search was also conducted to determine related work. A display was developed and pilot in-the-loop evaluations were conducted. The pictorial display was a simulated, high resolution radar image, augmented with various parameters to improve distance and motion cues Approaches and landings were accomplished, but with higher workloads and less accuracy than necessary for a practical system. Recommendations are provided for display improvements and a follow on simulation study in a moving based simulator. Author

N85-27844# Federal Aviation Administration, Washington, D.C.
NATIONAL AIRSPACE REVIEW, CHANGE 1 Interim Report
Jan. 1985 119 p Supersedes AD-A147768
(AD-A152369; AD-E900434) Avail NTIS HC A06/MF A01 CSCL 17G

Since the summer of 1982, the Federal Aviation Administration (FAA) has been hosting task group working sessions of the National Airspace Review (NAR). The NAR is a cooperative venture by the aviation industry and government. The NAR is comprehensively reviewing current air traffic controller procedures, flight regulations, and airspace for the purpose of validating the current system or identifying near-term changes which will promote greater efficiency. As a component of the National Airspace System Plan, the NAR will provide the operational framework for moving into the next generation National Airspace System (NAS). In the area of procedures, task groups have covered: terminal services, weather programs, traffic flow management, helicopter operations, separation standards and the National Flight Data System. GRA

N85-27847# National Aerospace Lab., Amsterdam (Netherlands). Hoofdafd. Vliegtuigen.
FLYING IN SPITE OF THE WEATHER
F. J. ABBINK 3 Aug. 1984 85 p refs In DUTCH; ENGLISH summary Presented at Neth. Assoc. for Aeron. Eng. Symp. on Aviation Meteorol., Delft, 13 Apr. 1984
(NLR-MP-84021-U; B8560217) Avail: NTIS HC A05/MF A01

The impact of weather on aircraft design, propulsion, avionics and on board equipment, and on air traffic control is surveyed. Flight hazards in different weather conditions are described in relation to impact on flight safety and operation costs. Author (ESA)

N85-27848# National Aerospace Lab., Amsterdam (Netherlands) Afd. Vliegtuigen
DEVELOPMENTS IN THE AREA OF AIR TRAFFIC CONTROL SYSTEMS AND THE RELATION WITH METEOROLOGY
T. H. M. HAGENBERG Mar. 1984 27 p refs In DUTCH; ENGLISH summary Presented at Neth. Assoc. for Aeron. Eng. Symp. on Aviation Meteorol., Delft, 13 Apr 1984
(NLR-MP-84029-U; AD-B089436L) Avail: NTIS HC A03/MF A01

Avionic systems such as secondary surveillance radar and microwave landing systems potential for further automation in air traffic control systems are discussed. The organization of air traffic services and the relation of these services with meteorology are outlined. Author (ESA)

N85-27849# National Aerospace Lab., Amsterdam (Netherlands).
A SYSTEM FOR TAKE-OFF AND LANDING MEASUREMENTS (STALINS)
1983 12 p In DUTCH; ENGLISH summary Sponsored by Netherlands Agency for Aerospace Programs
(B8580072) Avail: NTIS HC A02/MF A01

A high accuracy inertial system for measuring the flight path during takeoff and landing was developed to create independence from airfield equipment. Using a Litton LTN-58 inertial system, a RASP antenna, and a data processing computer program, an accuracy of 2 m in X and Y directions and 0.15 m in altitude is obtained. Author (ESA)

N85-28933# Defence Research Establishment, Ottawa. (Ontario).
A GENERAL AREA AIR TRAFFIC CONTROLLER SIMULATION USING COLOUR GRAPHICS
B. J. FORD Sep. 1983 151 p Original contains color illustrations
(Contract DREO-890)
(AD-A153634) Avail: NTIS HC A08/MF A01 CSCL 17G

The increased speed of aircraft and a greater density of air traffic are overtaxing air traffic controllers. Automation of some portions of the controller's information and the use of color to highlight dangerous situations will make the controller's work easier and possibly more accurate. One of the major aims of the study is to show that the use of a different colors to indicate varying distances between aircraft is a definite improvement over a monochrome display. The other major aim is to study the advantages and disadvantages of vector display and raster display technologies when applied to the air traffic controller scenario. A new set of graphics display routines was developed to be used for the simulation. Much consideration was given to the best methods to optimize the display routines, with attention given to real-time constraints. GRA

N85-28935# Sandia Labs., Albuquerque, N. Mex
THE AFTI/F16 TERRAIN-AIDED NAVIGATION SYSTEM
D. D. BOOZER, M. K. LAU, and J. R. FELLERHOFF 1985 7 p refs Presented at the Natl Aerospace and Electron. Conf., Dayton, Ohio, 20 May 1985
(Contract DE-AC04-76DP-00789)
(DE85-008411; SAND-85-0223C; CONF-8505116-1) Avail NTIS HC A02/MF A01

A recursive, real time, terrain aided navigation algorithm, AFTI/SITAN, was designed for use on the Advanced Fighter Technology Integration (AFTI) F16 aircraft. The algorithm implemented in a Zilog Z8001 microprocessor, can reliably locate the aircraft's position within a 926-m (0.5 nm) CEP circle and accurately estimate its position continuously (3 Hz). The design and execution of the algorithm are described, and simulation results using actual flight test data are presented. A median accuracy of less than 100 m was achieved over gently rolling, forested terrain using cartographic-based digital terrain elevation data. DOE

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A85-37182#
FATIGUE LIFE EVALUATION PROGRAM FOR THE KFIR AIRCRAFT
A. BROT (Israel Aircraft Industries, Ltd., Engineering Div., Tel Aviv, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers Haifa, Israel, Technion - Israel Institute of Technology, 1984, p 36-40.

A fatigue life evaluation program has been developed to provide fleet safety and economy for Kfir aircraft in service. The program includes damage-tolerance analysis, specimen, component, and full scale fatigue testing. In addition, the fatigue program led to several design improvements which increased the fatigue resistance of the aircraft A fleet-monitoring program has been developed which allows for safe and economical inspections of each individual aircraft in service Author

A85-37188#
CRACK PROPAGATION ANALYSIS OF LONGITUDINAL SKIN CRACKS IN A PRESSURIZED CABIN
H. MOR (Israel Aircraft Industries, Ltd., Engineering Div., Tel Aviv, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 78-83. refs

The crack growth of longitudinal skin cracks in pressurized cabins is affected by a bulging phenomenon. The bulging of cracks causes an increase in the stress intensity at the crack tips, in between frames, and damps out at the frames. This paper presents an analytical method which accounts for the bulging effect of one bay cracks. The method is based on thin shell theory results as presented by Folias (1977), and an empirical formulation presented by Swift for two bay cracks. It is supported by test results Author

A85-37206#
CONCEPTS AND APPLICATION OF AIRCRAFT DAMAGE TOLERANCE ANALYSIS
D. BROEK (FractuResearch, Inc., Columbus, OH) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 268-276. refs

This paper discusses the objectives of damage tolerance analysis. Subsequently, justification is given for the use of linear elastic fracture mechanics concepts as a basis for analysis. It is then demonstrated that the major sources of error are in the input rather than in the analysis per se, and that accuracy will not be improved through the use of fracture mechanics concepts with somewhat wider limitations. Finally, it is shown that relatively simple stress histories are quite adequate for damage tolerance analysis. Author

A85-37323
SOFTWARE-ENGINEERING ELEMENTS IN THE PROBLEM OF THE OPTIMAL DESIGN OF LIFT SYSTEMS FOR FLIGHT VEHICLES [ELEMENTY MATEMATICHESKOI TEKHNOLOGII V PROBLEME OPTIMAL'NOGO PROEKTIROVANIIA NESUSHCHIKH KOMPLEKSOV LETATEL'NYKH APPARATOV]
A. N. PANCHENKOV, IU. F. ORLOV, G. I. ANTOSHKINA, M. N. BORISIUK, V. D. MISHCHENKO, and R. IU. SHLAUSTAS IN: Applied software packs: Development techniques (Pakety prikladnykh program. Tekhnologiia razrabotki). Novosibirsk, Izdatel'stvo Nauka, 1984, p. 110-123. In Russian. refs
The structure of the applied-program package POLET for the optimal design of flight-vehicle lift systems is presented. The initial premises and main problems of optimal design are examined, and the problem modules and general program of POLET are described. B.J.

A85-37408
AIRCRAFT SERVICE TESTING OF ULTRASONICALLY WELDED PANELS
T. RENSHAW (Fairchild Republic Co., Farmingdale, NY) IN: National Technical Conference, 16th, Albuquerque, NM, October 9-11, 1984, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p. 686-695. refs
An account is given of the development of a proprietary process for the service testing of ultrasonically welded aircraft structure panels, such as those of the central fuselage section of the A-10 attack aircraft. Attention is given to the weld bonding operations schedule and the various stresses to which a structural panel is subjected during such processing. O C.

A85-37488
INSTATIONARY DOLPHIN FLIGHT - THE OPTIMAL ENERGY EXCHANGE BETWEEN A SAILPLANE AND VERTICAL CURRENTS IN THE ATMOSPHERE
J. L. DE JONG (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands) Optimal Control Applications and Methods (ISSN 0143-2087), vol. 6, Apr.-June 1985, p. 113-124. refs
A solution is presented, based on a simple dynamic model of a sailplane, to the optimal control problem formulated for the case of a dolphin flight trajectory defined as instationary and involving brusque and strongly varying normal loads. The optimal trajectory entails flying at small or negative normal loads in downraft regions; in upraft regions the sailplane is accelerated to nearly the point of maximal atmospheric velocity, where at high normal loads it is forced to climb. The problem is solved numerically for a 15-m racing class LS-3 craft, covering a number of different widths and strengths of the vertical currents. L.T.

A85-37945
TWEETY-BIRD REPLACEMENT
R. BRAYBROOK Air International (ISSN 0306-5634), vol 28, June 1985, p. 273-277; 279, 280.
An account is given of the development history, design features, and performance capabilities of the T-46A aircraft that will replace the T-37B as the U.S. Air Force's primary jet-engined trainer. The T-46A has a pressurized cabin that permits flight at over 10,000 m, thereby avoiding general aviation traffic. The two F109-GA-100 engines used are turbofans which yield exceptionally quiet operation Attention is given to competing designs over which the T-46A triumphed, and the armaments that can be incorporated by an attack/trainer variant that includes four underwing hardpoints and is intended for the export market. O.C.

A85-37946
A 320 - THIRD GENERATION AIRBUS
Air International (ISSN 0306-5634), vol. 28, June 1985, p. 281, 282, 285, 288-290 (5 ff.).
After presenting a history of the design development phase of the Airbus European consortium's efforts toward the production of the A300 airliner, attention is given to the design features and performance capabilities of the new generation A320. Two fuselage sizes are offered, of which the smaller, A320-100 seats 154 passagers and the larger A320-200 seats 172, at 81-cm pitch. A delay experienced in arriving at an agreement among the Airbus consortium's partners on their respective launching cost shares was used by the design staff to further refine their product and to clarify engine requirements. The CFM56-5 and V2500 turbofan engines, both rated at 23,500 lbs of thrust, were chosen as powerplant alternatives. O.C.

A85-38243
MIRAGE 2000 FIGHTER COMBINES ACCELERATION, LOW-SPEED STABILITY
R. R. ROPELEWSKI Aviation Week and Space Technology (ISSN 0005-2175), vol. 122, June 24, 1985, p. 38, 39, 41 (3 ff.).
An evaluation is made of the Mirage 2000B two-seat fighter's cockpit instrument suite, flight control characteristics, and combat mission profile performance. Little difference is noted between the weight and flight performance of this two-seat variant and its single seat counterpart, due to the elimination of the latter's twin 30-mm cannon. Both seats are equipped with HUDs, but that of the rear position merely duplicates the forward unit's data. Impressive turn capabilities are demonstrated throughout the flight envelope; the fly-by-wire control system uses inputs from the aircraft's air data computer to limit load factor and angle of attack throughout the operating range. Attention is given to the effectiveness of the airborne radar's air-to-air combat and air-to-ground ranging modes O C

A85-38244
SOVIETS TAILOR CARGO TRANSPORT FOR REMOTE-SITE OPERATIONS
D. E. FINK Aviation Week and Space Technology (ISSN 0005-2175), vol 122, June 24, 1985, p 55, 56.
The design features and probable airlift performance capabilities of the C-5 Galaxy-like An-124 large cargo transport aircraft recently exhibited by the USSR at the Paris Air Show are discussed. Several design features are noted which facilitate operation from unimproved runways at remote oil exploration and geological survey sites. The four turbofan engines used are in the 50,000-lb thrust class, and fitted with thrust reversers. A hinged nose section allows the deployment of a self-contained loading ramp. The design incorporates 12,000 lbs of composite materials in nonloadbearing airframe structures. A range of 4500 km is associated with the full payload of 330,000 lb O.C

A85-38245
TELEDYNE RYAN FOCUSES R & D EFFORT ON NEW RPVS, TARGET VERSIONS
K F. MORDOFF Aviation Week and Space Technology (ISSN 0005-2175), vol. 122, June 24, 1985, p. 89-91, 93.
An evaluation is made of proprietary development efforts aimed at the production of: (1) high altitude, long endurance RPV platforms for the relay of communications and the gathering of intelligence and targeting information, (2) 2,500-lb class RPVs for tactical penetration missions, and (3) mini-RPVs and drones for use in target or surveillance missions. The first of the above categories has engendered the 85-foot wingspan 'Spirit' RPV, which will conduct communications, electronic intelligence, sonobuoy monitoring and long range weather surveillance missions Over-the horizon targeting and cruise missile early warning and tracking missions are also envisioned for Spirit. O.C.

A85-38302
THE LIMITS OF STRATOFILM
J. L. RAND (Winzen International, Inc., East San Antonio, TX) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol 5, no 1, 1985, p. 5-8.
An abnormally large number of catastrophic failures have occurred in recent years which have prompted a number of investigations This paper documents the efforts by Winzen engineers to determine the cause oof these dangerous failures. It is concluded that catastrophic failure will occur if internal caps separate from the wall of the balloon at too low an altitude. Cap

separation may be prevented by the use of external caps. Author

A85-38303* National Aeronautics and Space Administration. Wallops Flight Center, Wallops Island, Va.
RECENT MATERIALS PROBLEMS RELATING TO CATASTROPHIC BALLOON FAILURES
I. S. SMITH (NASA, Wallops Flight Center, Wallops Island, VA) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no. 1, 1985, p. 9-11

Balloons fabricated of thin polyethylene materials have provided relatively inexpensive and reliable scientific research platforms for approximately three decades. Reliability of the modern day balloon, as launched by the U.S.A National Scientific Balloon Facility (NSBF), has been approximately 85 percent. Recent balloon failures, coupled with an increased ocurrence of catastrophic failures, created grave concern over the integrity of the present balloon inventory of the U.S.A. National Aeronautics and Space Administration (NASA). An investigative team was established by NASA to review the circumstances surrounding the catastrophic balloon failures, determine the cause and to make recommendations to correct the problem and to prevent its reoccurrence. The most probable cause of failure as determined by the investigation was the polyethylene balloon film, although the film had passsed the established standard quality control measures of the film manufacturer. The approach, findings, and conclusions of the investigation are presented along with planned procedures to assure future quality balloon film for NASA balloons. Author

A85-38306
EXTERNAL CAPS - AN APPROACH TO STRESS REDUCTION IN BALLOONS
K. H HAZLEWOOD (National Scientific Balloon Facility, Palestine, TX) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no 1, 1985, p 21, 22.

Recent findings of the catastrophic balloon failures investigation in the U.S. indicate that very large gross inflations, in balloons using present design philosophy, over-stress currently available materials. External caps are proposed as an economic approach to reducing those stresses to an acceptable level. Author

A85-38321
FEASIBILITY STUDIES OF 'POLAR PATROL BALLOON'
J. NISHIMURA, K. TSURUDA (Tokyo, University, Tokyo, Japan), M. KODAMA (Yamanashi Medical College, Yamanashi, Japan), and H FUKUNISHI (National Institute of Polar Research, Tokyo, Japan) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no. 1, 1985, p. 87-90. refs

Engineering and meteorological feasibilities of a circum-south-polar ballooning project, called 'Polar Patrol Balloon (PPB)', for space and geophysical researches are studied. It is planned to use zero-pressure balloons mounting an auto-ballasting system, utilizing the non-sunset condition in mid-summer. PPB will be launched to a level higher than 30 km from an observational base in the Antarctica and come back there by a circumpolar wind. It is predicted that the circumpolar period may be a few weeks in the case of mid-summer 30 km-level flight and its meridional deviation after a circumpolar flight may be within a few hundreds kilometers. Auto-ballasting and ARGOS-tracking, have been tested, and some on-board data accumulation systems and power supply are being developed If a collaboration with foreign bases is possible, results of PPB should be much more successful especially concerning simultaneous observations at various latitudes. Author

A85-38358#
MINIMUM-TIME PATH THROUGH WIND FIELDS
K. KATO and T NAKASHIMA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 32, no. 360, 1984, p. 66-71. In Japanese, with abstract in English

Numerical results are given concerning the minimum-time path through a region of position dependent wind fields. Five wind fields are used three are defined analytically, while the other two are composed from measured weather charts. Optimum paths thus obtained suggest the possibility of fuel savings when applied to flights across the Pacific Author

A85-38360#
RESEARCH TREND IN ADVANCED TECHNOLOGY HELICOPTER
A. AZUMA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol 32, no 361, 1984, p. 74-82. In Japanese refs

Recent helicopter developments are surveyed stressing improvements in speed, noise reduction, survivability and cost reductions Using composite materials, such as graphite epoxy, glass fiber, Nextel/polyimide, and Kevlar, for airframes the cost of manufacturing and weight can be reduced. Survivability can be improved by installing more than two engines. Vibration control systems such as nodal suspension and automatic flight controls including fly-by-wire and fly-by-fiber are detailed The current status in manufacturing the BO-105 (for emergency medical service) is discussed S H.

A85-38361#
NATURAL FREQUENCIES AND FLIGHT LOADS OF COMPOSITE MAIN ROTOR BLADE FOR HELICOPTER
M. OHTOMO, K SAITO, S. BANDO, A KAKINUMA, and N. SERA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 32, no. 361, 1984, p. 82-88 In Japanese.

The natural frequency and flight load of a helicopter composite blade are investigated, emphasizing the flight test. The blade weighs 10 5 kg and consists of glass fiber for the spar, Kevlar fiber for the skin, and carbon fiber for the T.E. strip. The natural frequencies of the rotor blade both in motion and stationary conditions are measured, and compared with the calculated values. In flight tests, loads of the blade and airframe and control forces are measured. It was found that no difference in variable loads exists between the composite and metal blades, with the composite blade stronger than the metal one Specifications of the composite blade and diagrams showing experimental results are included. S H.

A85-38365#
STUDY ON THE COMFORTABILITY OF HELICOPTER - FLIGHT TEST OF ACOUSTIC NOISE LEVEL
T ITO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol 32, no. 361, 1984, p. 101-110. In Japanese.

In order to reduce the acoustic noise level, the inner construction materials of helicopters are investigated, and their testing methods are described. The acoustic noise level is characterized and measured at various stages, such as take-off, horizontal flight, autorotation, climbing, and hovering. It was found that a glass wool base and glass-nylon cloth combination reduced significantly the acoustic noise. Rubber sheets in combination with a glass wool base showed a similar effect. Experimental results are given. S.H

A85-38434
WHO NEEDS ADVANCED-TECHNOLOGY AIRLINERS?
D LEARMOUNT Flight International (ISSN 0015-3710), vol 127, June 1, 1985, p. 77-80.

An evaluation is made of three leading airliner manufacturer's plans toward meeting carriers' demand for an airliner in the 140-170-seat capacity range While Boeing and McDonnell Douglas have chosen not to respond to this market with a third-generation, new-technology aircraft, respectively continuing production of the 737-300 and MD-80 series aircraft instead, Airbus Industrie will proceed with a design whose degree of new-technology integration more nearly approximates the projected third technological generation. Attention is presently given to the design features and prospective performance advantages of the A-320. O.C.

A85-38437

AV-8B-MEAN MARINE V/STOL MACHINE

M. GAINES Flight International (ISSN 0015-3710), vol. 127, June 1, 1985, p. 148-151.

An evaluation is made of the mission capability enhancements that accrue to the AV-8B, state-of-the-art variant of the Harrier VTOL attack aircraft in virtue of its incorporation and integration of advanced avionics and weapon delivery systems. An on-board oxygen generation system is used which obviates liquid oxygen supply requirements on long flights and amphibious ship operations. The stability Augmentation System employs a Departure Resistant System which facilitates safe aircraft handling at up to 122 deg angle-of-attack. An Angle Rate Bombing System renders the AV-8B highly accurate in its role as an air-to-ground weapons platform. The AV-8B will be delivered to the RAF for Central European Service under the designation GR 5, with minor differences in armament. O C.

A85-38438

LHX - A GIANT LEAP

M. GAINES Flight International (ISSN 0015-3710), vol. 127, June 1, 1985, p. 167-171.

Two versions of the state-of-the-art technology helicopter designated 'LHX' by the U.S. Army will replace current members of the light helicopter fleet in the 1990s: a scout/attack, or 'Scat', and a utility, 'Util', variant. The two LHX aircraft will employ the same engines and rotor elements; an overall commonality of 70 percent is anticipated. Unit flyaway cost of the Scat will be no more than $6 million in 1984 dollars, while the Util will be no more than $4 million. A total of 48 mission scenarios have been defined for the Scat version. Four Hellfire antitank missiles, two Stinger Post air-to-air missiles, and a gun system, constitute the armament requirements for Scat, which must be readily transportable aboard C-17, C-141, and C-5 airlifters. Low audio, visual, radar, and IR signatures are also demanded. Attention is given to several manufacturer's preliminary design determinations in the LHX competition. O.C

A85-38440

SOMETHING OLD, SOMETHING NEW

G. WARWICK Flight International (ISSN 0015-3710), vol. 127, June 1, 1985, p 182-184.

An assessment is made of the performance enhancements obtainable in helicopters and fixed wing aircraft by the development to technological maturity of the oblique-wing, forward swept wing, rotating/fixed 'X-wing', and flying wing configurations. Advancements in composite materials, computer-aided design methods, digital electronics, and electromechanical control devices, are noted to be uniquely capable of addressing outstanding operational problems in such long-considered configurational possibilities as the flying wing, with its intrinsic control instability, and the X-wing, in which a very stiff helicopter rotor is transformed into a set of four, back- and forward-swept wing surfaces. The flying wing configuration is suggested to be the basis of the U.S. Air Force's 'Stealth' bomber. O.C.

A85-38781#

AN AERODYNAMIC PERFORMANCE MODEL FOR HYBRID HEAVY LIFT SYSTEMS

B. M. PERSHING and M. J. ANDERSON (Aerospace Corp., El Segundo, CA) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 26-39. Sponsorship: U.S. Department of Agriculture. refs
(Contract USDA-53-04H-1-1-8488N)
(AIAA PAPER 85-0865)

A description is presented of a hybrid heavy lift system aerodynamic performance model which is employed in a timber harvesting econometric simulation developed for the USDA Forest Service. The model is capable of treating both multi-rotor hybrid systems, and single and tandem rotor helicopters, with positive and negative buoyancy. The model computes vehicle size, aerodynamic characteristics, basic performance capability, and time and fuel required to perform a timber yarding cycle. Comparison of predicted performance is made with H-34 and S-64 helicopter flight data and with S-64 yarding cycle field operation, the effects of winds and vehicle drag on yarding performance are shown. Author

A85-38784#

THE DESIGN AND DEVELOPMENT OF THE GRACE AIRCRAFT GAC-20 AIRSHIP

J. R. THEILE (Grace Aircraft Corp., Eugene, OR) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 53-57.
(AIAA PAPER 85-0869)

The Grace Aircraft GAC-20 is an all new airship being designed and built in compliance with the newly proposed Federal Aviation Administration General Airworthiness Standards for Airships. As such it is designed specifically for type certification and commercial use. This paper is a review of the design and development of the GAC-20. The mission profile and configuration are discussed as well as many important factors of the design. Major components discussed include the control car, propulsion system, landing gear, fins, control system, and envelope. Author

A85-38786#

THE CYCLO-CRANE - A NEW CONCEPT TO HEAVY VERTICAL LIFT

A. G. CRIMMINS (Aerolift, Inc., Tillamook, OR) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 63-67.
(AIAA PAPER 85-0871)

AeroLift represents one of the very few organizations devoted to the design, development, and construction of a hybrid aircraft. The Cyclo-Crane is a hybrid aircraft that utilizes aerostatic lift combined with aerodynamic lift and thrust. The Cyclo-Crane will offer heavy lift services, analogous to helicopter operations at a cost projected to be on the order of 25 percent of helicopters. The Cyclo-Crane concept is valid up to 75 tons of sling-load capability. The Cyclo-Crane combines the economical aerostatic lift from nonflammable helium with rotating airfoils to provide low cost, heavy lift service not previously available. Author

A85-38787#

DESIGN OF A SMALL AIRSHIP

J. THOMPSON IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 68-72.
(AIAA PAPER 85-0872)

A small (2 person) airship is nearing completion. The envelope is of 28,000 ft 3 volume with a fineness ratio of 3.15. Propulsion is a Honda 1200cc liquid cooled engine, a toothed-belt reduction drive and shrouded prop. The envelope was shaped by a novel procedure to yield a contour with first and second derivatives that are smooth and continuous. Author

A85-38788#

THE NEED TO RETURN TO HYDROGEN IN AIRSHIPS

M. BREDT (Buz Airship Co., New Orleans, LA) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 73-77.
(AIAA PAPER 85-0873)

The prohibitively high cost of helium outside North America prompts reconsideration of hydrogen's use as the lifting gas of LTA vehicles which have been designed to minimize the risks associated with hydrogen's flammability. Hydrogen can also serve a double role, as lifting gas and fuel. Attention is given to principles for the design of LTA vehicles incorporating lightweight, fire-retardant materials forming a rigid airframe. The use of reciprocating, hydrogen-fueled engines is noted to be able to furnish a substatial degree of buoyancy control. A wind turbine-powered hydrogen production infrastructure deployed along airship routes is considered as the basis for LTA financing and servicing. O.C.

A85-38791#
PROGRESS REPORT ON THE ENGINEERING DEVELOPMENT OF THE MAGNUS AEROSPACE LTA 20-1 AIRSHIP
J. DELAURIER, W. D. MCKINNEY, J. D. LOWE, D. R UFFEN, and A. S. KING (Toronto, University, Toronto, Canada) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 90-99. refs
(AIAA PAPER 85-0876)

Engineering research and development has been performed on the Magnus Aerospace Corporation's LTA 20-1, which is a unique heavy-lift airship design utilizing buoyancy, vectored thrust, and the Magnus effect for vertical lift. Its configuration consists of a large sphere rotating crosswise to its flight direction about end axles, from which a half ring-wing yoke is suspended. Attached to the yoke is a gondola and propulsive units. This unprecedented vehicle has required comprehensive engineering analysis, resulting in a candidate configuration for which favorable flight-dynamic behavior and performance have been predicted. This paper describes the work performed over the last two years, which includes wind-tunnel testing flight-dynamic analyses, structural calculations, performance predictions, and flying-model experiments Author

A85-38796*# Systems Technology, Inc., Hawthorne, Calif.
CONTROL RESPONSE MEASUREMENTS OF THE SKYSHIP-500 AIRSHIP
H. R. JEX, J. R. HOGUE (Systems Technology, Inc., Hawthorne, CA), and P. GELHAUSEN (NASA, Ames Research Center, Moffett Field, CA) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers New York, American Institute of Aeronautics and Astronautics, 1985, p. 130-141. refs
(AIAA PAPER 85-0881)

An examination is conducted of the Skyship 500's dynamic response to control inputs from elevators, rudders, and throttles at zero, 25, and 40 kts indicated airspeed Input frequency sweeps were made with pitch and turn controls at 25 and 40 kts, ranging in frequency from about 0.03 to 1.5 Hz. FFT data analysis was then applied to compute describing functions for each run. Frequency responses are noted to be very smooth, and comparisons. between repeat runs indicate excellent agreement. Summary plots of the faired describing functions from each run form the core of the data presented. These data constitute a comprehensive and reliable data base on which to predicate future dynamic simulation mathematical models of small airship dynamic response. O.C.

A85-38798#
A NEW CONCEPT OF HYBRID AIRSHIP
B. LINDENBAUM, D. L. QUAM, and W. T. GRADY (Aerial Mobility, Inc., Dayton, OH) IN Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 153-160.
(AIAA PAPER 85-0868)

An evaluation is made of a novel hybrid airship configuration, in which the powered lift-propulsion system is separated from the LTA unit in such a way as to permit the latter to move freely in the horizontal direction over small distances without significant restraint from the LTA unit. Attention is given to the case of a 25-ton payload hybrid airship's performance and physical characteristics, in light of practical airlifting tasks. The precision of the present hybrid airship configuration's pick-up and placement of underslung loads is noted. O.C.

A85-38850
THE AERODYNAMICS OF THE TU-154B AIRCRAFT [AERODINAMIKA SAMOLETA TU-154B]
T. I. LIGUM, S. IU. SKRIPNICHENKO, and A. V. SHISHMAREV Moscow, Izdatel'stvo Transport, 1985, 263 p. In Russian.

The aerodynamic aspects of the flight operations of the commercial Tu-154B aircraft with NK-8-2u turbofan engines are examined. The discussion covers the flight performance characteristics, flight conditions, and stability and controllability, including flight at large angles of attack and special flight conditions. Recommendations concerning aircraft operation under unfavorable meterological conditions are given, as are recommendations for reducing noise during the take-off. Ways to reduce fuel consumption during flight operations are discussed. V.L.

A85-38875
FUNDAMENTALS OF THE FLIGHT OPERATIONS OF HELICOPTERS: AERODYNAMICS [OSNOVY LETNOI EKSPLUATATSII VERTOLETOV: AERODINAMIKA]
A. M. VOLODKO Moscow, Izdatel'stvo Transport, 1984, 256 p. In Russian. refs

The theoretical and experimental fundamentals of the aerodynamics of single-rotor and coaxial-rotor helicopters are reviewed using a simple mathematical formalism and flight test results for the commercial helicopters Mi-8 and Ka-32. In particular, attention is given to the principal parameters and aerodynamic characteristics of the rotor and the rotor blade, pulse and vortex theories of the rotor, the rotor control system, and forces and moments acting on the rotor. Emphasis is placed on the physical meaning of the phenomena and processes involved and on how they affect the flight operations. V.L.

A85-39066* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RESULTS OF A WIND TUNNEL/FLIGHT TEST PROGRAM TO COMPARE AFTERBODY/NOZZLE PRESSURES ON A 1/12 SCALE MODEL AND AN F-15 AIRCRAFT
O. C. PENDERGRAFT, JR. (NASA, Langley Research Center, Hampton, VA) and J. NUGENT (NASA, Flight Research Center, Edwards, CA) IN· Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 101-110. refs
(SAE PAPER 841543.)

In 1975 NASA Dryden Flight Research Facility received the No. 2 prototype F-15 aircraft from the USAF to conduct the F-15 Propulsion/Airframe Interactions Program. About the same time, NASA Langley Research Center acquired a 1/12 scale F-15 propulsion model, whose size made it suitable for detailed afterbody/nozzle static pressure distribution studies. Close coordination between Langley and Dryden assured identical orifice locations and nozzle geometries on the model and aircraft. This paper discusses the sequence of the test programs and how retesting the model after completion of the flight tests greatly increased the ability to match hardware and test conditions. The experience gained over the past decade from involvement in the program should prove valuable to any future programs attempting to match wind tunnel and flight test conditions and hardware. Author

A85-39125
CHARACTERISTICS OF THE OSCILLATIONS OF A TAIL UNIT IN A FLOW OF AN INCOMPRESSIBLE GAS [O KHARAKTERE KOLEBANII OPERENIIA S RULEM V POTOKE NESZHIMAEMOGO GAZA]
V. A. PAVLOV, S. K. CHERNIKOV, and M. I. GERSHTEIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 98-100. In Russian.

The steady-state self-oscillations of a tail unit in a flow of an incompressible gas, with the rudder hinged in a statically indeterminate manner, is investigated analytically. It is noted that the nonzero frontal stiffness of the rudder results in a qualitative modification of the self-oscillations. An analysis of the behavior of the tail unit indicates that the amplitude of the oscillations at flow velocities higher than a critical value is stable and limited in magnitude; the amplitude decreases as the flow velocity increases. V.L.

A85-39164
SECONDARY POWER GENERATION SYSTEM CONSIDERATIONS FOR ADVANCED AIRCRAFT
R. H. ANDERSON (General Dynamics Corp., Fort Worth, TX) IN: Starting systems technology, Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 95-104.
(SAE PAPER 841604)

A generalized approach to secondary power generation for advanced military aircraft is presented. The objectives of such an approach are given along with a flow chart of the analysis. The individual elements of the approach are discussed, including the mission of the weapon system under study, hardware information sources, baseline aircraft design and its requirements, hardware concepts, and system evaluation and selection Both peacetime and wartime implications are considered. A generalized example of a power generation selection trade study that was actually performed for a single engine fighter aircraft is given. C D.

A85-39202* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
COMPUTER STUDY OF A JET FLAP ASTVOL 'HARRIER'
S. B. WILSON, III and L. D. LIPERRA (NASA, Ames Research Center, Moffett Field, CA) IN: V/STOL: An update and overview; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 1-13. refs
(SAE PAPER 841457)

A study of the costs/benefits trade-off was conducted for an Advanced Supersonic Short Takeoff and Vertical Landing (ASTOVL) aircraft incorporating a jet flap. The data used were the theory of jet flaps and high aspect ratio nozzles, experience with a V/STOL aircraft study performed for NASA Ames Research Center in February 1982, and a high performance aircraft-synthesis program (ACSYNT). The methodology was to accurately model the supersonic Harrier V/STOL aircraft design on ACSYNT, and then modify the design by both adding high aspect-ratio nozzles in place of the rear (core-flow) nozzles on the Pegasus-type turbofan engine, and integrating these nozzles on each wing's trailing edge, thus creating a jet flap The predicted performance advantages (increase in maximum lift coefficient with flap deflection and horizontal thrust recovery) were traded off against the disadvantages (additional weight and thrust loss due to ducting) on two representative missions. Author

A85-39204
SERIES FLOW TANDEM FAN - A HIGH-SPEED V/STOL PROPULSION CONCEPT
T. W. CLINGINGSMITH (LTV Aerospace and Defense Co., Dallas, TX) IN: V/STOL: An update and overview; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p 23-29. refs
(SAE PAPER 841496)

A promising high speed V/STOL propulsion concept, the series flow tandem fan (SFTF), was analyzed by Vought for a single engine airplane configuration. The SFTF propulsion system was evaluated for size, performance and technology issues by engine companies under contract. Under contract to the Naval Air Propulsion Center (NAPC), Vought assessed engine contractor definition of baseline and alternate SFTF propulsion systems when installed in a representative aircraft concept. This paper summarizes the results of these studies and shows the impact on VTO thrust requirements, exhaust temperature and airplane performance. Further, the effect of STOVL criteria on vehicle sizing and engine design is being studied under a follow-on contract. Author

A85-39208* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif
TWIN TILT NACELLE V/STOL AIRCRAFT
M. A. ESKEY, S. B. WILSON, III (NASA, Ames Research Center, Moffett Field, CA), W. VALCKENAERE (Grumman Aerospace Corp., Bethpage, NY), and J P LAREAU (U S Naval Air Systems Command, Washington, DC) IN: V/STOL: An update and overview; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc , 1984, p 67-81. refs
(SAE PAPER 841556)

This paper describes the second government-conducted, piloted flight simulation of the Grumman Design 698 V/STOL (vertical and short takeoff and landing) aircraft. Emphasis is on the aircraft's handling qualities as rated by various NASA, Navy, and GAC pilots with flight experience ranging from CTOL (conventional take-off and landing) to V/STOL aircraft. The Design 698 had been modified to resolve the flight problems that were of most concern to the pilots in the first investigation (Phase I) Those problems included an adverse nonminimum phase (NMP) acceleration response in both the longitudinal and lateral axes, a large thrust-response lag, and adverse ground effects. The adverse NMP acceleration is an attribute of the vertical vanes (a Grumman patent) positioned in the fan exhaust flow. The primary modifications included using the vertical-vane deflection as a thrust spoiling method, the addition of the cross-shafted propulsion system, and the implementation of two velocity and attitude control modes (standard and precision) for speeds below 50 knots. Author

A85-39211*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif
APPLICATIONS OF STATE ESTIMATION IN AIRCRAFT FLIGHT-DATA ANALYSIS
R. E BACH, JR. and R. C. WINGROVE (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol 22, July 1985, p. 547-554. Previously cited in issue 19, p 2798, Accession no. A83-41919. refs

A85-39212*# Virginia Polytechnic Inst. and State Univ., Blacksburg
CLASSICAL AND NEO-CLASSICAL CRUISE-DASH OPTIMIZATION
K. D. BILIMORIA, E. M. CLIFF, and H. J. KELLEY (Virginia Polytechnic Institute and State University, Blacksburg, VA) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 555-560. Previously cited in issue 20, p. 2851, Accession no. A84-42366. refs
(Contract NAG1-203)

A85-39217*# Boeing Commercial Airplane Co , Seattle, Wash.
WINGLET EFFECTS ON THE FLUTTER OF A TWIN-ENGINE TRANSPORT-TYPE WING
K. G. BHATIA, K. S. NAGARAJA (Boeing Commercial Airplane Co , New Product Div., Seattle, WA), and C. L. RUHLIN (NASA, Langley Research Center, Configuration Aeroelasticity Branch, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 587-594. Previously cited in issue 15, p. 2117, Accession no. A84-34907. refs

A85-39221#
APPROACH TO INTERIOR NOISE CONTROL. I - DAMPED TRIM PANELS
C. I. HOLMER (Cabot Corp., E-A-R Div., Indianapolis, IN) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 618-623. Previously cited in issue 01, p. 4, Accession no. A85-10900. refs

A85-39554#
TOWARD A UNIFYING THEORY FOR AIRCRAFT HANDLING QUALITIES
R. A HESS (California, University, Davis, CA) and I. SUNYOTO Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, July-Aug. 1985, p. 440-446. Previously cited in issue 06, p. 720, Accession no. A84-17966. refs

A85-39616#
MEETING THE 1985 FAA NOISE REGULATIONS WITH OLD ENGINES AND MODERN ACOUSTIC TECHNOLOGY
K S. IRWIN (Tracor Aviation, Inc., Goleta, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 7 p.
(AIAA PAPER 85-1120)
The application of FAR Part 36 Stage 2 noise limitations to four engine aircraft on January 1, 1985, generated the requirement to quiet the engines of earlier generation aircraft such as the Boeing 707. With reengining proven impractical for the 707, an approach was developed that achieved the required noise reductions through a combination of (1) Nacelle modifications incorporating the advanced acoustical liner material DynaRohr(TM) for noise attenuation, (2) reduced landing flap settings requiring lower thrust (and hence lower noise) on approach, and (3) a modest reduction in maximum gross takeoff weight, resulting in improved climb gradients. This paper describes the design approach, ground tests, flight tests, analyses, and results that led to FAA Certification of the Tracor/Shannon Quiet 707 in early 1985 Author

A85-39698*# McDonnell Aircraft Co., St. Louis, Mo
THE INVESTIGATION OF INLET/NOZZLE FLOWFIELD COUPLING USING COMPACT PROPULSION SIMULATORS
D. E. ZILZ (McDonnell Aircraft Co., St. Louis, MO) and R. O. BAILEY (NASA, Ames Research Center, Advanced Aerodynamics Concepts Branch, Moffett Field, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 13 p refs
(AIAA PAPER 85-1284)
An investigation of airframe/propulsion system flowfield coupling has been conducted in the Ames 11-Foot Transonic Wind Tunnel at Mach numbers from 0.40 to 1.40 and at angles-of-attack from -2 to +20 deg. Propulsive flows were simulated by flow-through, jet-effects, and turbo-powered simulators (CMAPS) techniques. The configuration was a 10 percent scale model of a VSTOL canard/wing fighter configuration with twin podded engine nacelles and nonaxisymmetric nozzles. Localized flowfield interactions were present and inlet-nozzle flowfield coupling was identified at supersonic flight conditions. The configuration with simultaneous inlet and nozzle flow simulation (CMAPS) exhibited lower drag supersonically than the flow-through/jet-effects configuration During this first wind tunnel application of twin simulators in a full aircraft configuration, the CMAPS and control system proved to be a flexible, reliable testing method. Author

A85-39785#
THE INTEGRATION OF A NEW CONCEPT IN VTOL AIRCRAFT PROPULSION
P. S. MOLLER (Moller International, Davis, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 7 p refs
(AIAA PAPER 85-1448)
Operational benefits and penalties of a lifting-fan VTOL aircraft, intended largely for commuter and other civil purposes, is examined Two (6-fan and 8-fan) models are considered; the 6-fan version, which is currently in the testing stage, is characterized by a top speed of 235 mph, maximum payload of 900 lbs, hover ceiling of 9,500 ft, and operational ceiling of 16,000 ft. Among propulsion-related problems, attention is paid to power-to-weight ratio requirements as a function of hover characteristics, engine or lifting component failure tolerance, and efficient cruise. Finally, thrust vectoring, hover control capability, and noise considerations are discussed. L.T.

A85-39786#
STARDUSTER - A SOLAR POWERED HIGH ALTITUDE AIRPLANE
R. J BOUCHER (Astro Flight, Inc, Marina del Rey, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 9 p. refs
(AIAA PAPER 85-1449)
This paper presents an analysis of a proposed solar powered high altitude airplane called 'Starduster'. Starduster is designed to reach extreme altitudes exceeding 200,000 feet and, although flight is limited to the daylight hours, long distance flights over thousands of miles are possible. Vehicle configurations are examined and subsystem functional requirements are defined. Author

A85-39789#
PROPULSION INFLUENCES ON AIR COMBAT
P. W. HERRICK (United Technologies Corp, Pratt and Whitney Group, West Palm Beach, FL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p. refs
(AIAA PAPER 85-1457)
The influences of aircraft propulsion systems on the conduct and outcome of air-to-air combat are traced from World War I to the foreseeable future. Propulsion characteristics are shown to heavily impact fighter aircraft performance, maneuverability, detectability, persistence, tactics, range, vulnerability, and weapons utilization. World War I influences relate to propeller/gun positioning and rotary/stationary engine choices. Post World War I benefits accrued from propeller, engine, and fuel advances. World War II air combat was affected by propeller influences, fuel injection, engine cooling, supercharging, and engine installation Jet engines provided speed, altitude, and damage tolerance at the expense of fuel economy, threat awareness, and missile susceptibility. Future propulsion advances will provide supersonic cruise and supermaneuverability while reducing aircraft detectability. Author

A85-39869#
THE DEVELOPMENT OF THE GENERALIZED ESCAPE SYSTEM SIMULATION PROGRAM
D. A FENDER (Ketron, Inc., Warminster, PA) and L. A. DAULERIO (U.S Naval Material Command, Naval Air Development Center, Warminster, PA) American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec 9-14, 1984 8 p. refs
(ASME PAPER 84-WA/DSC-20)
A program is described which generates six-dimensional trajectory predictions for the aircraft, the seat/occupant, the occupant alone, and the seat alone for existing or developmental seat ejection systems, and evaluates the effects of such systems and components as seat catapults, rails, rockets, stabilization mechanisms, and parachute systems on the trajectories The study also deals with the means of determining orientations between model elements, handling of large tables of aerodynamic coefficient data, minimization of memory requirements, and accuracy verification of the final model. L T.

N85-27851 Messerschmitt-Boelkow-Blohm G.m.b H., Ottobrunn (West Germany).
DEVELOPMENT OF A FUSELAGE FORWARD SECTION IN CARBON FIBER REINFORCED PLASTIC (CFRP) TYPE OF CONSTRUCTION [ENTWICKLUNG EINES RUMPFVORDERTEILES IN CFK-BAUWEISE]
M. VOGLSINGER Oct. 1984 44 p In GERMAN
(MBB/LFA34/CFK/PUB/008) Avail: Issuing Activity
A complete fuselage nose made of CFRP was developed and manufactured. Cost and time constraints imposed compromises, such as testing at room temperature without humidity and no buckling loading up to rupture. The main goals of the experimental program are nevertheless achieved and the suitability of this type of construction is demonstrated A CFRP portion of 50% is shown to be a sensible upper limit; a sufficient static strength is obtained; a mass reduction of 18% can be obtained; the reproducibility of the production method is demonstrated; and the higher CFRP

material and equipment costs are shown to be compensated by a reduced assembly cost. Author (ESA)

N85-27852*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

FRICTION AND WEAR BEHAVIOR OF ALUMINUM AND COMPOSITE I-BEAM STIFFENED AIRPLANE SKINS

K. E. JACKSON Jun. 1985 28 p refs Prepared in cooperation with Army Structures Lab., Hampton, Va.
(NASA-TM-86418; NAS 1.15:86418; USAAVSCOM-TM-85-B-2) Avail: NTIS HC A03/MF A01 CSCL 01C

Friction and wear behavior was determined for I-beam stiffened skins constructed of aluminum, graphite-epoxy composite, and glass hybrid composite under abrasive loading conditions typical of those occurring on the underside of a transport airplane during an emergency belly landing. A test apparatus was developed to abrade the test specimens on actual runway surface under a range of pressures (2-5 psi) and velocities (16-50 mph). These parameters were chosen to fall within the range of conditions typical of an airframe sliding on a runway surface. The effects of the test variables on the wear rate and the coefficient of friction are discussed and comparisons are made between the composite materials and aluminum. In addition, the test apparatus was equipped to monitor the temperature variations on the backside of the skins during abrasion and these results are presented. Author

N85-27853# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.

AN ASSESSMENT OF THE SUITABILITY OF THE BHGA STRUCTURAL TEST RIG FOR AERODYNAMIC TESTING OF HANG GLIDERS

E. A. KILKENNY Feb. 1985 29 p refs
(CA-8505; ISBN-0-947767-185) Avail: NTIS HC A03/MF A01

In response to a proposal by the BHGA to use their structural test rig to carry out aerodynamic testing of hang gliders, the existing structural test facility and the modifications already made for aerodynamic testing are described. Improvements to the instrumentation are discussed together with an assessment of the flow quality and recommendations made, based on experience gained from existing aerodynamic test facilities. Author

N85-27854*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ROTORCRAFT RESEARCH TESTING IN THE NATIONAL FULL-SCALE AERODYNAMICS COMPLEX AT NASA AMES RESEARCH CENTER

W. WARMBRODT, C. A. SMITH, and W. JOHNSON May 1985 90 p refs
(NASA-TM-86687; REPT-85140; NAS 1.15:86687) Avail. NTIS HC A05/MF A01 CSCL 01C

The unique capabilities of the National Full-Scale Aerodynamics Complex (NFAC) for testing rotorcraft systems are described. The test facilities include the 40- by 80-Foot Wind Tunnel, the 80- by 120-Foot Wind Tunnel, and the Outdoor Aerodynamic Research Facility. The Ames 7- by 10-Foot Subsonic Wind Tunnel is also used in support of the rotor research programs conducted in the NFAC. Detailed descriptions of each of the facilities, with an emphasis on helicopter rotor test capability, are presented. The special purpose rotor test equipment used in conducting helicopter research is reviewed Test rigs to operate full-scale helicopter main rotors, helicopter tail rotors, and tilting prop-rotors are available, as well as full-scale and small-scale rotor systems for use in various research programs. The test procedures used in conducting rotor experiments are discussed together with representative data obtained from previous test programs. Specific examples are given for rotor performance, loads, acoustics, system interactions, dynamic and aeroelastic stability, and advanced technology and prototype demonstration models. B.W.

N85-27855*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

ADDITION OF FLEXIBLE BODY OPTION TO THE TOLA COMPUTER PROGRAM, PART 1 Final Report

J. W. DICK and B. J. BENDA Oct. 1975 402 p refs 2 Vol.
(Contract NAS1-13259)
(NASA-CR-132732-1; NAS 1.26:132732-1) Avail: NTIS HC A18/MF A01 CSCL 01C

This report describes a flexible body option that was developed and added to the Takeoff and Landing Analysis (TOLA) computer program. The addition of the flexible body option to TOLA allows it to be used to study essentially any conventional type airplane in the ground operating environment. It provides the capability to predict the total motion of selected points on the analytical methods incorporated in the program and operating instructions for the option are described. A program listing is included along with several example problems to aid in interpretation of the operating instructions and to illustrate program usage. Author

N85-27856*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

ADDITION OF FLEXIBLE BODY OPTION TO THE TOLA COMPUTER PROGRAM. PART 2: USER AND PROGRAMMER DOCUMENTATION

J. W. DICK and B. J. BENDA Oct. 1975 205 p refs 2 Vol
(Contract NAS1-13259)
(NASA-CR-132732-2; NAS 1.26:132732-2) Avail: NTIS HC A10/MF A01 CSCL 01C

User and programmer oriented documentation for the flexible body option of the Takeoff and Landing Analysis (TOLA) computer program are provided. The user information provides sufficient knowledge of the development and use of the option to enable the engineering user to successfully operate the modified program and understand the results. The programmer's information describes the option structure and logic enabling a programmer to make major revisions to this part of the TOLA computer program. Author

N85-27857# National Research Council of Canada, Ottawa (Ontario).

A PRELIMINARY INVESTIGATION OF HANDLING QUALITIES REQUIREMENTS FOR HELICOPTER INSTRUMENT FLIGHT DURING DECELERATING APPROACH MANEUVERS AND OVERSHOOT

S. KEKELIUK and M. MORGAN Feb. 1985 35 p refs
(NRC-24173; NAE-AN-26) Avail: NTIS HC A03/MF A01

A preliminary flight investigation was carried out to highlight deficiencies of helicopters handling qualities when performing low speed instrument approaches. Steep decelerating microwave landing system approaches to a decision height of 50 feet, simultaneously decelerating to 20 knots, were performed in the NAE Airborne Simulator, a variable-stability Bell 205A helicopter. Tracking performance, in terms of height, azimuth and speed errors was of an acceptable standard, but pilot workload was extremely high, especially during the overshoot phase. Benefits of different levels of control system augmentation were not readily apparent in this high workload environment. A follow-on program is proposed where further attempts will be made to determine the effects of display and control sophistication on pilot workload during slow speed helicopter instrument procedures. Author

N85-27858# Dayton Univ., Ohio. Research Inst.

USAF DAMAGE TOLERANT DESIGN HANDBOOK: GUIDELINES FOR THE ANALYSIS AND DESIGN OF DAMAGE TOLERANT AIRCRAFT STRUCTURES, REVISION B Final Report, Sep. 1980 - Mar. 1984

J. P. GALLAGHER, F. J. GIESSLER, and A. P. BERENS Wright-Patterson AFB, Ohio AFWAL May 1984 1329 p
(Contract F33615-80-C-3229)
(AD-A153161; AFWAL-TR-82-3073-REV-B) Avail: NTIS HC A99/MF E05 CSCL 01C

This handbook supports the USAF Airplane Damage Tolerance Requirements contained in MIL-A-83444. The handbook provides

specific background data and justification for the detailed requirements of MIL-A-83444 and provides guidelines and state-of-the-art analysis methods to assist contractor and USAF personnel in complying with the intent of the specification and in solving cracking problems, in general, for metallic aircraft structures. The material contained in this document is general enough to be useful in the evaluation of the damage tolerance of in-service aircraft designed and qualified prior to the issuance of MIL-A-83444. The handbook has been structured to provide a clear and concise summary of the specification, MIL-A-83444, as well as supporting analysis methods, test techniques, and nondestructive inspection (NDI) methods are provided as state-of-the-art along with suggested and/or recommended practices, limitations, etc. For the convenience of the user, copies of appropriate USAF structural specifications are contained as an appendix to this handbook.
GRA

N85-27859# Aeronautical Research Labs., Melbourne (Australia)
FLIGHT TRIALS OF A MODIFIED GULFSTREAM COMMANDER CARRYING EXTERNAL STORES
P. A. FARRELL and A. GOLDMAN Sep. 1984 27 p
(AD-A153376; ARL/STRUC-TM-392) Avail. NTIS HC A03/MF A01 CSCL 01C

The Dept. of Aviation Australia has modified a gulfstream G.695A aircraft to carry external stores on the fuselage. A vibration test followed by a series of flight trails were conducted to satisfy some of the requirements of certification. A description of these tests together with the results is given. GRA

N85-27860# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
PARAMETER IDENTIFICATION RESULTS OF TESTS IN NONSTEADY SYMMETRIC FLIGHT WITH THE HAWKER HUNTER MK 7
J. H. BREEMAN 4 Jan. 1983 59 p refs
(Contract NIVR-1697)
(NLR-TR-83042-U; B8560426; AD-B089090L) Avail NTIS HC A04/MF A01

A flight test method for high speed aircraft was evaluated in nonsteady symmetric maneuvers with the Hawker Hunter Mk 7. The reproducibility of the estimated parameters is 1.5% for the drag model, 1% for the lift model, and 3% for the pitching moment model. However, this last result is strongly affected by the uncertainty in the center of gravity location. The results agree with findings derived from the same data after allowing for a difference in the mean aerodynamic chord used in the latter results. The results are consistent with flight tests of a Hawker Hunter Mk 12. Author (ESA)

N85-27861# National Aerospace Lab, Amsterdam (Netherlands).
NEW MATERIALS AND TECHNIQUES FOR AIRCRAFT STRUCTURES
1983 15 p In DUTCH; ENGLISH summary Sponsored by Netherlands Agency for Aerospace Programs
(B8580074) Avail: NTIS HC A02/MF A01

The structural static strength and stiffness, fatigue crack propagation resistance, residual strength, stress corrosion resistance, and fracture toughness of aircraft construction materials and the techniques to produce them are discussed. Aluminum alloys (Al Zn Mg Cu, Al Cu Mg), fiber (carbon, boron, keular) composite materials, titanium alloys, high strength steels, and adhesively bonded laminated sheet structures are discussed
Author (ESA)

N85-27862# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst fuer Physik der Atmosphaere.
THREE POWERED SAILPLANES AS METEOROLOGICAL INSTRUMENTATION FOR ATMOSPHERIC BOUNDARY LAYER STUDIES AT DFVLR
A. M. JOACHUM, M. E. REINHARDT, and H WILLEKE Nov. 1984 151 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-920) Original contains color illustrations
(DFVLR-FB-84-50, ISSN-0171-1342) Avail: NTIS HC A08/MF A01

Three ASK 16 powered sailplanes are used as meteorological research aircraft for atmospheric boundary layer studies The instrumentation and the data acquisition and evaluation systems as well as an error analysis are described. Data and results are presented. Author (ESA)

N85-28914# Technische Univ., Brunswick (West Germany). Inst. fuer Flugmechanik.
HELICOPTER AEROMECHANICS: INTRODUCTION AND HISTORICAL REVIEW
G. REICHERT *In* AGARD Helicopter Aeromech. 23 p Apr. 1985 refs
Avail NTIS HC A15/MF A01

Although the current generation of civil and military helicopters have greatly improved upon the previous generations, rotorcraft technology still has the potential for decided improvements. As high-payoff technologies aeromechanics (aerodynamics/dynamics), structures/materials, avionics/flight controls, and engine drive system technology can be identified, of which aeromechanics will be discussed in more detail. The general role of aeromechanics in military and civilian applications to rotary wing aircraft will be summarized and an overview of the state of the art will be given. In addition to direct performance improvements, there is great opportunity to improve the operating characteristics to a degree that the full performance characteristics inherent in the designs may be realized. Some current systems fail in the utilization of their full performance as a result of dynamical limitations or high vibrational levels G.L.C.

N85-28915# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
A SURVEY OF RECENT DEVELOPMENT IN HELICOPTER AERODYNAMICS
J. J. PHILIPPE, P. ROESCH, A. M DEQUIN, and A. CLER *In* AGARD Helicopter Aeromech 40 p Apr. 1985 refs Prepared in cooperation with Societe Nationale Industrielle Aerospatiale, Marignane, France
Avail: NTIS HC A15/MF A01

Various aspects of helicopter aerodynamics are addressed. The aerodynamics of isolated rotors and fuselages as well as some topics in interactional aerodynamics are dealt with. G.L C.

N85-28917*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif
RECENT DEVELOPMENTS IN THE DYNAMICS OF ADVANCED ROTOR SYSTEMS
W. JOHNSON *In* AGARD Helicopter Aeromech 51 p Apr. 1985 refs
Avail: NTIS HC A15/MF A01 CSCL 01C

The problems that have been encountered in the dynamics of advanced rotor systems are described. The methods for analyzing these problems are discussed, as are past solutions of the problems. To begin, the basic dynamic problems of rotors are discussed: aeroelastic stability, rotor and airframe loads, and aircraft vibration. Next, advanced topics that are the subject of current research are described: vibration control, dynamic inflow, finite element analyses, and composite materials. Finally, the dynamics of various rotorcraft configurations are considered: hingeless rotors, bearingless rotors, rotors with circulation control, coupled rotor/engine dynamics, articulated rotors, and tilting proprotor aircraft. G.L.C.

N85-28920# Royal Aircraft Establishment, Bedford (England). Helicopter Aeromechanics Section.
FLIGHT TESTING FOR PERFORMANCE AND FLYING QUALITIES
G. D. PADFIELD *In* AGARD Helicopter Aeromech. 51 p Apr. 1985 refs
Avail: NTIS HC A15/MF A01

A systematic review of flight test techniques and test data interpretation methods for helicopter performance and flying qualities is presented. The distinction is drawn between quasi-steady and dynamic testing and within these categories both clinical and role-related techniques are discussed Performance topics covered include steady state performance in hover and forward flight, flight envelope boundaries, take-off and landing performance, and helicopter agility. Flying qualities topics begin with a treatment of static stability tests and progress to dynamic stability, control response, system identification and role-related evaluation techniques Testing appropriate to certification and development phases and research activities are addressed. The exploratory nature of flight testing is evident throughout this work and safety aspects are emphasized when required. Results from recent and past test programs are used to illustrate the forms in which flight data can be presented, and data reduction and analysis methods established and under development are reviewed
Author

N85-28936 Department of the Air Force, Washington, D.C.
HEAT MANAGEMENT SYSTEM FOR AIRCRAFT Patent
A. H. MAYER, inventor (to Air Force) 19 Mar. 1985 11 p
Supersedes AD-D010635
(AD-D011658; US-PATENT-4,505,124; US-PATENT-APPL-SN-534996; US-PATENT-CLASS-62-180)
Avail· US Patent and Trademark Office CSCL 13A

A novel heat management system for aircraft is provided which is based on the aircraft fuel as the heat exchange medium and comprises a dedicated thermal reserve fuel tank for containing refrigerated aircraft fuel (or other expendable liquid) which is cooled by heat exchange with the primary aircraft fuel flow to the engines, a fuel line loop for conducting fuel through a plurality of heat exchangers associated with cooling loops for heat generating aircraft systems, and a central microprocessor based controller for controlling fuel flow and temperature throughout the fuel loop system and into the aircraft engine. Author (GRA)

N85-28937*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif
FUTURE OF V/STOL AIRCRAFT SYSTEMS: A SURVEY OF OPINIONS
K. C. WHITE, B. A. LAMPKIN, and H. ANDREWS (Naval Air Systems Command, Washington, D C) Jun 1985 15 p refs
(NASA-TM-86689; REPT-85146; NAS 1.15:86689) Avail NTIS HC A02/MF A01 CSCL 01C

The recent success of the British Harriers in the Falkland Islands conflict vividly underscored the potential of V/STOL aircraft in military operations in a difficult environment. Despite this apparent success of the Harrier, there has been a major decline of V/STOL funding in the research and development budgets of the U.S. government and industry The recent funding history of V/STOL systems is examined. Responses to a questionnaire which asked the question, Should there be an operational V/STOL aircraft other than the AV-8A and AV-8B in the military aircraft fleet of the U.S.A.? are presented and discussed. Author

N85-28938# Aeronautical Research Labs., Melbourne (Australia).
FURTHER INVESTIGATIONS TO IMPROVE THE FATIGUE LIFE OF THE MIRAGE 1110 WING MAIN SPAN
J. Y. MANN, A. S. MACHIN, and W. F. LUPSON Jan. 1985 31 p refs
(ARL-STRUC-TM-397; AR-003-984) Avail NTIS HC A03/MF A01

Wing main spars of Mirage IIIIO aircraft have undergone a refurbishment program to extend their fatigue lives by the installation of interference-fit steel bushes A supplementary investigation has been carried out to assess two potential techniques for reducing the influence of empty rivet holes (namely the installation of interference-fit steel pins and adhesively-bonded aluminium rivets), and to assess the improvements in fatigue life which might be introduced by a redesign of the spar at the previously critical location. It was found that both treatments of the rivit holes resulted in a further small improvement in the life of specimens refurbished with interference-fit steel bushes at the bolt holes, and that these lives were not significantly different from that of specimens of the new design of spar in which the cross-sectional area increased and the rivet holes omitted. However, considerable improvements in life were obtained when the bolt holes in the redesigned spar specimens were either cold-expanded (a factor of 4.1) or had interference-fit steel bushes installed in them (a factor of 3.4). Author

N85-28939# Technische Hochschule, Darmstadt (West Germany). Inst. fuer Flugtechnik
EXPERIMENTAL AND THEORETICAL DETERMINATION OF THE WING-INDUCED LATERAL WIND ON THE TAIL SURFACES IN OSCILLATING ROLLING MOTION. PART 1: APPLICATION OF THE MOBILE OSCILLATING DERIVATIVES (MOD) ON AN EXPERIMENTAL PART Final Report [EXPERIMENTELLE UND THEORETISCHE ERMITTLUNG DES INDUZIERTEN SEITENWINDES AM SEITENLEITWERK BEI OSZILLIERENDER ROLLBEWEGUNG. ROLLBEWEGUNG. TEIL 1: EXPERIMENTELLER TEIL UNTER VERWENDUNG DER MOBILEN OSZILLIERENDEN DERIVATIVWAAGE]
O DETERMANN and J OSER 1 Dec 1984 92 p refs In GERMAN 2 Vol.
(Contract BMFT-HA-514/61)
(IFD-1/84-PT-1) Avail: NTIS HC A05/MF A01

Induced oscillating lateral wind on tail surfaces was determined using a five-hole conical probe. The dynamic rolling-stability derivatives for force and moment measurement confirm the effects of the induced lateral wind The experimental values are identical to the theoretical values Author (ESA)

N85-28940# Technische Hochschule, Darmstadt (West Germany) Inst fuer Flugtechnik.
EXPERIMENTAL AND THEORETICAL DETERMINATION OF THE WING-INDUCED LATERAL WIND ON THE TAIL SURFACES IN OSCILLATING ROLLING MOTION. PART 2: THEORETICAL INVESTIGATIONS FOR CALCULATION OF THE LATERAL WIND Final Report [EXPERIMENTELLE UND THEORETISCHE ERMITTLUNG DES INDUZIERTEN SEITENWINDES AM SEITENLEITWERK BEI OSZILLIERENDER ROLLBEWEGUNG. TEIL 2: THEORETISCHE UNTERSUCHUNG ZUR BERECHNUNG DES SEITENWINDES]
J. OSER and O. DETERMANN 1 May 1984 50 p In GERMAN 2 Vol.
(Contract BMFT-HA-514/61)
(IFD-1/84-PT-2) Avail: NTIS HC A03/MF A01

The influence of geometrical parameters on ideal wing and wing-fuselage configurations was studied The rolling lateral wind is calculated using the lifting line method for wings with different aspect ratios, sweeps and planform tapers as well as for the corresponding wing-fuselage combinations. The theoretical results give a general view of the effects of the wing and fuselage geometrical data and position on the rolling lateral wind.
Author (ESA)

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A85-37896#
THE COCKPIT OF THE AIRBUS A310 [DAS COCKPIT DES AIRBUS A310]
J.-P. HACH (Deutsche Lufthansa AG, Cologne, West Germany) and P. H. HELDT Luft- und Raumfahrt (ISSN 0173-6264), vol. 5, 3rd Quarter, 1984, p 67-76. In German.

The design of the cockpit of the European Airbus A310, which is fundamentally different from those of earlier commercial aircraft, is described. The design principles of the cockpit are discussed and the overhead panel, Electronic Centralized Aircraft Monitor, flight autopilot, Flight Management System flight path computer, and electronic flight instruments are described The cockpit layout is depicted. C D.

A85-37925
COCKPIT OF THE FUTURE?
H. HOPKINS Flight International (ISSN 0015-3710), vol. 127, June 8, 1985, p. 59-61.

An evaluation is made of new perceptions that have arisen in the course of a NASA simulation study of novel transport aircraft cockpit configurations incorporating advanced display technologies and ergonomic concepts. In this study, general assumptions have been made for the case of the technological and commercial aircraft operating environment of the mid-1990s, the baseline is a two-crew member twin-engined jet aircraft, but alternative aircraft types can be simulated through software changes. The color-coded graphics displays used present flight path and speed, time-critical alert, path deviation, map, track, waypoint, time/distance to waypoint, course, wind, and weather data. Traffic information and obstacle clearance data, together with checklist and functional systems display capabilities, have also been incorporated O.C

A85-38319
ATTITUDE DETERMINATION IN A LIMB-SCANNING BALLOON RADIOMETER
J R DRUMMOND, D. TURNER, and A. ASHTON (Toronto, University, Toronto, Canada) (COSPAR, Symposium on Scientific Ballooning - IV, 7th, Graz, Austria, June 25-July 7, 1984) Advances in Space Research (ISSN 0273-1177), vol. 5, no. 1, 1985, p. 73-76. Research supported by the Natural Sciences and Engineering Research Council of Canada and University of Toronto

The determination of the line-of-sight with reference to the atmospheric horizontal is critical to the correct interpretation of signals from an emission-sensing, limb-scanning instrument. The use of signals from a two-sided, limb-scanning instrument, the University of Toronto Balloon Radiometer, to determine the beam position relative to the atmospheric horizontal is discussed. Some preliminary results from the engineering flight of the instrument are presented. Author

A85-38363#
TERRAIN/WIRE AND WIRELIKE OBSTACLES WARNING SYSTEM FOR HELICOPTERS
T. TAKENAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 32, no. 361, 1984, p. 94-96. In Japanese.

A terrain/wire and wirelike obstacle detecting system for helicopters employing a CO2 laser radar and FLIR/TV camera is proposed, and its structure and function are discussed. The CO2 laser radar provides a relatively large output power, resulting in reduced eye-hazard, and consists of a heterodyne detector for receiving and a pulse beam system for transmitting. The data collected are shown on a display panel with the aid of video signals from the FLIR or TV. Specifications of the CO2 laser radar and the construction details of the detecting system are presented. S.H.

A85-38401
ADVANCED AVIONICS MANAGEMENT SYSTEM PREVENTS PILOTS FROM BEING SWAMPED BY INFORMATION OVERLOAD
R. JOHNSTON (Allied Bendix Aerospace, Flight System Div, Teterboro, NJ) Defense Systems Review and Military Communications, vol. 3, no. 4, 1985, p. 11-14.

Pilots must not be so overwhelmed by flight instrument information as to experience distraction or stress. The organization of information demanded by this criterion has led to the recent development of an advanced Avionics Management System (AMS), which, although intended for a transport helicopter, is adaptable to a variety of other aircraft This multidisplay system combines various functions that are required for control of the cockpit and the management of mission profile and aircraft performance. The displays include an Electronic Altitude Director Indicator, an Electronic Horizontal Situation Indicator, a Color Multifunction Display, and a keyboard Primary and backup computers are incorporated in the AMS. O.C.

A85-38951
ADVANCED AIRCREW DISPLAY SYMPOSIUM, 6TH, PATUXENT RIVER, MD, MAY 15, 16, 1984, PROCEEDINGS
Patuxent River, MD, U.S. Naval Air Test Center, 1984, 216 p. For individual items see A85-38952 to A85-38961.

A systematic program for the development and evaluation of airborne color display systems is discussed along with airborne electronic color displays in the United Kingdom, color CRT in the F-15, the integration of sensor and display subsystems, and the modernization of engine displays. Attention is given to colored displays for combat aircraft, display technology and the role of human factors, and the past, present, and future of the pictorial format program Other topics explored are related to sensor-coupled vision systems, an argument for standardization in modern aircraft crew stations, and the command flight path display for the integrated pictorial presentation of the fundamental information necessary to effectively perform all normal basic flight operations. G R.

A85-38952#
A SYSTEMATIC PROGRAM FOR THE DEVELOPMENT AND EVALUATION OF AIRBORNE COLOR DISPLAY SYSTEMS
L D. SILVERSTEIN (General Physics Corp., Atlanta, GA), R. M MERRIFIELD, W. D SMITH (Boeing Commercial Airplane Co., Seattle, WA), and F. C. HOERNER (U S. Naval Air Test Center, Patuxent River, MD) IN: Advanced Aircrew Display Symposium, 6th, Patuxent River, MD, May 15, 16, 1984, Proceedings . Patuxent River, MD, U.S. Naval Air Test Center, 1984, p. 3-44 refs

The recent proliferation of new color display applications is partly related to a growing interest in the potential advantages of a color information display for enhancing human performance in complex man-machine systems. Another contributing factor is the availability of a rapidly evolving display technology to support advanced color display concepts. An obvious application of color display technology is connected with airborne operations. It is pointed out that piloting and airborne command/control tasks involve complex, highly-dense forms of information, entail periodic episodes of high operator workload, and are often performed under suboptimal environmental conditions. A systematic program for the development and evaluation of airborne color display systems has recently been initiated In the present paper, attention is given to the overall architecture of the program, details regarding the objectives and approach for current program activities, and a few select issues of interest for color display system design G.R

A85-38953#
AIRBORNE ELECTRONIC COLOR DISPLAYS - A REVIEW OF UK ACTIVITY SINCE 1981
J. R. CALDOW (Smiths Industries Aerospace and Defence Systems Co., Arlington, VA) IN: Advanced Aircrew Display Symposium, 6th, Patuxent River, MD, May 15, 16, 1984, Proceedings . Patuxent River, MD, U.S. Naval Air Test Center, 1984, p. 45-65. Research supported by the Department of Industry and Ministry of Defence of England.

After extended simulator studies, a color display system was installed in a research aircraft of the Royal Aircraft Establishment at Bedford, to provide an airborne assessment of the potential of such a system in transport aircraft. The present paper has the objective to outline the results of this airborne assessment and to indicate the extent of additional work which has been carried out in the United Kingdom over the last 2 1/4 years. Attention is given to background information, flight experience with color displays, general color vs monochrome impressions, problems related to scan, the format, an evaluation of colors, questions of legibility, flicker and apparent movement, eye fatigue, and additional research. G.R.

A85-38954#
COLOR CRT IN THE F-15
J. TURNER and H. WARUSZEWSKI (Sperry Corp., Sperry Flight Systems, Albuquerque, NM) IN: Advanced Aircrew Display Symposium, 6th, Patuxent River, MD, May 15, 16, 1984, Proceedings . Patuxent River, MD, U S Naval Air Test Center, 1984, p. 66-80C. refs

The use of color displays in the cockpit and their capability to satisfy requirements related to the military environment has been studied by the U.S. Air Force. One of the studies conducted was requested by the F-15 System Program Office (SPO) to investigate the feasibility of using a color display in a bubble canopy fighter cockpit environment. The findings indicated that color coded symbology provided a significant reduction in the error rate and detection time. Attention is given to the F-15 color display, the programmable signal data processor (PSDP), color display details, and aspects of advanced color display. It is concluded that color CRT displays will become an accepted part of the military cockpit and in some cases the dominant feature of the crew station. The use of color displays in tactical presentations, threat displays, caution and warnings, and map displays can reduce pilot workload and error rates. G R.

A85-38955#
INTEGRATION OF SENSOR AND DISPLAY SUBSYSTEMS
D. A. BOHRER and P. C. JENKINS (Rockwell International Corp., Collins Government Avionics Div., Cedar Rapids, IA) IN: Advanced Aircrew Display Symposium, 6th, Patuxent River, MD, May 15, 16, 1984, Proceedings . Patuxent River, MD, U.S. Naval Air Test Center, 1984, p. 81-95.

The proliferation of subsystems needed to satisfy operational requirements can lead to an increasing crew workload in military aircraft, while, in connection with another trend, a reduction of the crew complement is being considered. In response to these developments, attention has been given to the use of multifunction control heads and electronic multipurpose displays to produce a more effective crew/avionics interface. In the present study, a wider view is taken of a modern aircraft as a collection of interconnected subsystems, and the integration of all subsystems is considered. It is pointed out that such an approach will produce an avionics system with excellent user characteristics. Additional advantages are related to the ability to grow in an evolutionary manner, the ability to tolerate failures and damage, and the ability to support enhanced self-diagnostic and status reporting functions. Attention is given to the evolution of the integration viewpoint, integration drivers, integration candidates, and example system solutions. G.R.

A85-38957#
DISPLAY TECHNOLOGY AND THE ROLE OF HUMAN FACTORS
S. N. ROSCOE, J. S. TATRO, and E. J. TRUJILLO (New Mexico State University, Las Cruces, NM) IN. Advanced Aircrew Display Symposium, 6th, Patuxent River, MD, May 15, 16, 1984, Proceedings . Patuxent River, MD, U.S. Naval Air Test Center, 1984, p. 126-136. refs

While the transition from electromechanical flight instruments to multifunction electronic displays gains currently momentum, human factors engineers are not well prepared to provide quantitative information as contribution to the design process However, Tatro et al. (1983) have reported a step toward the demonstration of a holistic, multifactor experimental strategy for the design and evaluation of display and control systems. It is pointed out that vertical takeoff and landing (VTOL) aircraft have not reached their operational potential during all-weather instrument flight. The arising problems can be partly attributed to the inherent instability of the VTOLs' current control systems, while the remainder of the difficulties is caused by inadequate flight displays. Research is being conducted with the aim to eliminate these problems, taking into account the development of a multiple regression model of helicopter and VTOL pilot performance. Attention is given to a systems approach, and a simulation facility G.R.

A85-38958#
PICTORIAL FORMAT PROGRAM - PAST, PRESENT, AND FUTURE
G. D. LIZZA, J. M. REISING (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), and L. HITCHCOCK (Essex Corp., Warminster, PA) IN: Advanced Aircrew Display Symposium, 6th, Patuxent River, MD, May 15, 16, 1984, Proceedings . Patuxent River, MD, U.S. Naval Air Test Center, 1984, p. 137-143. refs

The operational use of pictorial graphics in the F-18's stores display sparked discussion between Air Force and Navy crew station design personnel regarding the long-term potential of this type of format for conveying information to the pilot. Based on these discussions, the joint Pictorial Format Program was launched; it consists of three phases. format development, format evaluation (single-seat), and format evaluation (two-seat). The first two phases are now complete, and the third is just beginning. The results, so far, indicate that pictorial formats are, indeed, an efficient means of portraying complex information to the aircrew. Author

A85-38959#
THE COMMAND FLIGHT PATH DISPLAY - ALL WEATHER, ALL MISSIONS
G. W HOOVER (Systems Associates, Inc., San Diego, CA), S. H. SHELLEY (Intermetrics, Inc., Cambridge, MA), V. CRONAUER (Systems Associates, Inc., Arlington, VA), and S. M. FILARSKY (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) IN: Advanced Aircrew Display Symposium, 6th, Patuxent River, MD, May 15, 16, 1984, Proceedings . Patuxent River, MD, U.S. Naval Air Test Center, 1984, p. 144-156.

A flight test program was conducted to demonstrate enhancement of pilot performance flying zero-zero conditions using the integrated Command Flight Path Display (CFPD). The CFPD concept requires minimal training for both IFR experienced and limited experienced pilots, compared to the training required when using conventional symbology. This enhancement is accomplished by providing attitude, altitude, direction and speed commands to the pilot in the form of an electronically generated presentation of the real world flight path which should be flown. During the flight test program, the performance of the pilots was measured subjectively through video recording of the Vertical/Head Up Display presentation. Objectively, the performance of the pilots was measured through digital data recordings of their inadvertent diversions from a mean flight path related to the presentation displayed on the Vertical/Head Up Displays. Author

A85-38961#
AN ARGUMENT FOR STANDARDIZATION IN MODERN AIRCRAFT CREW STATIONS
V. DEVINO (Grumman Aerospace Corp., Bethpage, NY) IN: Advanced Aircrew Display Symposium, 6th, Patuxent River, MD, May 15, 16, 1984, Proceedings . Patuxent River, MD, U.S. Naval Air Test Center, 1984, p. 186-195. refs

During the late 1940s and early 1950s, the armed services became increasingly aware that the lack of standardization with respect to aircrew station design was contributing to a very poor accident rate history. As a result of this development, DOD in 1951 established a panel which is now known as the Aircrew Station Standardization Panel (ASSP). The ASSP effort produced most of the crew station design standards which exist today. As the standardization effort matured, the ASSP met with decreasing frequency in the 1970s and then became dormant from June 1980 to 1983. The question arises now whether standardization is still needed. One argument against standardization is that reduced numbers and models of aircraft being procured do not warrant the effort involved in standardization. However, the author's reply to arguments against standardization is that the essential reasons for standardization are overriding and that the crew station of the future requires also standardization. G.R.

N85-27863# Applied Systems Inst., Inc., Washington, D.C.
AVIONICS DATA BASE Final Report
J. MCGOWAN, D. J. WON, and D. VAMETTEN Jan. 1985 272 p
(AD-A152415; FAA-APO-85-4) Avail: NTIS HC A12/MF A01 CSCL 09B

This document is a compendium of data for U.S. commercial avionics equipment produced by 61 manufacturers It contains data for the Air Transport Association (ATA) Specification 100 categories of auto flight, communications, indicating and recording, and navigation as well as for antennas and couplers. For each piece of equipment, the following information has been collected: technical specification, price, technical standard order number, ATA Specification 100 code, and manufacturer name, address, and phone number. In addition to this report, the data is available in machine readable form compatible with the IBM personal computer with R base 4000 Data Base Management System. GRA

N85-27864# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Navigation und Flugbahnvermessung.
THE AVIONICS FLIGHT EVALUATION SYSTEM (AFES) OF DFVLR
K. HURRASS and P. SCHULZ 1985 83 p refs In GERMAN; ENGLISH summary
(DFVLR-MITT-85-01; ISSN-0176-7739) Avail: NTIS HC A05/MF A01

An Avionics Flight Evaluation System (AFES) was developed, particularly for navigation systems. A tracking radar and a laser tracker on the ground, and an inertial navigation system onboard the test aircraft measure flight trajectories. The data are combined by optimal filters. In order to be able to evaluate in real time, computers are used at different locations. All elements of this measurement system are linked together by an efficient data transfer system. Besides the reference system, AFES contains subsystems for artificial traffic loading and measuring multipath effects. Author (ESA)

N85-28941*# Charles River Analytics, Inc., Cambridge, Mass.
EVALUATION OF A FAULT TOLERANT SYSTEM FOR AN INTEGRATED AVIONICS SENSOR CONFIGURATION WITH TSRV FLIGHT DATA Final Report
A. K. CAGLAYAN and P. M GODIWALA Jun. 1985 101 p refs
(Contract NAS1-17719)
(NASA-CR-172589; NAS 1.26:172589; R-85-02) Avail: NTIS HC A06/MF A01 CSCL 01D

The performance analysis results of a fault inferring nonlinear detection system (FINDS) using sensor flight data for the NASA ATOPS B-737 aircraft in a Microwave Landing System (MLS) environment is presented. First, a statistical analysis of the flight recorded sensor data was made in order to determine the characteristics of sensor inaccuracies. Next, modifications were made to the detection and decision functions in the FINDS algorithm in order to improve false alarm and failure detection performance under real modelling errors present in the flight data. Finally, the failure detection and false alarm performance of the FINDS algorithm were analyzed by injecting bias failures into fourteen sensor outputs over six repetitive runs of the five minute flight data. In general, the detection speed, failure level estimation, and false alarm performance showed a marked improvement over the previously reported simulation runs. In agreement with earlier results, detection speed was faster for filter measurement sensors soon as MLS than for filter input sensors such as flight control accelerometers. Author

N85-28942# Applied Systems Inst., Inc., Washington, D.C.
AVIONICS DATA BASE USERS MANUAL Final Report
J. MCGOWAN, D. J. WON, and D. VANETTEN Jan. 1985 117 p
(Contract DTFA01-83-Y-30629)
(AD-A153810; FAA-APO-85-5) Avail: NTIS HC A06/MF A01 CSCL 01C

This manual describes the uses, structure, and operating procedures-including data retrieval, entry and special functions-for the Avionics Data Base. This data base provides detailed data for avionics currently available for both air carrier and general aviation aircraft. Specific information contained in the data base includes price, weight, dimensions, manufacture, manufacture's address and telephone number, Technical Standard Order documentation, and ATA Specification 100 data. The Avionics Data Base was created using Microrim's R:Base Series 4000 Data Base Management System on the IBM Personal Computer. It contains three files or relations as they are referred to in this document. These relations are: Avionics - the relation that contains model specifications. Manufact - the relation that contains address and telephone number for the manufacturers. TSOREF - the relation that contains the Technical Standard Order (TSO) title, location, publication date and source document(s) for each TSO. Author (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.

A85-37233#
PRETWIST AND SHEAR FLEXIBILITY IN THE VIBRATIONS OF TURBINE BLADES
S. KRENK and O. GUNNESKOV (Forsogsanlaeg Riso, Roskilde, Denmark) ASME, Transactions, Journal of Applied Mechanics (ISSN 0021-8936), vol. 52, June 1985, p. 409-415. refs

A theory is developed for pretwisted beams with finite shear flexibility. The effect of pretwist is accounted for via the axial derivative of the St. Venant warping function. The shear flexibility relies on a decomposition of the shear stresses into torsion and shear contributions, and the normalized strain energy of the latter is expressed in terms of the shear flexibility tensor. An explicit approximation for the shear flexibility tensor is derived for cross sections of moderate wall thickness. A special Legendre transformation is used to obtain a consistent discretization, which is then cast in the form of a finite beam element. The accuracy of the method is illustrated by comparison with experimental results for a steam turbine blade, and the effects of pretwist and shear flexibility are discussed. Author

A85-37550
LIFT AND THRUST OF A LINEAR SYNCHRONOUS ENGINE WITH A SOLID-CONDUCTOR STATOR WINDING [SILY POD'EMA I TIAGI LINEINOGO SINKHRONNOGO DVIGATELIA S MASSIVNYMI PROVODNIKAMI OBMOTKI STATORA]
I. I. KURKALOV Beskontaktnye Elektricheskie Mashiny (ISSN 0320-6351), no. 23, 1984, p. 101-110. In Russian.
The characteristics of a linear synchronous engine featuring a stationary long stator which lacks ferromagnetic elements and has solid plate-shaped conductors are investigated. The lifting force and the thrust of the engine are calculated as a function of speed, acceleration, and passenger load, with allowance made for aerodynamic drag. The effect of the size of the excitation coil and of the stator conductors on the lift and thrust is analyzed, as is the effect of excitation current on the power consumption. V.L.

A85-37567
PROBABILISTIC PREDICTION OF THE FATIGUE LIFE OF THE COMPRESSOR BLADES OF GAS-TURBINE ENGINES UNDER TWO-LEVEL PROGRAMMED LOADING [VEROIATNOSTNOE PROGNOZIROVANIE USTALOSTNOI ZHIVUCHESTI KOMPRESSORNYKH LOPATOK GTD PRI DVUKHUROVNEVOM PROGRAMMNOM NAGRUZHENII]
M V. BAUMSHTEIN, A. V. PROKOPENKO, and V. N EZHOV (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), May 1985, p. 7-11. In Russian refs
An analytical-experimental approach to the probabilistic prediction of the fatigue life of the compressor blades of gas-turbine engines is proposed whereby the predictions are derived from the cyclic fracture toughness characteristics of the blade material under deterministic symmetrical two-level programmed loading. The approach involves statistical modeling of the random parameter vector of the fracture toughness characteristics. The method proposed here is verified through a direct experiment on compressor blades. V.L.

A85-37575
THE EFFECT OF STRESS RAISERS ON THE LOAD-BEARING CAPACITY OF TITANIUM-ALLOY COMPRESSOR BLADES [VLIIANIE KONTSENTRATOV NAPRIAZHENII NA NESUSHCHUIU SPOSOBNOST' KOMPRESSORNYKH LOPATOK IZ TITANOVYKH SPLAVOV]
IU S. NALIMOV, V V. OMELCHENKO, B A GRIAZNOV, and S. S. GORODETSKII (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), May 1985, p 100-105. In Russian. refs
The fatigue behavior of titanium alloy compressor blades of gas-turbine engines has been investigated experimentally as a function of the size and location of stress raisers simulating the damage sustained during service. For two specific types of compressor blades, the maximum size of defects that can be tolerated without an adverse effect on the fatigue life of the blade is determined. V.L.

A85-37582*# Queensland Univ., Brisbane (Australia).
SHOCK TUNNEL MEASUREMENTS OF HEAT TRANSFER IN A MODEL SCRAMJET
R. G. MORGAN and R. J. STALKER (Queensland, University, Brisbane, Australia) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 8 p. refs
(Contract NAGW-499)
(AIAA PAPER 85-0908)
The results of heat transfer measurements to the walls of a two dimensional scramjet combustion chamber in a shock tunnel are presented. Thin film heat transfer gauges on a ceramic glass substrate were used. The range of experimental conditions covered produced boundary layers ranging from laminar to transitional, as was independently checked by flow visualization. Empirical flat plate correlations, corrected for local pressure disturbances were used to make a comparison with the experimental results. In the fully laminar regime the heating rates were found to give approximate agreement with the empirical estimates. In the nonlaminar tests the heating rate is found to be well below the fully turbulent levels. It is not known at present if this is a transition effect, or if the pressure corrected flat plate turbulent correlations do not apply to the configuration used. Author

A85-37682#
RADIATIVE TRANSFER IN A GAS TURBINE COMBUSTOR
M. P. MENGUC, W. G. CUMMINGS, III, and R. VISKANTA (Purdue University, West Lafayette, IN) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985 9 p. refs
(AIAA PAPER 85-1072)
A solution of the radiative transfer equation for an axisymmetric cylindrical enclosure representing a typical gas turbine combustor and containing radiatively participating gases and particles is presented. Inhomogeneities of the radiative properties and temperature distribution of the medium are allowed for, and the boundaries are assumed to be diffusely emitting and reflecting. The effects of different types of fuels and axial and radial variations of temperature and soot properties on radiative heat flux distributions are investigated. Film cooling is shown to have a marked effect on wall heat flux, especially when it quenches the soot oxidation process. A medium is shown to radiate more if its temperature is uniform than if it has a center-peaked radial temperature profile. Author

A85-38436
TURBOSHAFT TRUCE IN EUROPE
J. MOXON Flight International (ISSN 0015-3710), vol. 127, June 1, 1985, p. 117, 118.
An evaluation is made of the technology development status and project management efficiencies of European helicopter turboshaft manufacturing companies that have increased mutual cooperation in order to improve competitiveness with American manufacturers of comparable equipment. The three major German, French, and British turboshaft manufacturers have already joined in mutually supportive technology development efforts; current negotiations to include Italian manufacturers are rendered organizationally more complex by the existence of three Italian firms with turboshaft manufacturing capabilities. Attention is given to the design features and prospective performance characteristics of state-of-the-art European helicopter powerplants. Design commonality throughout the engine shaft output range is the ultimate goal of the present efforts. O C

A85-38956*# National Aeronautics and Space Administration Flight Research Center, Edwards, Calif
MODERNIZING ENGINE DISPLAYS
E. T. SCHNEIDER and E. K. ENEVOLDSON (NASA, Flight Research Center, Edwards, CA) IN: Advanced Aircrew Display Symposium, 6th, Patuxent River, MD, May 15, 16, 1984, Proceedings . Patuxent River, MD, U.S Naval Air Test Center, 1984, p. 96-125.
The introduction of electronic fuel control to modern turbine engines has a number of advantages, which are related to an increase in engine performance and to a reduction or elimination of the problems associated with high angle of attack engine operation from the surface to 50,000 feet. If the appropriate engine display devices are available to the pilot, the fuel control system can provide a great amount of information. Some of the wealth of information available from modern fuel controls are discussed in this paper. The considered electronic engine control systems in their most recent forms are known as the Full Authority Digital Engine Control (FADEC) and the Digital Electronic Engine Control (DEEC). Attention is given to some details regarding the control systems, typical engine problems, the solution of problems with the aid of displays, engine displays in normal operation, an example display format, a multipage format, flight strategies, and hardware considerations. G.R.

A85-39057
ADVANCES IN AEROSPACE PROPULSION; PROCEEDINGS OF THE AEROSPACE CONGRESS AND EXPOSITION, LONG BEACH, CA, OCTOBER 15-18, 1984
Congress and Exposition sponsored by the Society of Automotive Engineers. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-594), 1984, 166 p. For individual items see A85-39058 to A85-39071.
(SAE SP-594)
The contributions presented deal with the design and experimental evaluation of propfan, turboprop, turboshaft, and turbojet engine components and systems. The topics include the aerodynamic performance of engine inlets, internal flow passages, internozzle region of a twin-jet nacelle, and wing-mounted turboprop configuration. Moreover, stability and control results for advanced turboprop aft-mount installations are included, as well as a discussion of technology application for added value of in-service support Finally, consideration is given to reliability assessment for gas turbine engine components, to failure mode analysis of new products, and to repair procedures for commercial aircraft jet nacelle composite structures. L.T

A85-39065* Army Propulsion Lab., Cleveland, Ohio
TEMPERATURE DISTORTION GENERATOR FOR TURBOSHAFT ENGINE TESTING
G. A. KLANN (U.S. Army, Propulsion Laboratory, Cleveland, OH), R. L BARTH, and T. J BIESIADNY (NASA, Lewis Research Center, Cleveland, OH) IN. Advances in aerospace propulsion, Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p 89-99 Previously announced in STAR as N85-15659 refs
(SAE PAPER 841541)
The procedures and unique hardware used to conduct an experimental investigation into the response of a small-turboshaft-engine compression system to various hot gas ingestion patterns are presented. The temperature distortion generator described herein uses gaseous hydrogen to create both steady-state and time-variant, or transient, temperature distortion at the engine inlet. The range of transient temperature ramps produced by the distortion generator during the engine tests was from less than 111 deg K/sec (200 deg R/sec) to above 611 deg K/sec (1100 deg R/sec); instantaneous temperatures to 422 deg K (760 deg R) above ambient were generated. The distortion generator was used to document the maximum inlet temperatures and temperature rise rates that the compression system could tolerate before the onset of stall for various circumferential distortions as well as the compressor system response during stall Author

A85-39067
APPLICATION OF TECHNOLOGY TO ACHIEVE VALUE - ADDED IN-SERVICE SUPPORT
L. A SCOTT (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) IN: Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc , 1984, p. 111-120.
(SAE PAPER 841566)
Repair and inspection/control programs for CF6 engines, that benefited from the application of new technology in materials, processes, methods, and management systems are reviewed. A procedure for determination of increases of reverted austenite in the Marage 250 material of fan mid shafts, due to seal deterioration, is described; the procedure utilizes field eddy current perturbations for measuring the change in surface conductivity associated with the damage. The use of IR thermography is also noted as a cost-effective inspection procedure for turbine blades. The repair programs discussed include fluoride ion cleaning/activated diffusion healing and dabber tig welding Finally, as a potential future application, a note is made of laser/fiber optic drilling. L.T.

A85-39069
RELIABILITY ASSESSMENT FROM SMALL SAMPLE INSPECTION DATA FOR GAS TURBINE ENGINE COMPONENTS
M. A. BURKETT (General Motors Corp., Allison Gas Turbine Div , Indianapolis, IN) IN: Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 135-143.
(SAE PAPER 841599)
At times, a reliability analyst is faced with life data where failures are found only by inspection. Test items must be inspected at the end of a test period, and then classed as failure or non-failure. Individual failure times are not known. When each item is inspected at a common age, the binomial distribution is routinely applied in practice and in the literature. This paper uses combinatorial mathematics to apply the binomial distribution to the more complicated case where each item is inspected at an arbitrary age. Conditional probabilities are used to extend the analysis when items undergo intermediate inspections. Author

A85-39071
ENGINE SYSTEM FIELD EXPERIENCE SIMULATION PROGRAM
J F. REDMAN and R. A. MITCHELL (Garrett Turbine Engine Co., Phoenix, AZ) IN· Advances in aerospace propulsion, Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc , 1984, p 151-160. refs
(SAE PAPER 841601)
A computer simulation program has been developed to assist aerospace engineers and managers in making decisions affecting fleet reliability, maintenance strategies, and engine operating costs. This program, based on years of turbine engine experience and innovative uses of the Weibull probability distribution, accurately forecasts removals of engine components, operating and interacting as a system, under different maintenance strategies. Input variables allow the user to tailor the simulation model to fit a specific fleet, engine and maintenance plan Outputs result in a comprehensive assessment of fleet and component reliability, maintenance requirements, and operating cost. An example of a simulation referred to as the LOCI engine simulation is presented. Author

A85-39103
SELECTING DESIGN PARAMETERS FOR AN ENGINE FROM THE TOTALITY OF FLIGHT CONDITIONS [VYBOR PROEKTNYKH PARAMETROV DVIGATELIA PO SOVOKUPNOSTI I POLETNYKH REZHIMOV]
A M. BEGUN and B. G. KHUDENKO Aviatsionnaia Tekhnika (ISSN 0579-2975), no 1, 1985, p 12-17. In Russian. refs
A method is proposed whereby the design parameters of the engine of a flight vehicle are selected from the totality of flight conditions and from the criteria which directly characterize the mission planned for the flight vehicle. A computational algorithm implementing this method is developed Computations for a single-rotor turboramjet engine are presented which demonstrate the practicality and efficiency of the method. V.L.

A85-39104
AN INVESTIGATION OF THE AUTOROTATION OF GAS-TURBINE ENGINES UNDER STARTUP CONDITIONS [K VOPROSU ISSLEDOVANIIA AVTOROTATSII GAZOTURBINNOGO DVIGATELIA NA PUSKOVYKH REZHIMAKH]
V. I DAINEKO Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 17-20 In Russian. refs
The autorotation of gas-turbine engines during startup is investigated analytically for low air flow rates (0-0.2 of the nominal values) The mechanism of autorotation is identified, and analytical expressions are derived for calculating such regimes. The results obtained are found to be in good agreement with experimental data for a commercial 750-kW gas-turbine engine. V L.

A85-39106

A COMPARATIVE EVALUATION OF CERTAIN PROMISING GAS-TURBINE ENGINES OF FOREIGN MANUFACTURERS IN TERMS OF THEIR THRUST CHARACTERISTICS AND FUEL EFFICIENCY [SRAVNITEL'NAIA OTSENKA NEKOTORYKH PERSPEKTIVNYKH INOSTRANNYKH GTD PO IKH TIAGOVYM KHARAKTERISTIKAM I EKONOMICHNOSTI]

L. N. KAMANIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 24-27. In Russian. refs

Altitude/speed and thrust characteristics are presented for several gas-turbine engines of foreign manufacturers designed for supersonic cruise aircraft. The engines discussed include a compound Rolls-Royce engine consisting of the main bypass engine and several modular turboramjet engines; the Pratt & Whitney VSCE-502B variable-cycle engine; the VCE-702 turbine bypass engine; and a dual-mode turbofan engine. V.L.

A85-39107

THE EFFECT OF THE PITCH OF AXISYMMETRIC NOZZLES ON THE EFFICIENCY OF THE NOZZLE ASSEMBLY AND OF THE TURBINE STAGE [VLIIANIE SHAGA OSESIMMETRICHNYKH SOPEL NA EFFEKTIVNOST' SOPLOVOGO APPARATA I TURBINNOI STRUPENI]

I. I KIRILLOV, K. G. RODIN, V. N. BUSURIN, G. L. RAKOV, V. A. RASSOKHIN, and L. S. GRINKRUG Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 28-32. In Russian.

The performance of nozzle assemblies and stages of small axial-flow turbines is investigated experimentally as a function of the spacing of the axisymmetric nozzles. An expression relating the efficiency of a turbine stage to the nozzle spacing is obtained. It is shown that an increase in the pitch of the nozzle exit sections by more than two rotor blade pitches does not lead to a decrease in the efficiency of the turbine stage. V.L.

A85-39112

A GENERALIZATION OF EXPERIMENTAL DATA ON HEAT TRANSFER FROM THE WORKING MEDIUM TO THE HOUSING COMPONENTS OF THE COMPRESSOR OF A GAS-TURBINE ENGINE [OBOBSHCHENIE OPYTNYKH DANNYKH PO TEPLOOTDACHE OT RABOCHEGO TELA K ELEMENTAM KORPUSA KOMPRESSORA GTD]

V. I. LOKAI, A. G. KARIMOVA, V. I. PROKOPEV, and O. L. MAKSIMOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 51-55. In Russian.

Generalized heat transfer equations are derived for the following characteristic parts of a compressor housing: the radial clearance zone above the rotor, the axial clearance zone behind the rotor, the end surfaces of the channels between the straightening vanes, and the housing surface in the radial clearance behind the straightening vanes. The expressions obtained are verified experimentally for a seven-stage compressor. V.L.

A85-39115

UNSTABLE COMBUSTION IN THE COMBUSTION CHAMBER OF A GAS-TURBINE AIRCRAFT ENGINE [NEUSTOICHIVOE GORENIE V KAMERE SGORANIIA AVIATSIONNOGO GTD]

A. V. ANDREEV and E. IU. MARCHUKOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 73-75. In Russian.

During the testing of a gas-turbine engine, regular vibrations were detected in the main combustion chamber. The vibrations, whose frequency was 400-500 Hz and whose amplitude did not exceed 15 kPa, were observed only during the simultaneous operation of the cascades of a dual-nozzle centrifugal injector. Here, the possible causes of this instability are investigated experimentally and analytically. The results of the study suggest that the unstable combustion is due to unstable mixing resulting from the self-oscillating flow of the fuel film in the second cascade of the injector. V.L.

A85-39118

ACCELERATED TESTING OF GAS-TURBINE AIRCRAFT ENGINES USING THE 'SOFTENING' METHOD [USKORENYE ISPYTANIIA AVIATSIONNYKH GTD S PRIMENENIEM METODA 'RAZUPROCHNENIIA']

A. S. GISHVAROV and I. KH. BADAMSHIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 79-82. In Russian.

A method for the accelerated testing of gas-turbine aircraft engines is proposed which is based on the fact that the reliability and the durability of engine components depend on their initial state achieved as a result of the fabrication process. Typically, the components of state-of-the-art gas-turbine engines are hardened by various treatments including diffusion heat treatments, plastic surface working, and application of antifriction and anticorrosion coatings. By dispensing with a hardening treatment, it is possible to modify the initial state parameter. The approach is illustrated by a specific example. V.L.

A85-39119

THE SOFTWARE PACK GRAD FOR THE ANALYSIS OF GAS-TURBINE ENGINES [PROGRAMMYI KOMPLEKS GRAD DLIA RASCHETA GAZOTURBINNYKH DVIGATELEI]

A. B. GOLLAND, E. B. MATS, S. A. MOROZOV, B. M. OSIPOV, O. I. TIMOSHENKO, A. P. TUNAKOV, and V. N. ERENBURG Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 83-85. In Russian.

The software pack GRAD has been designed specifically for the gasdynamic analysis of aircraft engines, including determination of the flow-path parameters for most gas-turbine engines (with only few constraints). The software pack consists of thirteen individual modules, each designed for solving a particular class of problems. Modules are included for the analysis of the altitude/velocity characteristics, thrust characteristics, climatic parameters, transient processes, and weight and dimensional characteristics. Also included are parameter optimization, identification, and diagnostic modules. V.L.

A85-39120

A COMPARISON OF EXPERIMENTAL CHARACTERISTICS OF POROUS AND BLADE IMPELLERS [SRAVNENIE EKSPERIMENTAL'NYKH KHARAKTERISTIK PORISTOGO I LOPASTNOGO IMPELLEROV]

IU. V. DRONOV, A. A. PANCHENKO, and V. F. PRISNIAKOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 85-87. In Russian.

Experiments have been carried out to compare the performance of porous and blade impellers, which are commonly used as hydrodynamic radial sealing devices for the shafts of the pumps of aircraft engines. It is shown that the use of a porous impeller in a pump makes it possible to reduce the radial clearance to a minimum, thus improving the tightness of the seal. With a porous impeller, seal tightness is insured in all operation modes. V L.

A85-39121

AN EVALUATION OF THE EXHAUST SYSTEM CONFIGURATION FROM THE CRUISE EFFICIENCY CRITERIA OF AN ENGINE IN AN AIRCRAFT SYSTEM [OTSENKA KONFIGURATSII VYKHODNOGO USTROISTVA PO KRITERIIAM TRANSPORTNOI EFFEKTIVNOSTI DVIGATELIA V SISTEME LETATEL'NOGO APPARATA]

O. M. ZHUKOV, V. S. KUZMICHEV, A. N. KOVARTSEV, M. A. MOROZOV, and B. D FISHBEIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 87-90. In Russian. refs

Three types of bypass engine exhaust systems, i.e., a system with separate nozzles, a system with a mixing chamber and a common nozzle, and a system with concentrically split fan flow, are evaluated in terms of engine cruise efficiency. It is shown that the efficiency of the system with split fan flow is less dependent on the degree of mixing than the efficiencies of the other two systems. The system with concentrically split fan flow is thought to be the best compromise solution for engines with current bypass ratios of 4-5 (and for a bypass ratio of 7 in the future). V.L.

A85-39122
THE STRUCTURE OF THE APPLICATION SOFTWARE PACK RAFIPKS FOR THE ANALYSIS OF PHYSICAL PROCESSES IN COMBUSTION CHAMBERS [O STRUKTURE PAKETA PRIKLADNYKH PROGRAMM PO RASCHETU FIZICHESKIKH PROTSESSOV V KAMERE SGORANIIA 'RAFIPKS']
V N. IGNATEV Aviatsionnaia Tekhnika (ISSN 0579-2975), no 1, 1985, p. 90-93. In Russian. refs

The software pack RAFIPKS includes a set of functionally related programs for the computer-aided design of combustion chambers and for the numerical modeling of the physicochemical processes occurring inside combustion chambers with the objective of design optimization. The pack consists of two base modules, one for the hydraulic design analysis and the other for the design verification based on an analysis of physicochemical processes inside the combustion chamber. The system has a user-friendly interface which makes it possible to use the software without any knowledge of a programming language and without reference to user manuals. V.L.

A85-39124
RATIONALIZING THE CHOICE OF AN ACTUATING MECHANISM FOR A JET DRIVE [OBOSNOVANIE VYBORA ISPOLNITEL'NOGO MEKHANIZMA STRUINOGO PRIVODA]
A. B. KONDRATEV and V. I. TOLMACHEV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 96-98. In Russian

The paper is concerned with the problem of selecting an optimum control system for jet-type drives with controlled or uncontrolled flow. An analysis of the control efficiency is presented, and an analytical expression is obtained for determining the required momenta. The relationship makes it possible to select the type of drive and to estimate the energy performance of jet drives for a given depth of control and time of transition. V.L.

A85-39126
DETERMINATION OF THE BLADE HEIGHT OF THE LAST COMPRESSOR STAGE FOR A REFINED THERMODYNAMIC DESIGN ANALYSIS OF TURBOFAN ENGINES [OPREDELENIE VYSOTY LOPATOK POSLEDNEI STUPENI KOMPRESSORA DLIA UTOCHNENIIA PROEKTNOGO TERMOGAZODINAMICHESKOGO RASCHETA TRDD]
E. D. STENKIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no 1, 1985, p. 101-103. In Russian.

A relationship is obtained for determining the blade height of the last compressor stage of turbofan engines, the blade height being the principal factor determining the magnitude of the relative radial clearance. In its final form, the relationship makes it possible to estimate, during a thermodynamic design analysis of turbofan engines, the magnitude of the relative radial clearance and its effect on the efficiency of the compressor. V.L

A85-39151
STARTING SYSTEMS TECHNOLOGY; PROCEEDINGS OF THE AEROSPACE CONGRESS AND EXPOSITION, LONG BEACH, CA, OCTOBER 15-18, 1984
Congress and Exposition sponsored by the Society of Automotive Engineers. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-598), 1984, 144 p. For individual items see A85-39152 to A85-39167.
(SAE SP-598)

Various papers are presented on the analytical aspects of starting systems technology. The subjects addressed include: computer-aided start system design and verification, air turbine starter sizing for a proper bleed source match, peak transient torques in pneumatic starter engine systems, control of fuel during starting of a gas turbine, air turbine starter turbine wheel containment, lubrication systems for air turbine starters, starter-engine interface concepts, and fast start system for a 200 kW gas turbine generator set. Also considered are: F-20 air turbine cartridge start system, pressurized air start system for small gas turbine engines, auxiliary and emergency power system, critical speed testing of a power take-off shaft subsystem, secondary power generation system considerations for advanced aircraft, airplane mounted accessory gearbox design, B-1B secondary power subsystem, and electric direct current starter motors for gas turbine engines. C D.

A85-39152
COMPUTER-AIDED START-SYSTEM DESIGN AND VERIFICATION
H. S. COLLINSWORTH (United Technologies Corp., Engineering Div., West Palm Beach, FL) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 1-14.
(SAE PAPER 841508)

The start simulation is a transient representation of engine and aircraft characteristics which are combined to construct a start system. The Computer Aided Start System (CASS) incorporates thermal effects indirectly through transient engine data. CASS is used to design start schedules and to evaluate those start schedules with known or updated aircraft installation effects. Author

A85-39153
AIR TURBINE STARTER SIZING FOR A PROPER BLEED SOURCE MATCH
W. H. ENGELMANN (Garrett Corp, Garrett Pneumatic Systems Div., Phoenix, AZ) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 15-19
(SAE PAPER 841509)

This paper presents a description of the sizing process for air turbine starters. The emphasis is on optimum system performance through proper component matching. The system includes all equipment from the pneumatic energy source, through the air delivery duct system, to and including the starter itself. While the load imposed by the engine defines the power output required at the starter, the limitations of the available bleed-air source and delivery system often dictate the starter size. All pneumatic system components must be properly matched to provide the smallest, lightest combination of components that will meet the engine starting requirements. Author

A85-39155
CONTROL OF FUEL DURING STARTING OF A GAS TURBINE
K J. RUMFORD (Avco Corp., Avco Lycoming Div., Stratford, CT) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 29-34.
(SAE PAPER 841511)

Advances made in the past 25 years in delivering the right amount of fuel to a gas turbine engine in order to start the engine without compressor surge or turbine overheating are reviewed. The aspects discussed include. initial combustion; acceleration; scheduling of fuel vs speed; fuel ratio vs speed, and fuel vs pressure; fuel density adjustments; fuel ramping controls; N-dot starting; temperature-controlled start, and safeguards The advantages and drawbacks of the various systems involved are addressed. C.D.

A85-39156
AIR TURBINE STARTER TURBINE WHEEL CONTAINMENT
J. R GIARD (Garrett Corp., Garrett Pneumatic Systems Div., Phoenix, AZ) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 35-39.
(SAE PAPER 841546)

Turbine wheel containment on air turbine starters has been standard practice for many years. Proven methods of designing reliable containment rings combine theoretical analyses and empirical relationships derived from large-scale testing programs. The choice of design and material must consider energy absorption, piercing resistance, and the effects on the surrounding static structure due to ring expansion and movement. New concepts such as dual-alloy rings may offer improvements in weight or reliability Author

A85-39157
LUBRICATION SYSTEMS FOR AIR TURBINE STARTERS
W. E. SCHMIDT and G. G. HOUSTON (Garrett Corp., Garrett Pneumatic Systems Div., Phoenix, AZ) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 41-53.
(SAE PAPER 841547)

The evolution of lubrication systems as starter speeds and motoring requirements have increased is reviewed. Problems related to lubrication, including temperature-related problems, higher overrunning speeds, limited cooling, oil level and motoring, and poor lubrication conditions are discussed. The necessity for a systems approach to lubrication selection is stressed, and several techniques of lubrication are considered, including splash lubrication, the 'holding pond' system, wet pad configuration, clutch-in-engine design, and shared engine oil systems Advanced lubricants are briefly addressed, and properties of aircraft-type gas turbine lubricants are listed. C.D.

A85-39158
STARTER-ENGINE INTERFACE CONCEPTS
G. R. TAYLOR (Garrett Corp., Garrett Pneumatic Systems Div., Phoenix, AZ) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p 55-60.
(SAE PAPER 841548)

New concepts for starter-engine interfaces that can extend starter life and improve reliability when used in current commercial and military aircraft installations are discussed. The pawl-and-ratchet clutches and sprag clutches currently being used are described and compared with improved types using continuous lubrication, wet-cavity interface, nonoverrunning, and sharing of lubrication with the main engine gearbox Diagrams of these clutches are shown. C.D.

A85-39160
F-20 AIR TURBINE CARTRIDGE START SYSTEM
L. ANDERSON (Garrett Corp., Garrett Pneumatic Systems Div., Phoenix, AZ) and W. F. KELLER (Northrop Corp, Los Angeles, CA) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 69-74.
(SAE PAPER 841570)

An air turbine cartridge start system (ATCS) was developed for the F-20 fighter aircraft to provide an assisted in-flight restart capability. Normal starts are accomplished with a pneumatic ground cart. In-flight engine restarts are accomplished using a catalytically decomposed hydrazine-water mixture as the energy source, to drive an air turbine starter. The products of decomposition are primarily steam and ammonia. The starter incorporates many safety features. Author

A85-39161
PRESSURIZED AIR START SYSTEM (PASS) FOR SMALL GAS TURBINE ENGINES
J. P. ROMINEK (Garrett Corp., Garrett Pneumatic Systems Div, Phoenix, AZ) IN: Starting systems technology, Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 75-80.
(SAE PAPER 841571)

Pressurized Air-Start System (PASS) technology was developed to offer a lighter weight alternative to conventional hydraulic or electric start systems for small gas turbine engine applications. PASS offers improved engine starting performance, notably at low ambient temperatures where high fluid viscosity values and reduced electrolyte levels can cause difficulties for hydraulic and battery-type start systems. The system consists of a pressure vessel/control manifold assembly, high pressure regulator, an air vane or air turbine starter, a recharge valve, and a turbine-driven recharge compressor. Production configurations of these components have been fabricated and are currently in use after completing performance checks, development testing, and field evaluation testing. Typical performance of the system and each of its individual components are described in this report Author

A85-39162
AUXILIARY AND EMERGENCY POWER SYSTEM
B. G. KIRKMAN (Lucas Aerospace, Ltd, Power Systems Div., Hemel Hempstead, Herts., England) IN. Starting systems technology, Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc, 1984, p. 81-88. refs
(SAE PAPER 841572)

An auxiliary and emergency power system which integrates the hydraulic and electric power requirements of an advanced aircraft with reduced stability and a fly-by-wire control system with a remotely mounted digitally controlled unit is described. The auxiliary and emergency power unit provides auxiliary/emergency electrical and hydraulic power by transmission of secondary mechanical power, generated in a turbine, through a gearbox to an auxiliary generator and an auxiliary hydraulic pump. These components are discussed The auxiliary electrical control unit, which is a full authority digital system control which incorporates the control and protection circuits for the generator, is discussed along with the choice of fuel and control of propellants for the emergency system Operational aspects of the system are addressed, as are its testing and maintainability. C.D.

A85-39163
CRITICAL SPEED TESTING OF THE GRUMMAN X-29A POWER TAKE-OFF SHAFT SUBSYSTEM
H. F. JOHNSON and W. A. MARESKO (Sundstrand Corp, Sundstrand Aviation Mechanical Div., Rockford, IL) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 89-94.
(SAE PAPER 841603)

Critical speed tests were performed on the Power Take Off shaft subsystem of the Grumman X-29A advanced technology demonstration aircraft. Test speeds up to 20,000 rpm were run to insure stable operation up to the maximum installed overspeed of 17,250 rpm. The subsystem was instrumented with proximity probes and accelerometers to measure shaft displacement and vibration. This paper will show that unprocessed data from proximity probes and accelerometers does not reliably indicate the location of a critical speed, and it will outline a method for processing this type data to accurately determine the critical speed. An example of reverse precession, as well as the effects of unbalance on critical speed, will be presented. Author

A85-39166
B-1B SECONDARY POWER SUBSYSTEM
B. J. COVEY (Rockwell International Corp., El Segundo, CA) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 123-130.
(SAE PAPER 841607)

The B-1B secondary power subsystem is a derivative of the subsystem used in the B-1A aircraft. In the B-1B, the earlier design has been modified to add an onboard alternate cross-bleed start capability for the main propulsion engines. The normal start system also has been changed from a hydromechanical link between each APU and the two related engines to a combination of a hydromechanical link and a pneumatic link. During this redesign, the APU starting and the APU/ADG coupling limitations revealed during the original B-1A RDT&E program also were addressed.

Development and preliminary qualification tests on the redesigned subsystem throughout the required operating environment indicate that the revised configuration meets all design objectives.
Author

A85-39167
ELECTRIC DIRECT CURRENT STARTER MOTORS FOR GAS TURBINE ENGINES
L. A. FIZER (AiResearch Manufacturing Co., Torrance, CA) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 131-137.
(SAE PAPER 841569)
The general operating requirements specific to turbine engines are described, and the resulting design features of gas turbine electric starters are presented. Engine drag characteristic, engine ignition requirements, and battery characteristics are discussed, and starter performance parameters are listed. The advantageous selection of motor size and weight, starter motor type, electromagnetic components, and electromagnetic design is considered. C.D.

A85-39203
MODEL TEST RESULTS OF THE SPLIT-FAN CROSS-DUCTED PROPULSION SYSTEM CONCEPT FOR MEDIUM SPEED V/STOL AIRCRAFT
W. E. BECK, JR., J. G CARLSON, and J. P. BAAS (Lockheed-California Co , Burbank, CA) IN: V/STOL· An update and overview; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc , 1984, p. 15-22
(SAE PAPER 841495)
An experimental test program has been conducted using an 0.25-scale aircraft model that incorporates internal propulsion system flow to establish the flow transfer performance and thrust/lift/control nozzle force generation capabilities of a cross-ducted, split fan V/STOL aircraft configuration's propulsion system On the basis of the limited amount of test data analyzed to date, these model tests have demonstrated that fan air transfer between forward and aft nozzles during hover can be readily accomplished by nozzle area changes, while total lift remains approximately constant. O.C.

A85-39206
RECENT DEVELOPMENTS IN EJECTOR DESIGN FOR V/STOL AIRCRAFT
D. C WHITTLEY and F. L. GILBERTSON (de Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada) IN V/STOL: An update and overview, Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 45-50. Research supported by the Department of National Defence of Canada.
(SAE PAPER 841498)
Two categories of ejector design have been investigated at de Havilland Aircraft of Canada: (1) Trailing edge ejector flap for augmentation of wing lift by supercirculation: primarily for STOL transport type aircraft of high aspect ratio. (2) Chordwise rectangular ejector located adjacent to the fuselage sides for vertical lift: primarily for STOVL combat type aircraft of low aspect ratio The paper reviews the underlying physical principles of the ejector type of thrust augmentor and suggests a logical procedure for development and optimization by experimental means. Methods of data analysis are shown which provide the foundation for empirical design and some examples of performance are given for each of the two ejector categories defined above. In addition, a new form of primary nozzle is described which serves to distribute the jet and promote fast mixing in the ejector throat. Author

A85-39207
ESTIMATION OF HOT GAS REINGESTION FOR A VTOL AIRCRAFT AT THE CONCEPTUAL DESIGN STAGE
K. A. GREEN and J. J. ZANINE (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) IN: V/STOL: An update and overview; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc , 1984, p 51-65. refs
(SAE PAPER 841555)
The estimation methodology presented has been embodied in a computer code for the rapid, first-order determination of inlet temperature rise due to near and far field exhaust gas reingestion in a VTOL aircraft; this code incorporates an interactive computer graphics package that displays aircraft planform configurations with superposed ground plane and undersurface stagnation lines. Ground plane wall jets can in this way be characterized, and isocontour lines of the wall jet temperature can be displayed in superimposition over the aircraft configuration The code, which is based on empirical relationships and simplified analytical approximations, was designed as a rapid evaluation tool and has shown reasonable agreement with model aircraft experimental data. O.C

A85-39209
DEVELOPMENT OF A PNEUMATIC THRUST DEFLECTOR
M. J. HARRIS and J. J. NICHOLS, JR. (David Taylor Naval Ship Research and Development Center, Bethesda, MD) IN: V/STOL: An update and overview; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p 93-100. refs
(SAE PAPER 841558)
The flight envelope of a high performance aircraft can be expanded through an enhancement of its lifting capacity or controllability, by means of thrust deflection. Attention is presently given to the development and test results for a pneumatic thrust deflector which operates by blowing a thin sheet of air tangentially across a curved surface adjacent to a turbojet engine's exhaust stream, the angle of thrust deflection varies with jet sheet momentum and requires no mechanical movement of surfaces. Investigation of this system with a small turbojet simulator yielded thrust deflections as great as 60 deg. This thrust deflection capability may be employed for increased maneuverability, heavy lift, or STOL. O.C.

A85-39577#
ADVANCED SINGLE-ROTATION PROPFAN DRIVE SYSTEM
R. D. ANDERSON, R. E. DEVLIN, A. S. NOVICK, and D. A. WAGNER (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) Journal of Propulsion and Power (ISSN 0748-4658), vol. 1, July-Aug. 1985, p. 259, 260; Abridged. Previously cited in issue 17, p. 2432, Accession no. A84-36957

A85-39580*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio.
FLAME RADIATION AND LINER HEAT TRANSFER IN A TUBULAR-CAN COMBUSTOR
R. W. CLAUS, G. M. NEELY, and F. M. HUMENIK (NASA, Lewis Research Center, Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 1, July-Aug. 1985, p. 270-278. Previously cited in issue 07, p. 872, Accession no A84-21300. refs

A85-39606*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPERIMENTS IN DILUTION JET MIXING - EFFECTS OF MULTIPLE ROWS AND NON-CIRCULAR ORIFICES

J. D. HOLDEMAN (NASA, Lewis Research Center, Modeling and Verification Branch, Cleveland, OH), R. SRINIVASAN, E. B. COLEMAN, G. D. MEYERS, and C. D. WHITE (Garrett Turbine Engine Co., Phoenix, AZ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p. Previously announced in STAR as N85-25266 refs

(AIAA PAPER 85-1104)

Experimental and empirical model results are presented that extend previous studies of the mixing of single-sided and opposed rows of jets in a confined duct flow to include effects of non-circular orifices and double rows of jets. Analysis of the mean temperature data obtained in this investigation showed that the effects of orifice shape and double rows are significant only in the region close to the injection plane, provided that the orifices are symmetric with respect to the main flow direction. The penetration and mixing of jets from 45-degree slanted slots is slightly less than that from equivalent-area symmetric orifices. The penetration from two-dimensional slots is similar to that from equivalent-area closely-spaced rows of holes, but the mixing is slower for the 2-D slots. Calculated mean temperature profiles downstream of jets from non-circular and double rows of orifices, made using an extension developed for a previous empirical model, are shown to be in good agreement with the measured distributions. Author

A85-39614#

PERFORMANCE OF A NEW NOSE-LIP HOT-AIR ANTI-ICING CONCEPT

H. A. ROSENTHAL and D. O. NELEPOVITZ (Rohr Industries, Inc., Chula Vista, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p.

(AIAA PAPER 85-1117)

A new simple anti-ice system has been developed for engine inlets. It has been designed to use turbine engine compressor bleed air that is injected tangentially into the leading edge chamber formed by the engine inlet lip and its bulkhead. The system has produced high internal heat transfer by causing the injected air to flow circumferentially at high internal velocities through the self-communicating chamber. The developmental work has consisted of basic analysis, full-scale ground tests, dry air flight tests, and icing tunnel tests. The system has been shown to be equivalent in performance to existing hot air systems but is simpler, more reliable, and lighter in weight. Author

A85-39620#

CANTILEVERED STATOR VANE TIP LEAKAGE STUDIES

N. G ADAMS (Garrett Turbine Engine Co, Phoenix, AZ) and H. K. HEPWORTH (Northern Arizona University, Flagstaff, AZ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p. refs

(AIAA PAPER 85-1136)

A test program has been conducted to study the nature of the tip leakage flow associated with cantilever stator blades in axial compressor systems. A lowspeed single stage test rig with a cantilever stator vane row has been developed. The rig simulates the flows which are characteristically found in typical middle-stage axial flow compressors. The test rig is designed specifically to accommodate flow visualization techniques to study the tip leakage flow. Extensive performance testing has demonstrated the test rig does simulate typical axial compressor performance characteristics. Careful performance parameter data reduction and analysis of high speed film footage taken during rig operation provides actual tip leakage streamline velocities. The data taken includes both on and off design conditions. Author

A85-39644#

FUEL INJECTION CHARACTERIZATION AND DESIGN METHODOLOGY TO IMPROVE LEAN STABILITY

C. E. SMITH, C. B. GRAVES (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL), R. ROBACK (United Technologies Research Center, East Hartford, CT), and D. D. DALESSANDRO (U.S. Naval Air Propulsion Center, Trenton, NJ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 7 p.

(Contract N00140-83-C-8899)

(AIAA PAPER 85-1183)

Prefilming, airblast fuel injectors for gas turbine combustors have exhibited improved atomization and mixing compared to pressure atomizing injectors, resulting in lower pattern factor, less smoke, and the ability to accommodate alternate fuels. As a consequence of the improved mixing, the airblast design introduces design challenges in operability; specifically, lean blowout during rapid deceleration and altitude relight. An analytical and experimental effort was undertaken to develop design methodology to improve the operability of airblast injectors without sacrificing full power performance. Laser Doppler Velocimeter (LDV) measurements made at the injector discharge plane of the baseline injector were compared to predictions from Pratt and Whitney's computational fluid dynamics code PREACH Single injector combustion tests were conducted to systematically evaluate independent combustor front-end design variables affecting lean blowout. Variables included injector discharge airflow angle, injector flowsplit, injector scale, combustion hole pattern, combustion hole axial distance from dome, and fuel effects. Results of the investigation include a set of combustor front-end design guides for improved stability and a phenomonological understanding of combustor front-end flowfields. Author

A85-39646#

DRIVE SYSTEM DEVELOPMENT FOR PROPFAN TEST ASSESSMENT PROGRAM

A. S. NOVICK, T. H. LINDSEY (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN), and W. E. ARNDT (Lockheed-Georgia Co., Marietta, GA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 8 p.

(AIAA PAPER 85-1188)

Advanced propfan powered aircraft have the potential for large fuel savings and direct operating cost advantages. The high speed efficiency of the propfan has been verified with the aid of wind tunnel tests. A Propfan Test Assessment Program, sponsored by NASA, is being conducted by an American aerospace company. This program has the objective to assess and evaluate the technologies relevant to a large scale propfan, taking into account structural integrity, source noise, and associated cabin noise and vibration. With regard to the drive system, all efforts are made to utilize proven engine hardware. Attention is given to the engine background, aspects of drive system design, component tests, and research testing. G.R.

A85-39647#

FUTURE PROP-FANS - TRACTOR OR PUSHER

J. GODSTON and C. REYNOLDS (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 9 p. refs

(AIAA PAPER 85-1189)

The propfan shows promise to provide the next propulsion system for short to medium range aircraft. NASA-sponsored studies in the early 1970s first identified the potential of the high speed swept propeller, subsequently called the propfan. Advantages of the propfan are related to lower fuel consumption and a reduction in the direct operating costs, taking into account a comparison with comparable technology high bypass ratio turbofans A number of programs are being conducted with the aim to establish propfan propulsion system technology readiness by 1987. Potential future systems are considered, giving attention to wing or fuselage engine installation, single vs. counter rotation, and gear vs. gearless design.

Propulsion system performance, weight, cost, and noise considerations are discussed. It is pointed out that tractor and pusher geared counter rotation propfan propulsion systems provide alternative configurations being studied by the industry and government agencies. G.R.

A85-39648#
THE UNDUCTED FAN ENGINE
A. R. STUART (General Electric Co., Evendale, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 5 p.
(AIAA PAPER 85-1190)

Studies conducted by an American aircraft engine company and an aircraft manufacturer are showing that the unducted fan engine is eminently suited for the efficient propulsion of high-speed subsonic commercial and military aircraft. Expenditures related to the high cost of the development of a new aircraft engine are only justified if the advantages provided by the engine in comparison to existing engines are sufficiently large. The present paper will discuss the merits of an engine which offers 30-50 percent fuel savings relative to existing turbofan engines. Attention is given to the historical trend of improvements in specific fuel consumption, the propulsive efficiency, a counter rotation schematic, low pressure turbine overall efficiency, and a three phase program designed to demonstrate and develop the technology for the considered concept. G.R.

A85-39649#
PROSPECTS AND PROBLEMS OF ADVANCED OPEN ROTORS FOR COMMERCIAL AIRCRAFT
A. A. BLYTHE and P. SMITH (British Aerospace, PLC, Civil Aircraft Div., Hatfield, Herts., England) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p.
(AIAA PAPER 85-1191)

This paper reviews the open rotor propulsion scene through the eyes of the aircraft designer. After studying the options, attention is focused on the 100-120 seater Feederliner/Regional Airliner where the maximum use can be made of existing powerplant and airframe developments. Fuel savings of 25-27 percent and range increases of 45 percent are predicted. The advantages of contra-rotation and the relative merits of wing-mounted and rear-mounted powerplants are discussed, leading to an appraisal of installation problems. Emphasis is placed upon the effect of economic and commercial considerations in powerplant selection. Finally, the effect of increased aircraft size, speed and range are discussed in relation to the development of new open rotor aircraft. Economic and certification requirements point to 1995 as the earliest likely date for entry into service, preceded by one more round of turbofan powered aircraft. Author

A85-39654#
ENGINE DESIGN FOR MAINTENANCE AND SUPPORT
J. M. WELLBORN (General Electric Co., Aircraft Engine Business Group, Lynn, MA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 7 p.
(AIAA PAPER 85-1204)

The U.S. Army's T700 turboshaft engine represents the state-of-the-art in the incorporation of design practices aimed at the minimization of maintenance and support, difficulties employing modular construction and permitting all unit and intermediate level maintenance tasks to be performed with only 10 hand tools. All line-replaceable units can be changed in less than 30 min, without disturbing other components. The T700 currently powers the H-60 series, AH-64, 214ST, and SuperCobra military helicopters. O.C.

A85-39655#
SUPPORTABILITY CONSIDERATIONS FOR ADVANCED ENGINE DEVELOPMENT
J. S. FILES (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 6 p refs
(AIAA PAPER 85-1205)

The development of an advanced engine is a complex process requiring integration of new propulsion technologies and engineering applications into innovative designs to provide the weapon system (aircraft) with enhanced capabilities. In order to bring these capabilities to bear on the threat, the aircraft must be mission ready, and available in sufficient quantities. The generalized term, 'supportability' has evolved as a qualitative descriptor of the resources required to provide a mission ready weapon system, as well as the resources required to sustain it in the fight to defeat the threat. The design of an advanced engine, and critical decisions made during development determine the in-service supportability and ultimate mission readiness/fighting capability of the engine and aircraft it powers This paper describes some critical interrelationships between the engine design/development process and supportability, cites historic examples illustrating their importance, and provides recommendations for future improvement. Author

A85-39656#
USAGE MONITORING - A MILESTONE IN ENGINE LIFE MANAGEMENT
M PAQUET, P. GATLIN (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL), and S M. COTE (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 7 p.
(AIAA PAPER 85-1206)

Aircraft/engine usage monitoring plays an important role in the operational phase of a weapons system. This is illustrated by the fact that usage monitoring can be used to forecast spare parts utilization and maintenance requirements, verify life limits, ensure up-to-date accelerated engine tests, such as ASMET's and AMT's, and potentially impact warranty obligations. Since each of the above areas are inter-related, engine usage monitoring/usage updates are most efficient when data is applied through a 'working system'. Both Navy MIL-E5007E and ENSIP recognize the importance of this process. Elements needed to establish a 'working system' will be described with the Pratt & Whitney J52-powered A6E/A6B aircraft used as an example. Author

A85-39657#
UNITED STATES AIR FORCE ENGINE DAMAGE TOLERANCE REQUIREMENTS
T. T. KING (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH), J. HURCHALLA, and D. H. NETHAWAY (United Technologies Corp., Government Products Div., West Palm Beach, FL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p.
(AIAA PAPER 85-1209)

This paper summarizes the damage tolerance requirements that are applied to Air Force engine development and acquisition programs. The importance of the damage tolerance control plan and the use of reliable inspection methods during development, production, and life management is emphasized. It is highlighted that development efforts in the last five years have identified process improvements for Fluorescent Penetrant Inspection (FPI). These improvements must be implemented within industry and Air Force depots to improve reliability to detect small flaws. Case examples of damage tolerance design are presented for an improvement to an existing engine (F100-PW-220 Increased Life Core) and for a new engine (PW5000). The Increased Life Core (ILC) information shows that damage tolerance requirements were met with small or modest increases in component weight, with cost savings and reduced inspection requirements and with lower life cycle costs (LCC). The importance of early trade studies to define the optimum life (Low Cycle Fatigue-LCF) and inspection

interval requirements for a new engine design is shown for the PW5000. Data presented for both of these examples clearly illustrate that damage tolerance is achieved without adverse impact on conventional measures of merit (i.e., weight and cost).
Author

A85-39663#
TIME RESOLVED MEASUREMENTS OF A TURBINE ROTOR STATIONARY TIP CASING PRESSURE AND HEAT TRANSFER FIELD
G. R. GUENETTE, A. H. EPSTEIN (MIT, Cambridge, MA), R. J. G. NORTON (Rolls-Royce, Inc., Atlanta, GA), and Y. CAO (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p. Research supported by the U S. Navy and Rolls-Royce, Inc. refs
(AIAA PAPER 85-1220)
This paper presents the results of a detailed experimental investigation of the time resolved heat transfer rate and static pressure distribution on the stationary casing above the tip of a transonic high pressure turbine rotor in a short duration turbine test rig (the MIT Blowdown Turbine Facility), which reproduced all of the full scale, non-dimensional turbine operating parameters. Measurements were made as a function of rotor corrected speed and of Reynolds No. The heat flux is shown to be highly unsteady with fluctuations of 80 percent across the blade spacing. Approximately 45 percent of the total heat load to the shroud is from the flow under the blade tip. The time averaged heat flux to the casing drops by a factor of 5 down the blade chord and is shown to vary as Re to the (0.8) power. The pressure measurements suggested that the flow in the tip region is primarily influenced by the pressure loading across the blade. Author

A85-39664#
MILITARY ENGINE DURABILITY IMPROVEMENTS THROUGH INNOVATIVE ADVANCEMENTS IN TURBINE DESIGN AND MATERIALS
T AUXIER, G. A. BONNER, D CLEVENGER, and S. N. FINGER (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 8 p.
(AIAA PAPER 85-1221)
The F100-PW-220 low bypass ratio military turbofan has in the course of extensive engine verification and accelerated mission testing exhibited turbine durability values comparable to those of cold section turbomachine components, while improving turbine efficiency. These gains are the result of advancements in active turbine cooling and materials processing during fabrication. Specific design features of consequence for reliability improvements encompass thermally matched tip segment support rings, the supply of cooling air by a tangential onboard injection system, rub-tolerant seals, and blade-to-blade dampers. The F100-PW-220 turbine rotor has demonstrated 17,000 cycles in heated spin tests. O.C.

A85-39684#
A REVIEW OF SOME RECENT U.K. PROPELLER DEVELOPMENTS
R. M. BASS and D. G. M. DAVIS (Dowty Rotol, Ltd., Gloucester, England) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 9 p. refs
(AIAA PAPER 85-1261)
The development of high-performance aircraft propellers in the UK is reviewed for the period 1974-1985 and illustrated with photographs, drawings, and diagrams. Topics examined include the design requirements of higher-speed aircraft, the application of modern computational techniques to the theoretical treatment of the propeller flowfield, wind-tunnel experiments, performance and acoustic testing, blade aerodynamics, and the use of contrarotating propellers to recover the energy lost in efflux swirl. Consideration is given to the use of composite materials to save weight and to constant-speed variable-pitch control systems.
T.K.

A85-39693#
AIRCRAFT PRELIMINARY DESIGN COMPARISON OF ADVANCED COMPOUND ENGINES WITH ADVANCED TURBINE ENGINES FOR HELICOPTER APPLICATIONS
W. L. ANDRE (U.S. Army, Research and Technology Laboratories, Moffett Field, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 5 p.
(AIAA PAPER 85-1276)
Results of a preliminary design study, undertaken by the Army in view of the LHX program, of the Advanced Turbine Engine versus the Advanced Compound Engine are summarized. Mission requirements and weight and power considerations are discussed. Performance analysis indicates that at altitudes above 4000 ft the compound engine will outperform the turbine engine, whereas below 4000 ft the opposite is true. An equal-transmission comparison reveals that the two aircraft would have close gross weights for the mission; the engine weight increase for the compound engine is offset by the fuel and tankage weight reductions. An overall preference for a compound engine is indicated. L.T.

A85-39694#
DEVELOPMENT OF AN ADVANCED VANELESS INLET PARTICLE SEPARATOR FOR HELICOPTER ENGINES
B V R. VITTAL, D. L. TIPTON, and W. A. BENNETT (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 10 p. refs
(AIAA PAPER 85-1277)
Allison has designed and developed an advanced integral engine particle separator to meet the challenging operational requirements of helicopter engines of the future. The vaneless, low weight, high efficiency separator represents a significant advancement in engine tolerance to adverse operational conditions and promises new levels of engine reliability, durability, and life cycle costs. This paper presents the analytical methods developed, the design process, and the extensive experimental validation of the design. Author

A85-39695#
VARIABLE CYCLE TURBOSHAFT TECHNOLOGY FOR ROTOR-CRAFT OF THE 90'S
C. ROGO and E. H. BENSTEIN (Teledyne CAE, Toledo, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 11 p. Army-sponsored research. refs
(AIAA PAPER 85-1278)
Results of an efficiency optimization study of variable-capacity turboshaft engines are applied to an advanced turboshaft engine with a turbine inlet temperature of 1447 K and 683 kW power rating. Two radial turbine geometries were tested in a cold-flow rig, the nozzle area was varied over a flow range of 62-120 percent of the design flow rate. Quantitative data are obtained on the effects of leakage and cooling injection. It is found that in a rotorcraft application the concept will provide over 14 percent SFC reduction potential at 60 percent power. Furthermore, an 11-14-percent fuel consumption decrease is expected, as compared with an equivalent-technology conventional simple-cycle engine.
L.T.

A85-39696#
SECONDARY POWER UNIT OPTIONS FOR ADVANCED FIGHTER AIRCRAFT
C. RODGERS (Solar Turbines, Inc., Turbomach Div., San Diego, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 9 p. refs
(AIAA PAPER 85-1280)
Future high performance fighter aircraft will demand more compact, lighter weight secondary power units capable of providing faster starts and rapid response over wider aircraft operating envelopes. Advancements in propulsion technology continue to task the design and optimization of secondary power systems to the point where an inflight power outage of a few seconds can

no longer be tolerated. The first approach in pacing Advanced Tactical Fighter (ATF) secondary power demands involves continued generic improvements to conventional air-breathing gas turbine auxiliary power units, to extend starting ability and start reliability for higher altitudes, and to increase power density The second approach is the Super Integrated Power Unit which is capable of operating in both air-breathing and stored energy gas operator modes and, thus, is less sensitive to altitude effects. This paper presents the technology accomplishments as well as the future research and development paths for both of these secondary power system approaches. Author

A85-39699#
INTEGRATION OF VECTORING NOZZLES IN A STOL TRANSONIC TACTICAL AIRCRAFT
D. E BERNDT (Rockwell International Corp., Los Angeles, CA), R. GLIDEWELL (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), and G R. BARNES (Rolls-Royce, Inc., Atlanta, GA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 10 p
(AIAA PAPER 85-1285)

Two types of single-engine STOL aircraft configurations that utilize vectorable nozzles are discussed as part of the phase II of STOL Nozzle Exhaust concept study These are the conventional single nozzle that can be deflected through 70 deg and achieves aircraft balance through blown oversized canards of through ducting fan exhaust upstream to a pitch pipe exhaust, and a three-poster configuration featuring two vectoring nozzles near the aircraft CG in addition to a conventional rear nozzle. Wind tunnel testing was carried out at Mach numbers from 0 6 to 1.5. Tests reveal higher drag levels of the side nozzle configuration, which is attributed to the jet scrubbing drag of the side nozzles on the fuselage. On a full scale it may be minimized by careful nozzle integration. It is anticipated that a 700-ft field-length aircraft can be designed to meet the same mission requirements as a conventional configuration, with a 3-4 percent penalty in the takeoff gross weight L.T.

A85-39701#
ADVANCED FLOATWALL COMBUSTOR LINER TECHNOLOGY ELIMINATES TF30-P-100 TRANSITION DUCT FATIGUE CRACKING
T. L. DUBELL, J J. LETOURNEAU, and R M. KAPLAN (United Technologies Corp., Engineering Div , West Palm Beach, FL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 6 p.
(AIAA PAPER 85-1288)

The TF30-P-100 engine has experienced thermal fatigue cracking of its combustor transition duct (that transitions the hot gases from the burner cans to the turbine annulus). The cracking is caused by excessive thermal gradients in a conventional sheet metal louver design. The problem can be eliminated by the application of a new technology approach. The new design is a segmented configuration which utilizes a combination of convective cooling and film cooling for enhanced heat transfer characteristics. The liner is segmented both axially and circumferentially to minimize thermal stresses and fatigue cracking For the liner segments (panels), it utilizes high temperature turbine materials that are cast to the finished dimension The panels are fastened to a sheet metal shell which operates at relatively low temperatures and carries the structural load. This design essentially eliminates the low cycle fatigue failure mode. This configuration has been successfully demonstrated in TF30-P-100 engine tests. One liner was used to obtain temperature and pressure measurements A second liner was successfully run in an accelerated mission test. Author

A85-39702#
COMPARISON OF ADVANCED COOLING CONCEPTS USING COLOR THERMOGRAPHY
G. MYERS, J. VAN DER GEEST, J. SANBORN, and F. DAVIS (Garrett Turbine Engine Co., Phoenix, AZ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p. refs
(AIAA PAPER 85-1289)

A variety of advanced liner-cooling concepts were proposed to meet the low-coolant-flux, high-effectiveness requirements of future high-temperature-rise gas turbine combustors These concepts were compared at temperature levels similar to the actual liner environment. A thermographic camera and digital image analysis system were employed to acquire hot-side metal temperature distributions for each configuration over a wide range of coolant fluxes Results indicate that cold-side convection, augmented by rectangular fins and combined with film cooling, offers the largest potential reduction in coolant flux requirements. Performance results, including hot-side temperatures and liner pressure drop measurements, are presented for seven cooling methods. Hot-side metal temperature predictions made using a one-dimensional heat-transfer model are presented for several of the configurations tested and show good agreement with the measurements. Author

A85-39703*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ADVANCED LINER-COOLING TECHNIQUES FOR GAS TURBINE COMBUSTORS
C. T. NORGREN and S. M. RIDDLEBAUGH (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 13 p. Previously announced in STAR as N85-21115. refs
(AIAA PAPER 85-1290)

Component research for advanced small gas turbine engines is currently underway at the NASA Lewis Research Center. As part of this program, a basic reverse-flow combustor geometry was being maintained while different advanced liner wall cooling techniques were investigated. Performance and liner cooling effectiveness of the experimental combustor configuration featuring counter-flow film-cooled panels is presented and compared with two previously reported combustors featuring. splash film-cooled liner walls; and transpiration cooled liner walls (Lamilloy). Author

A85-39704#
THE INFLUENCE OF BLADE WAKES ON THE PERFORMANCE OF OUTWARDLY CURVED COMBUSTOR PRE-DIFFUSERS
S. J STEVENS and A P. WRAY (Loughborough University of Technology, Loughborough, Leics., England) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p Research supported by Rolls-Royce, Ltd.; Ministry of Defence. refs
(Contract MOD-AT/2170/065/XR)
(AIAA PAPER 85-1291)

An experimental investigation has been carried out to study the performance of a short outwardly curved pre-diffuser sited immediately downstream of an engine representative outlet guide vane blade row. The flow conditions prior to the OGVs were produced by a single stage compressor rotor. Particular emphasis has been placed on investigating the interactions that occur in such systems. Even when the OGVs were operating at off-design incidences the wakes entering the diffuser decayed rapidly and were no longer significant at diffuser exit. At off-design conditions the overall loss of the OGV/diffuser system increased, due mainly to a deterioration in OGV performance It has been demonstrated that flaring the OGV passage reduces the radial pressure gradient at diffuser inlet and is an effective way of maintaining blade performance. Author

A85-39705#
TECHNOLOGY FOR THE DESIGN OF HIGH TEMPERATURE RISE COMBUSTORS
D. W. BAHR (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p. refs
(AIAA PAPER 85-1292)

The results of analytical and experimental studies to determine the design technology needs of high temperature rise (Delta T) combustors and to define candidate design concepts for meeting these needs are reviewed. These studies show that several unique design considerations and constraints apply, because a high proportion of the available airflow must be allocated to the combustion process at the high Delta T operating conditions. This airflow allocation is necessary to obtain efficient combustion and acceptable smoke emission levels at the high Delta T conditions. Important technology needs include design features to provide stable operation over very wide Delta T ranges and design concepts to minimize liner cooling airflow requirements. Candidate design concept features for providing these needed high Delta T combustor capabilities are described. Included are advanced design concepts to provide combustion process staging capabilities, as well as advanced liner cooling and structural design concepts. The current development status of these various advanced design concepts is also assessed. Author

A85-39707#
'SMART' ENGINE COMPONENTS - A MICRO IN EVERY BLADE?
A. H. EPSTEIN (MIT, Cambridge, MA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 5 p.
(AIAA PAPER 85-1296)

The feasibility and potential benefits of closed-loop adaptive systems and subsystems of aircraft gas turbine engines are argued. The examples of application include active turbine tip clearance control, active exhaust nozzle position optimization, inlet distortion control, and active blade stall alleviation Consideration is also given to more complex potentially advantageous configurations such as magnetic suspension bearings and piezoelectrically actuated smart structures and seals. The actuator, sensor, and processing technologies which permit the practical implementation of such systems are reviewed. Finally, data transmission and control system architecture, as well as reliability considerations, are addressed. L.T.

A85-39716#
CALCULATION OF THE FLOW IN A DUMP COMBUSTOR
E. F. BROWN (Virginia Polytechnic Institute and State University, Blacksburg, VA) and A. A. HALE (Sverdrup Technology, Inc., Arnold Air Force Station, TN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p. USAF-supported research. refs
(AIAA PAPER 85-1309)

A numerical model for dump combustor calculations with the parabolized Navier-Stokes equations downstream of the separation region is presented. The model takes advantage of the lack of backflow in the separation region at the combustor entrance and the lack of feedback to upstream condition. Since an explicit solution is derived, the model furnishes a solution in one pass. When calculations were compared with data on the radial velocity and turbulence kinetic energy profiles in a combustor, a significant lack of accuracy was observed. However, the techniques did show promise in terms of lowered computation time and memory requirements. M.S.K.

A85-39717*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SMALL GAS TURBINE COMBUSTOR STUDY - FUEL INJECTOR PERFORMANCE IN A TRANSPIRATION-COOLED LINER
S. M. RIDDLEBAUGH and C. T. NORGREN (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p. refs
(AIAA PAPER 85-1312)

The effect of fuel injection technique on the performance of an advanced reverse flow combustor liner constructed of Lamilloy (a multilaminate transpiration type material) was determined. Performance and emission levels are documented over a range of simulated flight conditions using simplex pressure atomizing, spill return, and splash cone airblast injectors. A parametric evaluation of the effect of increased combustor loading with each of the fuel injector types is obtained. E.A.K.

A85-39718#
APPLICATION OF 3-D AEROTHERMAL MODEL AND FLOW VISUALIZATION TECHNIQUE TO THE COMBUSTOR EXIT GAS TEMPERATURE STUDY
Y. SATO, T. TAGASHIRA, H. TOH, and T. WATANABE (Ishikawajima-Harima Heavy Industries Co., Ltd., Research and Development Dept., Tokyo, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p.
(AIAA PAPER 85-1313)

A three-dimensional numerical analysis was performed of the exit gas temperature distribution of an aircraft gas turbine combustor. The model was configured with boundary conditions for the air flow velocity in the chamber, taking into account swirlers and air holes, the fuel droplet size and the fuel spray angle. The calculations comprise a k-epsilon model for turbulence, a chemical kinetic model for heat release, Lagrangian droplet transport, and eddy breakup in reaction to turbulence. Good agreement was found, including identification of hot spots, in comparisons with experimental data with a real combustor. M.S K

A85-39739*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SUMMARY OF NONAXISYMMETRIC NOZZLE INTERNAL PERFORMANCE FROM THE NASA LANGLEY STATIC TEST FACILITY
L. D LEAVITT (NASA, Langley Research Center, Hampton, VA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 15 p. refs
(AIAA PAPER 85-1347)

Early experimental work on multifunction nozzles (prior to 1978) concentrated on quantifying the isolated and installed performance of specific nozzle designs at various power settings during cruise, vectored thrust, and reverse thrust operating modes. Since 1978, however, significant effort has been expended on developing a parametric data base on nozzle internal design variables which could lead to improved internal performance and/or lower structural weight. Much of this work has been conducted in the Static Test Facility of the NASA/Langley 16-Foot Transonic Tunnel using subscale models and high pressure air to simulate jet exhaust. A review of the research effort on nonaxisymmetric multifunction nozzles along with a summary of many of the results is presented. In addition, internal performance results from subscale models tested in the Static Test Facility and from full-scale engine/nozzle tests are compared. Author

A85-39743#

APPLICATION OF SYSTEM IDENTIFICATION TECHNIQUES TO POSTSTALL COMBUSTOR DYNAMICS

S. J. PRZYBYLKO (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 9 p. (Contract F33615-84-C-2432)

(AIAA PAPER 85-1353)

In aircraft turbine engines, the occurrence of an occasional breakdown in the flow of air through the compression section of the engine is possible. These flow breakdowns are called surges or stalls. Usually the engine resumes normal operation without pilot intervention. However, it can happen that the surges are not self-recovering and result in engine flameout In some cases pilot action is required to prevent excessive engine operating temperatures. It is pointed out that these nonrecoverable stalls are extremely dangerous and have resulted in engine destruction and loss of aircraft. After an investigation of this problem, it was eventually realized that the combustor played a large role in determining whether a particular surge was recoverable or not. In the present paper, a description is provided of computer models which have been developed to simulate engine poststall behavior. G.R

A85-39765#

ENGINE THRUST MEASUREMENT UNCERTAINTY

J. H. ROBERTS, J. H. LEWIS, D. H. GLICKEN, R. MORIN, J. M MANCINI, and D G. HAAS (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 17 p. refs

(AIAA PAPER 85-1404)

Accurate thrust measurement for modern, high bypass ratio turbofans is best conducted by means of full scale tests in both altitude and sea level facilities satisfying three requirements: (1) instrumentation and data systems must be verified through the application of statistical measurement analysis, in which overall measurement uncertainties are evaluated by combining individual errors and then using cross-stand engine test results for comparison; (2) test facilities must accommodate the large air flow to the extent that the surrounding environment can represent conditions at altitude; finally, (3) the influence of wind momentum on thrust during sea level testing must be taken into account. In the present case, a turbulence control structure was used to eliminate thrust variations due to wind. O C.

A85-39771#

DEVELOPMENT AND EVALUATION OF AN INTEGRATED FLIGHT AND PROPULSION CONTROL SYSTEM

P. D. SHAW, K. BLUMBERG, D. JOSHI (Northrop Corp , Aircraft Div., Hawthorne, CA), R ANEX, J. H. VINCENT (Systems Control Technology, Inc., West Palm Beach, FL), and C SKIRA (USAF, Wright Aeronautical Laboratory, Wright-Patterson AFB, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 15 p. USAF-sponsored research. refs

(AIAA PAPER 85-1423)

A multivariable control methodology has been developed for functional integration of a fighter aircraft's aerodynamic controls with those of its propulsion system (inlet, engine, thrust vectoring and reversing nozzle). The technique accounts for and, where possible, takes advantage of the significant cross-couplings between flight and propulsion control systems. The design method was applied to an aircraft incorporating advanced technology features, such as variable cycle engines, variable geometry inlets, vectoring/reversing nozzles, canards, and propulsive lift. The basis of the procedure is partitioning of the system into smaller, manageable control design tasks. This procedure is outlined, the overall control structure shown, and the propulsion subsystem control approach focused upon. An example of control system performance is given for a short takeoff and landing (STOL) scenario Author

A85-39772*# McDonnell Aircraft Co., St. Louis, Mo.

INTEGRATED FLIGHT/PROPULSION CONTROL - ADAPTIVE ENGINE CONTROL SYSTEM MODE

W A YONKE (McDonnell Aircraft Co., St. Louis, MO), L. A. TERRELL (United Technologies Corp , Pratt and Whitney Group, West Palm Beach, FL), and L. P. MEYERS (NASA, Flight Research Center, Edwards, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 9 p.

(AIAA PAPER 85-1425)

The adaptive engine control system mode (ADECS) which is developed and tested on an F-15 aircraft with PW1128 engines, using the NASA sponsored highly integrated digital electronic control program, is examined. The operation of the ADECS mode, as well as the basic control logic, the avionic architecture, and the airframe/engine interface are described By increasing engine pressure ratio (EPR) additional thrust is obtained at intermediate power and above. To modulate the amount of EPR uptrim and to prevent engine stall, information from the flight control system is used. The performance benefits, anticipated from control integration are shown for a range of flight conditions and power settings. It is found that at higher altitudes, the ADECS mode can increase thrust as much as 12 percent, which is used for improved acceleration, improved turn rate, or sustained turn angle. M.D.

A85-39774#

DYNAMIC ENGINE BEHAVIOR DURING POST SURGE OPERATION OF A TURBOFAN ENGINE

A E. BURWELL (Arnold Engineering Development Center, Arnold Air Force Station, TN) and G T. PATTERSON (Sverdrup Technology, Inc., Arnold Air Force Station, TN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 11 p

(AIAA PAPER 85-1430)

Analysis and evaluation were conducted on the results of four engine test programs that were conducted over a five year period at Arnold Engineering Development Center (AEDC) to investigate the phenomena of nonrecoverable stall. The testing utilized four modern turbofan engines and encompassed a range of simulated flight conditions, engine control variations, stall inducement techniques, and potential stall clearing techniques. This paper describes a typical engine test program including the facility, engine, instrumentation, and data acquisition/recording requirements It also presents the data analysis techniques employed and representative results Author

A85-39775#

MODELING POST-STALL OPERATION OF AIRCRAFT GAS TURBINE ENGINES

J. V. FRENCH (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p.

(Contract F33615-79-C-2087)

(AIAA PAPER 85-1431)

Aero and thermodynamic models of the post-stall operation of aircraft gas turbine engines are presented, including approaches and results for three systems compared to test data. Considerations of ease of model use and computational efficiency are presented. The resulting one-dimensional flow models are shown to represent the primary modes of post-stall engine operation. Author

A85-39776#

REVIEW OF EMPIRICAL AND ANALYTICAL SPECIFIC IMPULSE METHODOLOGIES

D. K. DAVIS (Hercules, Inc., Hercules Aerospace Div., Magna, UT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 8 p. refs

(AIAA PAPER 85-1434)

This paper describes work which evaluated various empirical specific impulse (Isp) methodologies developed by Thiokol-Elkton, Lockheed, Hercules, Software and Engineering Associates (SEA), and Landsbaum. A new empirical method developed at Hercules using a large motor database was also included All the methods were used to evaluate the Hercules motor database. The Isp values calculated by the empirical method present in the Hercules motor design optimization program were included in the methodologies comparisons. The database evaluation showed that all the methods except the SEA method gave results which had an average error less than 1 percent. The newly developed Hercules method gave the most accurate results. The results for the interim Solid Performance Program (SPP), the 1984 version of the SPP, and two modifications of each version were included to allow the comparison of analytical methods to empirical methods. The comparison between analytical and empirical methods showed that, for the motor database, the average errors for the empirical methods were comparable to those of the analytical methods. The empirical results had larger standard deviations values than the analytical methods. Author

A85-39790#
DERIVATIVE T56 ENGINE DEVELOPMENT EXPERIENCE
T. F. GEE (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 7 p.
(AIAA PAPER 85-1459)

The full-scale development program for installation of the Navy T56-A-427, the series IV derivative of the T56 turboprop engine, on E-2C and C2-A aircraft is described. The program is aimed at improving the operability and durability characteristics and encompasses improvements to the reduction gearbox, combustion liners, engine control system, and compressor and turbine. Development testing of the engine was completed May 31, 1985, having accumulated 1255 h on schedule; performance goals, including the maximum power rating (4600 shp at sea level), maximum continuous rating (3180 shp at 25,000 ft), 20-percent surge margin, and constant propeller speed at 1106 rpm, were exceeded Further work is being carried out on turbine durability. L.T.

A85-39791#
THE CONCEPTION AND DEVELOPMENT OF A FAMILY OF SMALL ENGINES FOR THE 1990'S
D. LEWIS and M. J. BULLER (Rolls Royce, Ltd, Watford, Herts., England) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 8 p. refs
(AIAA PAPER 85-1460)

This paper reviews the process of conceiving and evolving a strategy, design, and a development program for an aero-engine by a European team pooling their expertise and particularly their experience. A new aircraft engine family, the RTM 322, is used to illustrate the setting of project priorities and how sometimes difficult decisions are made for strict adherence to these priorities. Significant changes in the formulation of development programs whilst incurring some increase in front-end costs should produce major rewards in terms of 'right first time' results and lowering of the risk levels. Finally advanced engineering programs to substantiate growth potential of the family are discussed. Author

A85-39794#
AXISYMMETRIC THRUST REVERSING THRUST VECTORING EXHAUST SYSTEM FOR MANEUVER AND BALANCED FIELD LENGTH AIRCRAFT
J. A COHN, D. J. DUSA, C. D. WAGENKNECHT, and J. P. WOLF (General Electric Co., Cincinnati, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 14 p. refs
(AIAA PAPER 85-1466)

A generic axisymmetric multifunctional exhaust system, one of the candidate thrust reversing and thrust vectoring systems, is described, with a review of the projected STOL maneuver requirements. Several nozzle configurations are presented for J-79 nozzles, initially used in the F4, Phantom, Hustler, and F16 Falcon; the J93 nozzle for the XB70; and the F110 and F404 nozzles for F16 Falcon and F18 Hornet. The effects of interference of the engine efflux in the reverse thrust mode with aircraft surfaces are discussed. Experimental data are presented for a 1/8 scale quadrant of a thrust reverser; it is concluded that full-scale reverse thrust capability of 65-75 percent is substantiated. L.T.

A85-39798#
NONCONTACT ENGINE BLADE VIBRATION MEASUREMENTS AND ANALYSIS
W. B. WATKINS, W. W. ROBINSON (United Technologies Corp., Engineering Div., West Palm Beach, FL), and R. M. CHI (United Technologies Research Center, East Hartford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 9 p. refs
(AIAA PAPER 85-1473)

A noncontact vibration measurement method for rotating turbine blades is presented. Blade passage through a focused light beam guided and received by optic fibers triggers signals for comparisons with reference signals tuned to the expected intervals. The data permit calculation of the angular positions of the blades and, therefore, the displacements. The all-blade vibrational spectrum is extracted by treating the data as a Fourier spectrum. Blades, however, can vibrate in frequency, time and phase-to-phase modes, and require the recording of time intervals between vibrations to detect any approach to a fundamental mode. M.S.K.

N85-27865 Department of the Air Force, Washington, D.C.
SEGMENTED ZONED FUEL INJECTION SYSTEM FOR USE WITH A COMBUSTOR Patent
G W. MOORE and R. G. CARROLL, inventors (to Air Force) 19 Feb. 1985 6 p
(AD-D011640; US-PATENT-4,499,735,
US-PATENT-APPL-SN-578304; US-PATENT-CLASS-60-739)
Avail US Patent and Trademark Office CSCL 21E

A segmented, zoned fuel injection system for use within the entrance area of a combustor is described. The fuel injection system has a plurality of spray bars formed as part of closely-spaced apart segments The spray bars are zoned to permit additional control of profile and flow rate of fuel injected into the combustor. This design permits radial profile control within the combustor, maintains higher efficiency at low fuel flows and easy replacement and/or maintenance of the components thereof. GRA

N85-27866 Department of the Air Force, Washington, D C.
SPACER STRUCTURE Patent
G. WEBB, inventor (to Air Force) 19 Feb. 1985 7 p Supersedes AD-D008756
(AD-D011641; US-PATENT-4,500,255,
US-PATENT-APPL-SN-256880; US-PATENT-CLASS-415-189)
Avail: US Patent and Trademark Office CSCL 21E

A structure useable as a spacer is described. In a preferred embodiment, the spacer is ideally suited (one of a plurality of identical spacers) for use as a spacer between every two adjacent stator vanes of a stator vane ring of a multiplestage fan of a gas turbofan engine The spacer is in the form of a rectangular solid and comprises a metal face skin member having a curved aerodynamically configurated outer surface with a centrally-located longitudinally-positioned concavity which functions as a rib, and a backing pad member that is made of a molded polyethelene material with integral peripheral edge lip seals that are coated with a polyurethane material, and that is joined by its outer surface to the inner surface of the face skin member, with the backing pad member having an embeddded rib skin stiffner positioned under, along, and in contact with the concavity in the face skin member. In the adaptation as a fan stator vane spacer, each spacer is releasably attached by novel means to the fan stator vane ring in the space on the ring between every two adjavent fan stator vanes, and is positioned in the force-to-aft fan air flow such that the fan air flows over the curved aerodynamically configured outer surface of the face skin member in the direction of the longitudinally-positioned concavity. In this adaptation, the spacer proides peripheral sealing, ice impact resistance, and face skin stability, and prevents or at least minimizes fan air flow short circuits around vane ends and beneath the spacer. GRA

N85-27867*# Oklahoma State Univ., Stillwater. School of Mechanics and Aerospace Engineering
PREDICTIONS AND MEASUREMENTS OF ISOTHERMAL FLOWFIELDS IN AXISYMMETRIC COMBUSTOR GEOMETRIES Ph.D. Thesis. Final Report
D. L. RHODES and D. G. LILLEY May 1985 169 p refs
(Contract NAG3-74)
(NASA-CR-174916, NAS 1.26:174916) Avail: NTIS HC A08/MF A01 CSCL 21E

Numerical predictions, flow visualization experiments and time-mean velocity measurements were obtained for six basic nonreacting flowfields (with inlet swirl vane angles of 0 (swirler removed), 45 and 70 degrees and sidewall expansion angles of 90 and 45 degrees) in an idealized axisymmetric combustor geometry. A flowfield prediction computer program was developed which solves appropriate finite difference equations including a conventional two equation k-epsilon eddy viscosity turbulence model. The wall functions employed were derived from previous swirling flow measurements, and the stairstep approximation was employed to represent the sloping wall at the inlet to the test chamber. Recirculation region boundaries have been sketched from the entire flow visualization photograph collection. Tufts, smoke, and neutrally buoyant helium filled soap bubbles were employed as flow tracers. A five hole pitot probe was utilized to measure the axial, radial, and swirl time mean velocity components. Author

N85-27868*# Ohio State Univ., Columbus. Dept. of Engineering Mechanics.
A STUDY OF INTERNAL AND DISTRIBUTED DAMPING FOR VIBRATING TURBOMACHINER BLADES Final Report, 15 Apr. 1983 - 15 Apr. 1985
A. W. LEISSA Jun. 1985 24 p refs
(Contract NAG3-424)
(NASA-CR-175901; NAS 1.26:175901) Avail: NTIS HC A02/MF A01 CSCL 21E

Internal and distributed damping as possible methods for reducing the vibration response of turbomachine blades and theoretical methods for analyzing damped vibration were studied. It is demonstrated how the Ritz-Galerkin methods may be used to straightforwardly to analyze forced vibrations with damping. This is done directly without requiring the free vibration eigenfunctions. The Galerkin method is an effective technique for these types of problems. The Ritz method has the further advantage of not needing to satisfy the force type boundary conditions, which is particularly important for plates and shells. But proper functionals representing the forcing and damping terms must be developed, and this is done. Two types of damping--viscous and material (hysteretic) are considered Both distributed and concentrated exciting forces are treated. Numerical results are obtained for cantilevered beams and rectangular plates. Studies showing the rates of convergence of the solutions are made. In the case of the cantilever beam, approximate solutions from the present methods are compared with the exact solutions. R.J.F.

N85-27869*# Princeton Univ., N J Dept. of Mechanical and Aerospace Engineering.
THE ROLE OF SURFACE GENERATED RADICALS IN CATALYTIC COMBUSTION Final Report
D. A. SANTAVICCA, Y. STEIN, and B. S. H. ROYCE Jun. 1985 24 p refs
(Contract NAG3-353)
Avail: NTIS HC A02/MF A01 CSCL 21B

Experiments were conducted to better understand the role of catalytic surface reactions in determining the ignition characteristics of practical catalytic combustors Hydrocarbon concentrations, carbon monoxide and carbon dioxide concentrations, hydroxyl radical concentrations, and gas temperature were measured at the exit of a platinum coated, stacked plate, catalytic combustor during the ignition of lean propane-air mixtures. The substrate temperature profile was also measured during the ignition transient Ignition was initiated by suddenly turning on the fuel and the time to reach steady state was of the order of 10 minutes. The gas phase reaction, showed no pronounced effect due to the catalytic surface reactions, except the absence of a hydroxyl radical overshoot It is found that the transient ignition measurements are valuable in understanding the steady state performance characteristics E.A.K.

N85-27870*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FUTURE FUNDAMENTAL COMBUSTION RESEARCH FOR AEROPROPULSION SYSTEMS
E J. MULARZ 1985 8 p refs Presented at the 21st Joint Propulsion Conf., Monterey, Calif.; sponsored by AIAA, SAE, ASME and ASEE
(NASA-TM-87049; E-2612; NAS 1.15:87049, AIAA-85-1398; USAAVSCOM-TR-85-C-11) Avail: NTIS HC A02/MF A01 CSCL 21E

Physical fluid mechanics, heat transfer, and chemical kinetic processes which occur in the combustion chamber of aeropropulsion systems were investigated. With the component requirements becoming more severe for future engines, the current design methodology needs the new tools to obtain the optimum configuration in a reasonable design and development cycle. Research efforts in the last few years were encouraging but to achieve these benefits research is required into the fundamental aerothermodynamic processes of combustion. It is recommended that research continues in the areas of flame stabilization, combustor aerodynamics, heat transfer, multiphase flow and atomization, turbulent reacting flows, and chemical kinetics Associated with each of these engineering sciences is the need for research into computational methods to accurately describe and predict these complex physical processes Research needs in each of these areas are highlighted. E.A K.

N85-27871# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio School of Engineering.
INVESTIGATION OF HEAT TRANSFER TO A TURBINE BLADE CASCADE USING A SHOCK TUBE M.S. Thesis
J. E GOCHENAUR Dec. 1984 107 p
(AD-A153090; AFIT/GAE/AA/84D-6) Avail: NTIS HC A06/MF A01 CSCL 21E

In order to increase the turbine inlet temperatures at which gas turbine engines operate it is important to understand the heat transfer mechanisms which govern turbine blade heating. This study used a shock tube to generate high temperature gas flows which were allowed to pass through a turbine blade cascade. A Germanium surface thermocouple was used to provide temperature historics at five locations on a turbine blade for a range of flow temperature to blade temperature ratios. Heat transfer rates were determined from these temperature histories using a finite differencing scheme to approximate the heat equation It was found that the rate of heat transfer along the pressure side of the blade decreased with chordwise position from a maximum value at the leading edge. On the blade suction side, heat transfer rates were found to be considerably greater at the 1/4 and 1/2 chord positions than at the leading edge. GRA

N85-27872# National Aerospace Lab., Amsterdam (Netherlands).
FAN NOISE SUPPRESSION IN TURBOFAN ENGINES
1983 13 p In DUTCH, ENGLISH summary Sponsored by Netherlands Agency for Aerospace Programs
(B8580076) Avail: NTIS HC A02/MF A01

The optimum impedance of the sound absorbing materials of the intake and exhaust ducts of turbofan engines is investigated. To detect the circumferential modes, measurements were performed in a mode simulator in which spiraling sound waves can be generated or suppressed using a ring of loudspeakers in the wall. A computer program to calculate the sound absorbtion of sound absorbing material lined ducts together with the sound radiated on the ground was developed. The acoustic impedance of a Helmholtz-resonator type liner is determined using a two-microphone technique in which the amplitude and phase inside and on the resonator are measured. Author (ESA)

N85-27873# National Aerospace Lab., Amsterdam (Netherlands).
TESTING OF MATERIALS AND COATINGS FOR JET ENGINE COMPONENTS UNDER SIMULATED OPERATIONAL CONDITIONS
1983 14 p In DUTCH; ENGLISH summary Sponsored by Netherlands Agency for Aerospace Programs Original contains color illustrations
(B8580073) Avail: NTIS HC A02/MF A01

Two installations were built to test turbine blades, vanes, and compressor components under simulated polluted-air operational conditions. A burner rig controlled by a process computer was constructed to test the thermal fatigue of turbine blades and vanes at high temperatures. A compressor, and a combustion and mixing chamber were constructed to simulate the conditions under which the compressor components operate. Results show that most materials need a special coating when used in the Western European atmosphere. Author (ESA)

N85-27874# SIGRI Electrogradhit G.m b.H., Meitingen (West Germany).
REACTION-BONDED AND FIBER-REINFORCED SIC STATIC AND DYNAMIC GAS TURBINE COMPONENTS Final Report, Jun. 1983
W. HEIDER, H. BOEDER, and H. FERBER Bonn Bundesministerium fuer Forschung und Technologie Dec. 1984 90 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie.
(BMFT-FB-T-84-302; ISSN-0340-7608) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 19.50

The development, manufacturing, and testing of static gas turbine components in reaction sintered silicon impregnated silicon carbide (SiSiC) and the application of carbon fiber reinforced silicon carbide (CSiC) in dynamically loaded components were studied for the development of a ceramic gas turbine for high process temperatures. The SiSiC can be applied for static high temperature turbine components and CSiC with a long oxidation stability for dynamically loaded components Line production of complex-shaped turbine components is based on the improvement of the injection molding technique and on the production of combustion chambers and of a turbine entrance spiral.
Author (ESA)

N85-28147# Joint Publications Research Service, Arlington, Va.
VIBRATIONS OF ROTORS CONNECTED THROUGH COUPLINGS WITH BACKLASH Abstract Only
E. L. POZNYAK and G. P. MAYOROV *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-85-004) p 19-20 15 May 1985 Transl. into ENGLISH from Mashinostr. (Moscow), no. 5, Sep - Oct. 1984 p 36-42
Avail: NTIS HC A06/MF A01

Couplings with backlash for turbine sets, while suitable for compensation of manufacturing and assembly imprecision, cause vibration of the rotors they connect - especially when the shifts of those rotors are not perfectly aligned. Such couplings are either of the fixed type without friction or of the flexible type with very significant friction, flange couplings and end sleeves belonging in the first group while those in the second group have a sleeve and claw, a sleeve with slit, or a sleeve with teeth. A qualitative performance and vibration analysis for the various types of couplings is based on corresponding force and motion diagrams. A computer-aided quantitative analysis for coupled rotors in an SKV 150 MW - 3000 rpm turbine set (total length 12 m, total mass 30 tons, pitch circle of toothed sleeve coupling 14 cm in diameter) confirms the theoretical prediction that the force distribution becomes more uniform with a decreasing relative magnitude of unbalance force as the load is increased. Experimental data indicate, however, that the mechanism of vibration buildup is much more complex, being not only different for vertical and horizontal vibrations but also leading to instability.
Author

N85-28148# Joint Publications Research Service, Arlington, Va.
PRECISION DIE FORGING OF BLADES OR GAS TURBINES Abstract Only
E. G. SHASTIN *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-85-004) p 27 15 May 1985 Transl. into ENGLISH from Energomashinostr. (Moscow), no. 8, Aug. 1984 p 20-22
Avail: NTIS HC A06/MF A01

Precision die forging of blades for supersonic gas turbines and compressors is continuously competing with precision die casting, such blades being made of either heat-resistant alloy steels or titanium alloys. One problem in die forging is preheating the blanks and heat treatment without building up a weak surface layer thicker than the allowance for subsequent machining, this layer being either depleted of carbon and alloying elements (steels) or saturated with oxygen and hydrogen (titanium alloys). This problem has been solved by forging in a protective atmosphere or under vacuum. Two other problems are ensuring the necessary deformation of materials with low plasticity within a narrow temperature range and ensuring adequate mechanical strength and stability of the dies. These two problems, solved earlier by sequential forging and by hardening the platen, are now solved by utilizing the superplasticity effect in alloys with certain structural characteristics during deformation along certain temperature - strain-rate rate curves. Author

N85-28149# Joint Publications Research Service, Arlington, Va.
STRESSED-STRAINED STATE OF TIGHTENING BUCKLES IN SECTIONAL RUNNERS OF GAS TURBINES Abstract Only
I. K. BAKUMENKO and N. A. KULAKOVSKAYA *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-85-004) p 27-28 15 May 1985 Transl. into ENGLISH from Energomashinostr (Moscow), no. 9, Sep. 1984 p 7-10
Avail: NTIS HC A06/MF A01

The mechanical state of the 10 tightening buckles in sectional runners of GTN-16 gas turbine-generator sets at high operating temperatures and speeds, after balancing, is analyzed on the basis of the total force and moment balance. The Poisson effect for rotating disks and a 2 5 to 4-times nominal safety margin under variable load are taken into account. Rotational and thermal stresses as well as contact strsses are included, in addition to plain flexural and torsional stresses. A safety factor for tightness is defined for the joints, which can be higher or lower depending on the balance of forces on a joint. The calculations have been programmed in FORTRAN-4 for an M-222 computer. Calculations have been checked by experiments, the object being to design tightening buckles with more stable joints so as to reduce vibrations. Author

N85-28943 Department of the Air Force, Washington, D.C.
STRUTLESS DIFFUSER FOR GAS TURBINE ENGINE Patent
G H. DUNCAN, III and D. L. COOPER, inventors (to Air Force) 12 Mar. 1985 5 p Supersedes AD-D010244
(AD-D011662, US-PATENT-4,503,668; US-PATENT-APPL-SN-484390; US-PATENT-CLASS-60-39.32)
Avail: US Patent and Trademark Office CSCL 21E

This patent discloses an improved diffuser for a gas turbine engine which is mounted between a compressor section and a burner section. The diffuser eliminates struts by using the exit guide vanes of the compressor for support. The vanes are fixedly mounted to an inner case wall and to a double outer wall. A cantilevered case wall being one of the double outer walls can flex both radially and axially to relieve thermal stress in the vanes. Additionally, probes can be mounted in access ports formed in the double outer wall. Compressor leakage gas is prevented from entering voids in the double outer wall by a seal seated between the cantilevered case wall and the other case wall. GRA

N85-28944*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ADVANCED SECONDARY POWER SYSTEM FOR TRANSPORT AIRCRAFT
A. C. HOFFMAN, I. G. HANSEN, R. F. BEACH, R. M. PLENCNER, R. P. DENGLER, K. S. JEFFERIES, and R. J. FRYE May 1985 38 p refs
(NASA-TP-2463, E-2434, NAS 1.60:2463) Avail: NTIS HC A03/MF A01 CSCL 21E

A concept for an advanced aircraft power system was identified that uses 20-kHz, 440-V, sin-wave power distribution. This system was integrated with an electrically powered flight control system and with other aircraft systems requiring secondary power. The resulting all-electric secondary power configuration reduced the empty weight of a modern 200-passenger, twin-engine transport by 10 percent and the mission fuel by 9 percent. Author

N85-28945*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DEAN: A PROGRAM FOR DYNAMIC ENGINE ANALYSIS
G. G. SADLER and K. J. MELCHER 1985 18 p refs Proposed for presentation at the 21st Joint Propulsion Conf., Monterey, Calif., 8-10 Jul. 1985; sponsored by AIAA, SAE and ASME Prepared in cooperation with Army Research and Technology Labs.
(NASA-TM-87033; E-2588; NAS 1.15:87033; USAVSCOM-TR-85-C-10) Avail: NTIS HC A02/MF A01 CSCL 21E

The Dynamic Engine Analysis program, DEAN, is a FORTRAN code implemented on the IBM/370 mainframe at NASA Lewis Research Center for digital simulation of turbofan engine dynamics. DEAN is an interactive program which allows the user to simulate engine subsystems as well as a full engine systems with relative ease. The nonlinear first order ordinary differential equations which define the engine model may be solved by one of four integration schemes, a second order Runge-Kutta, a fourth order Runge-Kutta, an Adams Predictor-Corrector, or Gear's method for still systems. The numerical data generated by the model equations are displayed at specified intervals between which the user may choose to modify various parameters affecting the model equations and transient execution. Following the transient run, versatile graphics capabilities allow close examination of the data. DEAN's modeling procedure and capabilities are demonstrated by generating a model of simple compressor rig. Author

N85-28946# Universal Energy Systems, Inc., Dayton, Ohio.
MULTI-DUCTED INLET COMBUSTOR RESEARCH AND DEVELOPMENT Final Report, 31 Aug. 1981 - 31 Aug. 1984
G. D. STREBY Wright-Patterson AFB, Ohio AFWAL Mar. 1985 26 p refs
(Contract F33615-81-C-2074; SB5448-81-C-0518)
(AD-A153753; AFWAL-TR-85-2004) Avail: NTIS HC A03/MF A01 CSCL 21E

Hydrodynamic simulations were conducted of dual inlet side dump combustor configurations to obtain flow visualization and residence time data using the Water Tunnel test rig facility of the Ramjet Technology Branch AFWAL/PORT Wright-Patterson AFB, Ohio. Tests were conducted for inlet duct angles of 30, 45, and 60 degrees for variations in the combustor dome plate height from 0.0 to 6.0 inches, for total combustor fluid flow rates of 200, 300 and 400 gallons per minute, for nozzle area to combustor area ratios of 0.20, 0.29 and 0.39, and for combustor lengths of 20.13, 39 0 and 53.25 inches. The inlet duct Reynolds Numbers for each total flow rate tested were 125,640 for 200 gallons per minute, 188,400 for 300 gallons per minute, and 251,300 for 400 gallons per minute. Also reported on are specialized research efforts concluded to support advanced combustor studies. GRA

N85-28947# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio. Aerodynamics and Airframe Branch.
IMPROVED STATISTICAL ANALYSIS METHOD FOR PREDICTION OF MAXIMUM INLET DISTORTION Final Report, 1 Jan. 1983 - 31 Mar. 1984
D. SEDLOCK Mar. 1985 116 p refs
(AD-A153767; AFWAL-TR-84-3085) Avail: NTIS HC A06/MF A01 CSCL 12A

This report presents the results of an investigation to develop an analytical method which predicts the maximum pressure distortion level and provides a synthesized pressure distortion map at the entrance to the turbine engine compression system. The method uses inlet total pressure statistical properties and a random number process to predict the most probable maximum pressure distortion and pressure distortion map. The validity of the method is demonstrated by comparing predicted maximum distortion levels and pressure contour maps with measured peak distortion levels and pressure contour maps obtained from analog screening of inlet pressure data. GRA

N85-28948# Tennessee Univ., Tullahoma.
COMPRESSOR AND TURBINE MODELS - NUMERICAL STABILITY AND OTHER ASPECTS Final Report, 1 May 1982 - 1 May 1984
K. C. REDDY and S. N NAYANI AEDC Apr. 1985 70 p
(Contract F40600-82-C-0003)
(AD-A153811, AEDC-TR-85-5) Avail: NTIS HC A04/MF A01 CSCL 12A

This report deals with the mathematical-numerical models used at AEDC for the simulation of aircraft engine compressors and turbines. Numerical stability problems encountered in a one-dimensional compressor model (COMP2SP) have been eliminated with appropriate changes in the algorithm. A multidimensional finite volume code (ATAC), which simulates the operation of a turbine, has been analyzed, and the source of numerical oscillations in that code has been isolated. Subsequently, proper changes to the ATAC code have been made at AEDC and numerical oscillations have been eliminated. Stage characteristics based on the total pressure loss coefficient and the deviation angle as functions of incidence angle have been found to be less sensitive to errors in interpolation for intermediate speeds than the pressure and temperature coefficients as functions of the flow coefficient. Multidimensional compressor model equations suitable for simulating the circumferentially distorted flows have been developed. Characteristics and compatibility equations are derived for the imposition of inflow and outflow boundary condition. GRA

08

AIRCRAFT STABILITY AND CONTROL

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

A85-37195#
DESIGN OF DIGITAL FLIGHT CONTROL SYSTEMS FOR HELICOPTERS
B. PORTER (Salford, University, Salford, England) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 146-152. refs

In this paper, general results from the singular perturbation analysis of the transfer function matrices of discrete-time tracking systems are used to design a fast-sampling error-actuated digital controller and associated transducers for the automatic control of the longitudinal motions of the CH-47 helicopter. It is demonstrated that tight non-interacting robust control of the vertical velocity an pitch attitude of the helicopter is readily achievable by the implementation of an appropriate fast-sampling digital controller which generates practically acceptable gang-collective and differential-collective rotor control inputs. Author

A85-38168#

PERTURBED MOTION OF AIRPLANE AND SAFE STORE SEPARATION

S. C. RAISINGHANI and S RAO (Indian Institute of Technology, Kanpur, India) Defence Science Journal (ISSN 0011-748X), vol. 34, July 1984, p. 221-234. refs

A method is presented to predict the perturbed motion of an airplane following stores jettisoning. The mass, moment of inertia, forces, and moments acting on the airplane are suitably split into contributions from the stores and the rest of the airplane parts. The separation of stores is assumed to result in a step change of mass, moment of inertia, forces, and moments contributed by stores. The resulting set of perturbed state equations of motion are solved for two illustrative airplane-stores combination. A criterion is evolved to qualitatively indicate locations for safe store separation. It is suggested that the present method be used to predict airplane perturbed motion following stores separation for a given airplane-store combination and results be used in conjunction with store trajectory analysis for finally declaring a store location as safe or unsafe. Author

A85-38357#

AN EVADING PATH AGAINST 3 D OBSTACLES

K. KATO and H. SOGA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol 32, no 360, 1984, p. 59-66. In Japanese, with abstract in English.

A quasi-optimum flight path is determined in order to evade three-dimensional obstacles. The procedure consists in solving two linear complementary problems, and is an extension of Funk's terrain-following control into three-dimensional space. The formulation includes upper as well as lower bounds for flight-admissible space and gives a near minimum-distance path following terrain or obstacles. Author

A85-38364#

AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS) OF HELICOPTER USING AN OPTICAL CONTROL ALGORITHM

T. TAKISHIMA, T. SATO, M. TAKAHAMA, and T. OTSUKI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 32, no. 361, 1984, p. 96-101. In Japanese.

An automatic flight control system for single-rotor helicopters using an optical algorithm to obtain a stabilized autoapproach is developed. The mathematical analysis of the optimal control system using a kinematic equation of the airframe is carried out. The system was tested with the Sikorsky S-61 helicopter, and it was shown that it was resistant to the gain variation and had a low vibrational fluctuation in the autoapproach profile. Block diagrams are included. S.H.

A85-38369#

DEVELOPMENT OF THE BK 117 HELICOPTER

T. MASUE Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol 32, no. 362, 1984, p. 142-148. In Japanese. refs

The structural specifications of the BK 117 helicopter and the technical problems encountered in its development are described. The BK 117 is a joint venture of Japan and Federal Republic of Germany and since its first flight in 1977, no accident or emergency landing have been recorded. The BK 117 has been commercialized as a multipurpose helicopter, and type certification has been issued by U.S., FRG, and Japan. S.H.

A85-38794#

AN EXPERIMENTAL DETERMINATION OF THE LONGITUDINAL STABILITY PROPERTIES OF THE LTA 20-1 AIRSHIP

J. D. LOWE, A S. KING, W. D. MCKINNEY, and D. R. UFFEN (Toronto, University, Toronto, Canada) IN: Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 115-123.

(AIAA PAPER 85-0879)

A dynamically-scaled, radio-controlled flying model of the LTA 20-1, which is a spherically shaped heavy lift airship, has been used to experimentally assess the longitudinal stability properties of the vehicle. Test results have confirmed analytical stability predictions. In general, it has been found that a horizontal tail is required to provide adequate damping properties in cruise flight. Author

A85-38795#

DYNAMIC CHARACTERISTICS OF THE STARS AEROSTAT

J. A. KRAUSMAN, S P. JONES, and B. D. SUNKARA (TCOM, Columbia, MD) IN Lighter-Than-Air Systems Conference, 6th, Norfolk, VA, June 26-28, 1985, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1985, p. 124-129. refs

(AIAA PAPER 85-0880)

The STARS is a asmall tethered aerostat with inverted-Y fins and a large windscreen. In a previous study, a mathematical model and various dynamic characteristics of the aerostat were reported The present paper updates and extends the dynamic analysis including the correction of a minor error in the previously reported work. The principal effect of the lattgr is in the lateral fin interference factors with no change in the longitudinal coefficients Additional studies of the STARS include calculation of the turbulence transfer functions and power density functions from which RMS displacements are calculated. Author

A85-38970#

THE WIND TUNNEL INVESTIGATION FOR OBTAINING ROLLING MOMENT WITH SMALL ASYMMETRY

X. HUANG and H. CAI (Beijing Institute of Aerodynamics, Beijing, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 69-73. In Chinese, with abstract in English.

A wind tunnel experimental method, which is used for obtaining the rolling moment with small asymmetry, has been developed. The experimental Mach numbers are 4, 5, 6 The angle of attacks range from -2 deg to 6 deg, and the Reynolds number, about 5 million. The experiment results and repeatance error are given in the paper. The experiment investigation shows that the tolerance in machining can cause as large as a 0.0001 coeffiicent of the rolling moment. It is even somewhat larger than that of the nosetip. Author

A85-38974#

DISCUSSIONS ON THE REGULAR BEHAVIOR OF THE LONGITUDINAL DYNAMIC RESPONSE OF AIRCRAFT DURING VARIABLE SWEEP FLIGHTS

D LIU (China Aerodynamic Research and Development Centre, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 93-96. In Chinese, with abstract in English. refs

The regular behavior of the aircraft dynamic response and its relation to the aerodynamics of the aircraft during variable sweep and accelerated flights are discussed in this paper, and the mechanism for the regular behavior of the aircraft response is also analyzed. It is pointed out that the decrease of the incidence, flight-path angle, and the flight altitude at initial time during the variable sweep and accelerated flight is the foundational characteristic of the aircraft response, and that the aerodynamic center moving backward, and therefore the increase of the static stability, is the foundational cause for it. It is also pointed out that the dynamic response at the initial time can be predicted using the varying rate, at the time when sweep angle begins to vary, of the static stability to the sweep angle. Author

A85-39059* National Aeronautics and Space Administration Langley Research Center, Hampton, Va.
STABILITY AND CONTROL RESULTS FOR ADVANCED TURBOPROP AFT-MOUNT INSTALLATIONS
P. L. COE, JR., Z. T. APPLIN, and L. J. WILLIAMS (NASA, Langley Research Center, Hampton, VA) IN: Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 19-26. refs
(SAE PAPER 841479)

An experimental investigation was recently conducted in the NASA-Langley Research Center 4- by 7-Meter Tunnel to explore the effects of aft-mounted advanced turboprop installations on the low-speed stability and control characteristics of a representative transport aircraft configuration. For the conditions investigated, the experimental results indicate that the longitudinal and directional stability of the configuration was not adversely affected by aft-pylon-mounted single-rotation tractor or counter-rotation pusher propeller installations. The results indicate that for the single-rotation tractor configuration the propeller induced aerodynamics are dominated by the interaction of the propeller slipsteam with the pylon, and that the propeller contribution to the stability characteristics for the counter-rotating pusher configuration is dominated by propeller normal forces The longitudinal and directional control effectiveness, engine-out characteristics, and ground effects are also presented. Author

A85-39567*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SLOW AND FAST STATE VARIABLES FOR THREE-DIMENSIONAL FLIGHT DYNAMICS
M. ARDEMA (NASA, Ames Research Center, Moffett Field, CA) and N. RAJAN (Stanford University, Stanford, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, July-Aug 1985, p. 532-535.

The identification of a new fast variable for three-dimensional flight dynamics is discussed It is shown that the variable gives a value of the flightpath angle which is consistent with the velocity-altitude state equations and that the accuracy of single-perturbation analyses is increased by decreasing the magnitude of boundary-layer corrections The values of the flightpath angle along the three-dimensional energy-state extremal are found to be lower by approximately an order of magnitude than those along the two-dimensional energy-state solution M.D.

N85-27875# Air Force Wright Aeronautical Labs, Wright-Patterson AFB, Ohio.
USE OF QUATERNIONS IN FLIGHT MECHANICS Final Technical Report, Jul. 1982 - Sep. 1983
W. L. HANKEY, L. E. MILLER, and S. J. SCHERR Mar. 1984 48 p
(Contract AF PROJ. 2307)
(AD-A152616; AFWAL-TR-84-3045) Avail. NTIS HC A03/MF A01 CSCL 12A

In analyzing aircraft spin and other flight maneuvers with large rotation rates based upon first principles, the non-linear aerodynamic equations (Navier-Stokes) must be coupled with the rigid-body dynamic equations of motion. In both systems of equations it is desirable to use a body axes system to describe the forces and moments, and utilize a surface-oriented coordinate system for obtaining the flowfield grid. To solve this system of equations it is necessary to describe the position of the aircraft with respect to a fixed inertial coordinate system. The classic method is to use the Euler angles to define the aircraft orientation. However, singularities and ambiguities exist when the elevation angle is plus or minus ninety degrees. This difficulty has been overcome in the field of inertial guidance by the use of quaternions to describe the aircraft position in space. It is the purpose of this report to investigate this technique for numerically solving aircraft spin problems. Two problems are addressed, the first is a nonsymmetric body and the second is a symmetric configuration The rotational dynamics and the solution for the quaternions and Euler angles are determined for both problems. Hamilton (circa 1840) was the first to point out that the three Euler angles are inadequate to uniquely define the orientation of a body in space and that four variables are required to resolve the predicament. Hence he invented the quaternion which is a scalar plus a vector, totalling four elements. GRA

N85-27876# Naval Postgraduate School, Monterey, Calif.
ANALYSIS OF CONTROL SYSTEM FROM A VIEWPOINT OF DESIRED POLE PLACEMENT AND DESIRED DEGREE OF ROBUSTNESS M.S. Thesis
J. CHANG Dec. 1984 83 p
(AD-A152627) Avail NTIS HC A05/MF A01 CSCL 12A

A design method for solving the problem of robustness to cross-coupling perturbations in multivariable control systems for the X22A V/STOL aircraft is presented in this thesis. The method uses numerical optimization procedures to manipulate the system feedback gains as direct design variables. The manipulation is accomplished in a manner that produces desired performance by pole placement and robustness by modification of the minimum singular values of the system return difference matrix. Channels affected by cross-coupling perturbation may be recognized by the character of their transfer function Bode plots. The mechanism used by the pole placement and robustness routine in obtaining a robust design is evident from the gain changes associated with the transfer function diagram and the zero shifts shown on pole-zero plots. The pole placement and robustness routine uses gain equalization and zero assignment to modify the characteristics of the system in the areas of low singular values, producing a robust design. GRA

N85-27877# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering
DESIGN OF ROBUST CONTROLLERS FOR A MULTIPLE INPUT-MULTIPLE OUTPUT CONTROL SYSTEM WITH UNCERTAIN PARAMETERS APPLICATION TO THE LATERAL AND LONGITUDINAL MODES OF THE KC-135 TRANSPORT AIRCRAFT M.S. Thesis
H. H. RUSSELL Dec 1984 380 p
(AD-A153100; AFIT/GE/ENG/84D-72) Avail: NTIS HC A17/MF A01 CSCL 01D

A multiple input-multiple output flight control design on the KC-135 aircraft is completed using Quantitative Feedback Theory (QFT). The three degrees-of-freedom model for the lateral mode is reduced to a two degrees-of-freedom model. From this model a robust controller is developed to perform two maneuvers over a wide range of the aircraft flight envelope. The three degrees-of-freedom for the longitudinal mode is then used to develop a robust controller to perform one maneuver. The first and second body bending modes are then added to remove the rigid bosy constraint and a robust control is developed for the non-rigid aircraft. The robust controllers developed for the lateral and longitudinal modes are simulated over a large range of the aircraft's flight envelope. The conclusion drawn from the research is that this method is very effective in designing multiple input-multiple output systems with plant uncertainty. GRA

N85-27878# McDonnell Aircraft Co, St. Louis, Mo
CONTROLLER REQUIREMENTS FOR UNCOUPLED AIRCRAFT MOTION, VOLUME 1 Final Report, Aug. 1981 - Apr. 1984
K. D. CITURS Wright-Patterson AFB, Ohio AFWAL Sep. 1984 198 p
(Contract F33615-81-C-3605)
(AD-A153173; AFWAL-TR-84-3060-VOL-1) Avail: NTIS HC A09/MF A01 CSCL 01A

Use of uncoupled, six-degree-of-freedom (6-DOF) motion is rapidly becoming state-of-the-art in terms of necessary flight control laws and aerodynamic capability. The next generation of aircraft may use uncoupled, 6-DOF control capability in conjunction with other new technologies. In order for future applications of 6-DOF control to be successful, the pilot must be able to command motion and acceleration magnitudes with sufficiently good system response characteristics to accomplish particular missions or tasks. This study sought to develop design criteria and gather appropriate substantiating data for cockpit control devices for 6-DOF motion which will assure compatibility among the pilot, control device(s) and aircraft response and thus allow efficient implementation of the 6-DOF control capability. Phase 1 consisted of defining existing data on the design of cockpit controllers for 6-DOF motion. Application of 6-DOF aircraft motion to aircraft mission requirements was examined. A set of tentative criteria was formulated and test plans developed to gather data necessary to validate and expand the tentative criteria. A simulation was conducted using the motion based simulator at Wright-Patterson AFB. Results of the simulation were combined with the results of the literature survey to form a set of design guidelines. Volume 1 presents the results of the literature survey, summarizes the simulation effort and presents the design criteria. GRA

N85-27879# McDonnell Aircraft Co., St. Louis, Mo.
CONTROLLER REQUIREMENTS FOR UNCOUPLED AIRCRAFT MOTION, VOLUME 2 Final Report, Aug. 1981 - Apr. 1984
K. D. CITURS Wright-Patterson AFB, Ohio AFWAL Sep. 1984 558 p
(Contract F33615-81-C-3605)
(AD-A153300; AFWAL-TR-84-3060-VOL-2) Avail: NTIS HC A24/MF A01 CSCL 01D

Use of uncoupled, six-degree-of-freedom (6-DOF) motion is rapidly becoming state-of-the-art in terms of necessary flight control laws and aerodynamic capability. The next generation of aircraft may use uncoupled, 6-DOF control capability in conjunction with other new technologies such as Integrated Flight-Fire Control (IFFC). In order for future applications of 6-DOF control to be successful, the pilot must be able to command motion and acceleration magnitude with sufficiently good system response characteristics to accomplish particular missions or tasks. This study sought to develop design criteria and gather appropriate substantiating data for cockpit control devices for 6-DOF motion which will assure compatibility among the pilot, control device(s) and aircraft response and thus allow efficient implementation of the 6-DOF control capability. Phase 1 consisted of defining existing data on the design of of cockpit controllers for 6-DOF. Application of 6-DOF aircraft motion to aircraft mission requirements was examined A set of tentative criteria was formulated and test plans developed to gather data necessary to validate and expand the tentative criteria. A simulation was conducted using the motion-based simulator at Wright-Patterson AFB. Results of the simulation were combined with results of the literature survey to form a set of design guidelines. Volume 1 (AD-A153300) presents the results of the literature survey. Volume 2 is a detailed discussion of the simulation and analysis of the data. GRA

N85-27880# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Flaechenflugzeuge.
IN-FLIGHT INVESTIGATION OF THE INFLUENCE OF PITCH DAMPING AND PITCH CONTROL EFFECTIVENESS ON LANDING APPROACH FLYING QUALITIES OF STATICALLY UNSTABLE TRANSPORT AIRCRAFT
K. WILHELM and D. SCHAFRANEK Feb. 1984 66 p refs
(DFVLR-FB-84-12; AD-B085878L) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 26

A in-flight simulator was used to investigate the flying qualities of statically unstable transport aircraft. The numerical values of pitch damping and pitch control effectiveness were varied in combination with a constant amount of instability. Over 70 landing approaches were flown by 3 pilots evaluating 5 configurations. Pilot ratings on the basis of the Cooper-Harper scale and a special effort rating scale and statistical values of measured performance data are presented. Decreasing the pitch damping in combination with an unchanged amount of instability leads to unacceptable flying qualities due to extreme difficulties with pitch attitude tracking. High values of pitch control effectiveness make the aircraft oversensitive and are not accepted by the pilots. An increase in turbulence intensity aggravates the influence of pitch damping reduction and control effectiveness increase on the flying qualities. Author (ESA)

N85-27881# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Flaechenflugzeuge.
IDENTIFICATION OF GUST INPUT AND GUST RESPONSE CHARACTERISTICS FROM DO 28 TNT FLIGHT TEST DATA
D ROHLF Nov. 1984 59 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-919)
(DFVLR-FB-84-48; ISSN-0171-1342) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 21

A method to determine gust reponse characteristics and simultaneously estimate the discrete gust input from flight test data using system identification techniques is presented. The method is restricted to longitudinal motion of aircraft with separated wing and tail surfaces at low Mach numbers. The applicability of the method is demonstrated by analyzing free flight catapult tests and dynamic wind tunnel tests with models of the Do 28 TNT aircraft. A good fit of the measured and identified time histories is achieved by considering the dynamic terms which are important for angles of attack varying rapidly due to gusts. Author (ESA)

N85-27882# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abt. Flaechenflugzeuge.
PROPOSALS FOR THE DETERMINATION OF NECESSARY ELEVATOR HANDLING CHARACTERISTICS OF SAILPLANES IN HIGH SPEED RANGE
G STICH and D. SCHMERWITZ Dec. 1984 38 p refs In GERMAN; ENGLISH summary
(DFVLR-FB-84-52) Avail: NTIS HC A03/MF A01; DFVLR, Cologne, DM 14.50

For high performance sailplanes with relaxed longitudinal static stability or slight instability in high speed range, pitch controllability using the elevator (stick deflection per load factor) is demonstrated by measurements in steady turns. A flight test program with a sailplane proves the theoretical investigations. A proposal for a simple procedure which allows the determination of pitch controllability in high speed range in the case of relaxed longitudinal static stability or slight instability is presented. Author (ESA)

N85-27883# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
ACTIVE CONTROL SYSTEMS: REVIEW, EVALUATION AND PROJECTIONS
Loughton, England Mar. 1985 392 p refs In ENGLISH and FRENCH Symp held in Toronto, 15-18 Oct. 1984
(AGARD-CP-384; ISBN-92-835-0375-9) Avail: NTIS HC A17/MF A01

Numerous topics relative to digital flight control systems are discussed. Active control technology applications, optimization of systems architecture for both reliability and costs control cam design, handling qualities, and the operational demonstration of systems reliability are among the topics covered.

N85-27884# Centre d'Etudes et de Recherches, Toulouse (France).
ACTIVE CONTROL TECHNOLOGY (ACT): PAST, PRESENT AND FUTURE
M. J. PELEGRIN *In* AGARD Active Control Systems: Rev., Evaluation and Projections 30 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

The past, present and future developments in the field of active control technology are surveyed. The improvement of aircraft performance, the reduction of operating costs, and the reduction of workloads are seen as benefits derived from active control technology. R.J.F.

N85-27885# General Electric Co , Binghamton, N Y.
THE STATE-OF-THE-ART AND FUTURE OF FLIGHT CONTROL SYSTEMS
In AGARD Active Control Systems: Rev., Evaluation and Projections 4 p Mar. 1985
Avail: NTIS HC A17/MF A01

The evolution of flight control systems from non-electronic primary controls with electronic secondary augmentation systems to modern electronic Primary Fly-By-Wire systems is traced. Current system configurations are related to their origins in both aircraft and electronics technology. The future of flight control technology is discussed in view of the payoff which is expected from the increased integration of the various aircraft control functions. The integration of the aerodynamic and propulsive control systems provides a new level of control which will make the aircraft dramatically more maneuverable. The coupling of the integrated flight control system with the avionics system will permit advanced guidance and attack modes which will combine to increase the lethality of the combat system. The system will reconfigure its control laws to allow continuation of the mission or at least controlled flight in the face of battle damage if sufficient control power, lift, and propulsion remain. System architecture will be such as to support advanced maintainability features which will provide vastly improved system availability and persistance. R J.F.

N85-27886*# Systems Technology, Inc., Hawthorne, Calif.
A PERSPECTIVE ON SUPERAUGMENTED FLIGHT CONTROL ADVANTAGES AND PROBLEMS
D MCRUER, D JOHNSTON, and T MYERS *In* AGARD Active Control Systems: Rev., Evaluation and Projections 20 p Mar. 1985 refs
(Contract NAS2-11388)
Avail: NTIS HC A17/MF A01 CSCL 01C

Superaugmented aircraft are an important subclass of actively controlled, higly-augmented aircraft The aircraft without augmentation is unstable, and the control system not only redresses the stability and control imbalance but also provides effective vehicle dynamics which may differ in kind from those associated with conventional aircraft. The properties of highly unstable aircraft and typical superaugmented control systems used to remedy their dynamic deficiencies are explored generically. The following topics are considered: basic flight control system architectures suitable to reduce or completely alleviate the unstable aircraft characteristics; the primary dynamic characteristics and regulatory properties of typical superaugmented aircraft control systems, including governing factors in the linear system, dominant mode characteristics, and fundamental stability margin properties; and flying qualities features for superaugmented aircraft with rate command/attitude hold, extended bandwidth, and attitude command configurations. R.J F.

N85-27887# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
ASPECTS OF APPLICATION OF ACT SYSTEMS FOR PILOT WORKLOAD ALLEVIATION
K. WILHELM and B. GMELIN *In* AGARD Active Control Systems: Rev., Evaluation and Projections 20 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

An essential element in the construction of future civil and military aircraft will be the inclusion of Active Control Technology (ACT) in the design process. This will be true for fixed-wing aircraft as well as for rotary-wing aircraft. The implementation of ACT makes possible improvements in flight performance and handling qualities. In particular, ACT can lead to alleviation of pilot workload in performing a specific task. This can be achieved by reducing undesirable motions and effects and adjusting the aircraft dynamics to a certain flight task and to the pilot. The above-mentioned problem areas concerning the implementation of ACT are discussed. Piloting problems with conventional systems and the influence of ACT systems on flying qualities and pilot workload are covered Results from wind tunnel testing and flight testing using a BO 105 type helicopter and the HFB 320 in-flight simulator are given. R.J.F

N85-27888# General Dynamics Corp., Fort Worth, Tex.
APPLICATION OF AFTI/F-16 TASK-TAILORED CONTROL MODES IN ADVANCED MULTIROLE FIGHTERS
R D. TOLES, D R. MCMONAGLE (Air Force, Edwards AFB, Calif.), D. C. ANDERSON, and J. H. WATSON *In* AGARD Active Control Systems: Rev., Evaluation and Projections 11 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

The next generation of multirole fighter aircraft will benefit from recent advances in flight control technology. The advent of digital fly-by-wire flight control capability for vehicles with relaxed static stability, as recently demonstrated by the AFTI/F-16, means a much higher level of performance is now attainable in handling qualities and weapon delivery effectiveness. Specifically, digital implementation of control laws permits the designer to attain a higher level of man/machine capability and performance, even at the flight envelope extremities. Multiple, separate task-tailored modes can be designed and employed to perform tasks with distinctly different flight dynamics requirements, achieving better performance than any single, multipurpose mode. Recently developed design concepts which support the above assertions are discussed. These concepts were employed on the AFTI/F-16 aircraft which dramatically demonstrated the benefits of digital flight control and task-tailored modes. R.J.F.

N85-27889# Grumman Aircraft Engineering Corp., Bethpage, N. Y.
X-29 DIGITAL FLIGHT CONTROL SYSTEM DESIGN
A. WHITAKER and J. CHIN *In* AGARD Active Control Systems: Rev., Evaluation and Projections 13 p Mar. 1985 refs
Avail· NTIS HC A17/MF A01

The X-29 Technology Demonstrator is a Forward Swept Wing Aircraft with primary longitudinal control provided by a large canard. The wing body is balanced to be neutrally stable for minimum drag. The canard is sized for high maneuverability resulting in a configuration which is 35% unstable. This configuration with its high aerodynamic efficiency became practical through the application of Active Control System Technology in the design of the Digital Flight Control System. The design concept for the X-29 flight control system was to utilize the available state-of-the-art and existing hardware to fly a very unusual aircraft. The purpose was to achieve an Advanced Application of Control Configured Vehicle with minimum cost and risk in the hardware development. As a result, the system architecture is very conservative using demonstrated techniques. The Normal Longitudinal Control Law, on the other hand, is based on Modern Control Theory. The unique features of the aircraft configuration, the control system architecture, and control surface arrangement are discussed. The hardware selected for implementation is described The control law development is outlined to include the constraints which result from the 35% static instability. R.J.F.

N85-27890# Royal Aircraft Establishment, Bedford (England). Flight Systems Dept.
THE EVOLUTION OF ACS FOR HELICOPTERS: CONCEPTUAL SIMULATION STUDIES TO PRELIMINARY DESIGN
J. S. WINTER, G D. PADFIELD, and S. L. BUCKINGHAM *In* AGARD Active Control Systems: Rev , Evaluation and Projections 14 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

In the development of suitable control algorithms for future active control technology battlefield helicopters, handling qualities appropriate to a wide range of tasks will need to be identified and incorporated into the design process before detailed control laws may be defined. Work in identifying appropriate characteristics through piloted simulation studies of a conceptual model of the controlled helicopter, subsequent control law studies and the use of computer aided design and analysis of the sensitivity of the controlled vehicle are discussed R J.F.

N85-27891# Smiths Industries Ltd., Bishops Cleeve (England).
ACT APPLIED TO HELICOPTER FLIGHT CONTROL
W. R. RICHARDS *In* AGARD Active Control Systems: Rev., Evaluation and Projections 12 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

Benefits of ACT applied to helicopters are potentially significant resulting in a considerable challenge to avionic equipment suppliers. The impact of mechanical link removal and replacement by electrical/optical signalling is discussed. ACT control systems configurations suitable for installation in helicopters in the 1988 and 1992 time scales with anticipation of continued component technological development are identified. New control laws are discussed based on requirements for higher bandwidth controllers, and non-interaction of control axes. Author

N85-27892# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Aircraft Div.
SOME FLIGHT TEST RESULTS WITH REDUNDANT DIGITAL FLIGHT CONTROL SYSTEMS
U. KORTE *In* AGARD Active Control Systems: Rev., Evaluation and Projections 14 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

Under contract of the German MOD a quadruredundant, full authority digital Flight Control System has been developed by MBB for use in naturally unstable aircraft and flight tested in a single seater F-104 G which has been modified as a CCV demonstrator aircraft. From Dec. 1977 to Nov. 1981 the new FCS was tested in 118 flights in five different configurations of the aircraft. 22 of the flights were made in unstable configurations with instabilities up to 22 % MAC. In a follow-on program from Aug. 1982 to April 1984 a simple digital Backup-Controller (Software) and an integrated digital Autopilot were developed and successfully flight tested. Total number of flights with the digital FBW-system was 176. Some of the experiences and results are presented which were made with the operational FBW-system and the backup-software. Author

N85-27893# British Aerospace Public Ltd Co., Lancashire (England). Aircraft Group.
AN UPDATE OF EXPERIENCE ON THE FLY BY WIRE JAGUAR EQUIPPED WITH A FULL-TIME DIGITAL FLIGHT CONTROL SYSTEM
E. DALEY *In* AGARD Active Control Systems: Rev., Evaluation and Projections 15 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

An overview of the Fly By Wire Jaguar Demonstrator Program which was recently successfully completed with the flight trials of a highly unstable configuration of 10% negative maneuver margin. The aircraft is unique, being equipped from the outset with a quadruplex digital flight control system, with no form of electrical or mechanical backup system. The U.K. demonstrator program was sponsored by MoD, with the aim of the design, development and demonstration of a safe, practical, full time fly by wire flight control system for a combat aircraft. The primary aim was achieved in 1981 with the first flight of the aircraft, and further objectives of the flight demonstration of the aircraft in a highly unstable configuration in pitch, and with a Stall Departure/Spin Prevention system, was successfully completed. The flight control system, its flight certification and all phases of its flight trials is briefly described. Author

N85-27894# British Aerospace Aircraft Group, Brough (England). Aircraft Group.
ACT FLIGHT RESEARCH EXPERIENCE
D. J. WALKER and R M. HORNER (RAE, Farnborough) *In* AGARD Active Control Systems: Rev., Evaluation and Projections 7 p Mar. 1985
Avail: NTIS HC A17/MF A01

Hunter XE 531 was the subject of a 15 year ACT program. The initial years involved the design, implementation and flight testing of a full authority quadruplex FCS flight control system. Using the aircraft as an experimental facility, a joint program emerged with British Aerospace, concentrating on handling aspects, ending with the loss of the aircraft through engine failure on take-off in 1982. The whole program is reviewed and the large variety of multidisciplinary topics covered are briefly described. Author

N85-27895# McDonnell Aircraft Co, St. Louis, Mo.
OPERATIONAL AND DEVELOPMENTAL EXPERIENCE WITH THE F/A-18A DIGITAL FLIGHT CONTROL SYSTEM
W. A. MORAN *In* AGARD Active Control Systems: Rev., Evaluation and Projections 13 p Mar. 1985
Avail: NTIS HC A17/MF A01

The control system of the F/A-184 Hornet is a four channel fly by wire system using digital processors. During the development of the F/A-18, more than 75 control law variations were flown. Many of these variations were made necessary by flexible aerodynamic characteristics which sometimes defied prediction and by evolving structural loads requirements, as well as by the usual refinements in control laws resulting from flight experience. The digital flight control computer provided the ability to make these changes with relative ease. It also provided the flexibility to solve problems which on past generation aircraft might have been treated either with placards or with expensive structural modifications. The control system and the testing of the system is described in detail. Author

N85-27896# Naval Air Test Center, Patuxent River, Md. Strike Aircraft Test Directorate.
FLIGHT TESTING AND DEVELOPMENT OF THE F/A-18A DIGITAL FLIGHT CONTROL SYSTEM
R. A. BURTON, B. T. KNEELAND, U H. RABIN (Systems Control Technology, Inc, Palo Alto, Calif.), and R. S. HANSEN (Systems Control Technology, Inc., Palo Alto, Calif.) *In* AGARD Active Control Systems: Rev, Evaluation and Projections 18 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

The improvement in the F/A-18 handling qualities from level 3 to level 1 for several mission tasks is documented. A new approach to the problem of extracting equivalent system models are handling qualities characteristics for fully augmented aircraft is introduced. This approach identified equivalent aerodynamic parameters and time delays of the flight control system and instrumentation system. This approach makes use of a mature and efficient integrated system identification procedure which uses several algorithms including a maximum likelihood method. This advanced equivalent system analysis method and the use of closed loop pilot mission related task testing are used to evaluate the F/A-18 digital FCS during its development. This is in contrast to classical open loop test techiques such as droplet inputs which gave little insight into the FCS and airframe interface. The correlation between equivalent time delays and the pilot handling qualities rating's obtained from closed loop mission task demonstrate that the equivalent system methodology can successfully be used to document the handling qualities of a highly augmented aircraft. In addition, the flexibility of the F/A-18 digital FCS allow for the correction of handling qualities and structural problems in a manner that has not previously been possible. Author

N85-27897# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany)
OLGA: AN OPEN LOOP GUST ALLEVIATION SYSTEM
H. BOEHRET, B. KRAG (DFVLR, Brunswick), and J. SKUDRIDAKIS (DFVLR, Wesseling, West Germany) *In* AGARD Active Control Systems: Rev., Evaluation and Projections 16 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

Aircraft with a modern wing of high aerodynamic efficiency and low wing loading are sensitive to gusts and, therefore, only offer limited passenger comfort in turbulent weather. The OLGA (Open Loop Alleviation) system was developed in cooperation with the DFVLR to improve the passenger ride comfort for such types of aircraft. The open loop principle was chosen because investigations showed this to be superior to a feed back type system. The gust angle of attack, calculated from sensor signals determines the performance of the system. Symmetric aileron deflection and the elevator are used for the compensation of the gust induced lift and pitching moment. Both control surfaces are operated by electromechanical actuators. After theoretical design work, the open loop principle was the subject of intensive wind tunnel investigation using a remotely controlled wind tunnel model of the Do 28 TNT experimental aircraft. After realizing the hardware, the system was implemented and flight tested in the real Do 28 TNT airplane. The flight test results and its comparison with those obtained from the hardware simulation and the wind tunnel investigations are discussed. Author

N85-27898*# Lockheed-California Co., Burbank.
DEMONSTRATION OF RELAXED STATIC STABILITY ON A COMMERCIAL TRANSPORT
J. J. RISING, W. J. DAVIS, and C. S. WILLEY *In* AGARD Active Control Systems Rev., Evaluation and Projections 18 p Mar. 1985 refs
(Contract NAS1-15326)
Avail: NTIS HC A17/MF A01 CSCL 01C

The application of relaxed static stability was studied under a program to determine ways of improving the energy efficiency in current and future transport aircraft. Pitch active control systems (PACs) were developed for application in the near term to current aircraft and in the next generation to advanced aircrft of the future. Analyses identified potential drag benefits of: (1) 2% for current transport aircraft with neutral stability; and (2) as much as 17% for next generation aircraft with high aspect ratio supercritical wings which must operate 10 to 15% statistically unstable to achieve optimum performance. Flight test evaluations of the near-term PACs were conducted to a 3% mean aerodynamic chord (MAC) negative static margin on a Lockheed L-1011 aircraft. The advanced PACs was demonstrated to a 20% MAC negative static margin on a piloted visual motion simulator at the NASA Langley Research Center. Test results for both systems showed flying qualities characteristics as good as current conventional aircraft. M.G.

N85-27899# Messerschmitt-Boelkow-Blohm G.m b H., Hamburg (West Germany). Transport Aircraft Div.
REALISATION OF RELAXED STATIC STABILITY ON A COMMERCIAL TRANSPORT
U. P. GRAEBER *In* AGARD Active Control Systems. Rev., Evaluation and Projection 11 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

The requirements of some airlines to increase the fuel capacity of a given transport aircraft led to a combined solution of an additional tank and the application of relaxed static stability. Some steps that led to the final solution are reviewed and some of its problems and benefits are shown Author

N85-27901# London Univ. (England).
THE AERODYNAMICS OF CONTROL
A. D. YOUNG *In* AGARD Active Control Systems: Rev , Evaluation and Projections 17 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

Traditional forms of control, novel forms developed to deal with flight conditions where the traditional forms lose effectiveness, and direct force controls are reviewed. Dynamic effects, missile controls and computational methods for predicting the aerodynamic characteristics of controls (or motivators) are briefly discussed. Finally, comments are offered on major areas calling for future research. Author

N85-27902*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ACTIVE CONTROL LANDING GEAR FOR GROUND LOAD ALLEVIATION
J. R. MCGEHEE and D. L. MORRIS (AFWAL) *In* AGARD Active Control Systems: Rev., Evaluation and Projections 12 p Mar. 1985 refs
Avail NTIS HC A17/MF A01 CSCL 01C

Results of analytical and experimental investigations of a series-hydraulic active control landing gear show that such a gear is feasible when using existing hardware and is very effective in reducing loads, relative to those generated by a conventional (passive year) gear, transmitted to the airframe during ground operations. Analytical results obtained from an active gear, flexible aircraft, take-off and landing analysis are in good agreement with experimental data and indicate that the analysis is a valid tool for study and initial design of series-hydraulic active control landing gears. An analytical study of a series-hydraulic active control main landing gear on an operational supersonic airplane shows that the active gear has the potential for improving the dynamic response of the aircraft and significantly reducing structural fatigue damage during ground operations. M.G.

N85-27903# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
WING BUFFETING ACTIVE CONTROL TESTING ON A TRANSPORT AIRCRAFT CONFIGURATION IN A LARGE SONIC WINDTUNNEL
R. DESTUYNDER *In* AGARD Active Control Systems: Rev., Evaluation and Projections 10 p Mar. 1985 refs In FRENCH; ENGLISH summary
Avail: NTIS HC A17/MF A01

A large half-model, duplicating the structural characteristics of a typical civil transport aircraft, was developed to study the unsteady response of active flaperons in the ONERA/S1 Modane Sonic Tunnel. The buffeting envelope results at large angles of attack or large Mach numbers were analyzed and the structural response to the buffeting phenomena was damped by introducing unsteady aerodynamic forces generated by the active flaperons Thus a multicontrol system, operating on the various eigen modes of the wing structure was applied Significant reduction of the consequences of this buffeting, both structural strain (fatigue) and airframe motion (comfort), were obtained, which could be translated into an effective widening of the usable flight envelope. Author

N85-27905# National Aerospace Lab., Amsterdam (Netherlands).
HOW TO HANDLE FAILURES IN ADVANCED FLIGHT CONTROL SYSTEMS OF FUTURE TRANSPORT AIRCRAFT
M. F G. VANGOOL *In* AGARD Active Control Systems: Rev., Evaluation and Projections 11 p Mar 1985 refs
Avail: NTIS HC A17/MF A01

Indications exist that future transport aircraft will be designed according to active control technology concepts, using fly-by-wire flight control systems. Some philosophical considerations on the treatment of failures in these advanced flight control systems are given both from the industry and from the certification authorities point of view. It is concluded that early cooperation of parties involved is of utmost importance. Some results of an exploratory simulator investigation directed at the pilot appreciation of degradation in the aircraft handling qualities after failures in the primary flight control system are included. One of the problems encountered was large variability of the pilot ratings. The existing handling qualities criteria can be shown to have difficulty in explaining the pilot rating trend Author

N85-27906# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France). Div. des Etudes Avancees.
THE INTERACTIVE GENERATION OF SPECIFICATIONS FOR AN ONBOARD SOFTWARE SERIES (GISELE) [GENERATION INTERACTIVE DE SPECIFICATIONS D'ENSEMBLE LOGICIEL EMBARQUE (GISELE)]
J. CHOPLIN and D. BEURRIER *In* AGARD Active Control Systems: Rev., Evaluation and Projections 11 p Mar 1985 refs In FRENCH
Avail: NTIS HC A17/MF A01

GISELE is a software tool designed to be used for establishing software specifications for onboard systems which require a very high level of security. This interactive tool permits the design and editing of specifications in an appropriate language as well as the design of a very complete group of tests under the specifications. In addition, GISELE provides an aid to management and modification of specifications, and contributes a method for the means for the design and preparation of tests of the software constructed from these specifications. Transl. by A.R.H.

N85-27907# Societe Nationale Industrielle Aerospatiale, Toulouse (France).
CERTIFYING COMPLEX DIGITAL SYSTEMS ON CIVIL AVIATION AIRCRAFT [CERTIFICATION DES SYSTEMES DIGITAUX COMPLEXES A BORD D'AVIONS CIVILS]
P. TOULOUSE *In* AGARD Active Control Systems: Rev, Evaluation and Projections 12 p Mar. 1985 In FRENCH
Avail: NTIS HC A17/MF A01

The certification of equipment using digital techniques creates a delay with regards to demonstrating the security level because the software which controls these systems is subject to a new category of definition errors which are not present in analog systems. The demonstration of an acceptable level of security is applied in a qualitative manner considering together a total analysis equipment faults, a process of verifying the software in relation to the criticality of the function provided by the equipment using the software, and, if necessary, by architectural precautions which provide freedom from the consequences of eventual latent software errors or of not easily predicted failure modes of equipment This effort should be reflected in documentation acknowledged as acceptable by all parties to the certification. Transl by A R H.

N85-27908# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
THE FLIGHT CONTROL SYSTEM FOR THE EXPERIMENTAL AIRCRAFT PROGRAMME (EAP) DEMONSTRATION AIRCRAFT
H. J. KAUL, F. SELLA (Aeritalia, Turin), and M J. WALKER (British Aerospace P L.C., Preston, England) *In* AGARD Active Control Systems: Rev., Evaluation and Projections 16 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

The EAP is designed to be a highly maneuverable combat aircraft with a primary role of air superiority and a secondary role of ground attack. The performance capability is optimized by making the aircraft both longitudinally and directionally aerodynamically unstable in parts of the flight envelope. This requires artificial stabilization which is provided by the flight control system (FCS). The control laws also include control of angle of attack to prevent departure and spin, and features to safeguard the structure, to give a carefree maneuvering capability The FCS is a full time fly by wire system based upon quadruplex digital computing and duo-duplex primary actuation, requiring no facility for reversion to back up or mechanical control. The system includes an extensive preflight test capability which checks that the system is fully operational prior to flight. It is designed to have a very high level of integrity; the design aim is to achieve a safety critical failure rate of less than 1 0 x 10 to the -6 power per flight hour. Author

N85-27909# Boeing Military Airplane Development, Seattle, Wash.
AUTOMATIC FLIGHT CONTROL MODES FOR THE AFTI/F-111 MISSION ADAPTIVE WING AIRCRAFT
M. R. EVANS, R. J. HYNES, D. C. NORMAN, and R. E. THOMASSON *In* AGARD Active Control Systems: Rev., Evaluation and Projections 13 p Mar. 1985
Avail: NTIS HC A17/MF A01

The advanced fighter technology integration F-111 mission adaptive wing (AFTI/F-111 MAW) is a joint Air Force and NASA Program that involves equipping an experimental F-111 aircraft with a variable camber wing and control modes that utilize the capabilities of this advanced technology wing. These new control modes are both manual and automatic modes that use variable camber to increase the performance of the aircraft. The automatic modes that have been added are: (1) maneuver camber control (MCC) - varies the camber to maximize lift/drag (L/D); (2) cruise camber control (CCC) - varies the camber to maximize horizontal velocity using an online optimization technique; (3) maneuver load control (MLC) - directly controls wing root bending moment once a threshold has been exceeded; and (4) maneuver enhancement and gust alleviation (ME/GA) - generates variable camber and horizontal tail commands to increase the maneuver response of the aircraft to pilot inputs and reduce the gust induced normal acceleration. These modes were integrated with the existing F-111 command augmentation system in a dual digital fail safe control system configuration for flight testing. Author

N85-27910# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
THE STOL AND MANEUVER TECHNOLOGY PROGRAM INTEGRATED CONTROL SYSTEM DEVELOPMENT
D J. MOORHOUSE and D. R. SELEGAN *In* AGARD Active Control Systems: Rev., Evaluation and Projections 10 p Mar 1985 refs
Avail: NTIS HC A17/MF A01

A technology demonstration program was initiated to flight validate and mature near-term technologies applicable to adding STOL capability to a supersonic fighter, with a goal of also enhancing combat mission performance using the same technologies. A key technology is the development of a control system to integrate flight, propulsion, braking and steering controls. The STOL and Maneuver Technology Demonstration Program is defined with emphasis on the control system development. Many design options are available for such a system and criteria are not well defined. The expected benefits and problems of the control system development, the design options, the status of control system and flying qualities design criteria and the specific approach taken in defining program requirements are discussed. Finally, the expected contribution to future aircraft designs is examined. Author

N85-27911# Westland Aircraft Ltd., Yeovil (England). Systems Technology.
THE EVOLUTION OF ACTIVE CONTROL TECHNOLOGY SYSTEMS FOR THE 1990'S HELICOPTER
G. C. F. WYATT *In* AGARD Active Control Systems. Rev., Evaluation and Projections 11 p Mar. 1985 refs
Avail: NTIS HC A17/MF A01

The primary flight control system requirements for both military and civil helicopters operating in the 1990's are reviewed and a rationale for system architectures which maximize the common features of military and civil active control systems is proposed While the need for caution is recognized if system performance is not to be compromised through an unbalanced application of the methodology, substantial cost and weight savings are predicted. The particularly demanding problems of the avoidance of common mode system faults in a civil application are addressed and a solution to these problems is proposed. Author

N85-28918# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik
MISSION REQUIREMENTS AND HANDLING QUALITIES
B. L. GMELIN and H J. PAUSDER *In* AGARD Helicopter Aeromech. 37 p Apr. 1985 refs
Avail: NTIS HC A15/MF A01

With the appearance of new missions for helicopters and with the development of a new generation of rotary-wing aircraft it has become obvious at the latest that future activities in the field of handling qualities must include the mission characteristics as well as the influences of the different subsystems implemented in the helicopter system. Therefore, mission analyses and consideration of system elements influencing mission performance are the basis for this work. The missions under consideration emphasize military missions but refer to civil missions, too. The system elements influencing mission performance include the basic helicopter, the pilot, the information system, the control system, interfaces, etc. G L.C.

N85-28949*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

PILOTED SIMULATION OF AN ALGORITHM FOR ONBOARD CONTROL OF TIME-OPTIMAL INTERCEPT

D. B. PRICE, A. J. CALISE (Drexel Univ.), and D D. MOERDER (Information and Control Systems, Inc., Hampton, Va.) Jun. 1985 48 p refs

(NASA-TP-2445; L-15896; NAS 1.60:2445) Avail: NTIS HC A03/MF A01 CSCL 01C

A piloted simulation of algorithms for onboard computation of trajectories for time-optimal intercept of a moving target by an F-8 aircraft is described. The algorithms, use singular perturbation techniques, generate commands in the cockpit. By centering the horizontal and vertical needles, the pilot flies an approximation to a time-optimal intercept trajectory Example simulations are shown and statistical data on the pilot's performance when presented with different display and computation modes are described. E.A.K.

N85-28950# National Aerospace Lab., Tokyo (Japan).

GUST LOAD ALLEVIATION OF A CANTILEVERED RECTANGULAR ELASTIC WING. WIND TUNNEL EXPERIMENT AND ANALYSIS

1984 37 p refs In JAPANESE; ENGLISH summary

(NAK-TR-86; ISSN-0089-4010) Avail: NTIS HC A03/MF A01

An experimental and theoretical study on gust load alleviation (GLA) of a cantilevered rectangular elastic wing with an active aileron was described. The beneficial effects predicted by the theoretical analysis were verified in a low subsonic wind tunnel. The root mean square value of the wing motion to random gust decreased by 45-50% when the GLA system was turned on The aileron was actuated according to the first order control law. The law used was obtained by modifying an optimal control law of seventh order which was originally formulated with the aid of an LQG approach. In the mathematical wing model, only the first bending mode and aileron motions were taken into account because the frequencies of the second and higher modes of the wing were much higher than the frequency spectrum contained in the gust generated. The unsteady aerodynamic prediction incorporated in the GLA system was corrected by test data for steady flow so that the response due to the aileron motion was estimated with good accuracy. E.A.K.

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.

A85-37491#

EUROPEAN TRANSONIC WIND TUNNEL

W. SCHMIDT Dornier Post (English Edition) (ISSN 0012-5563), no. 1, 1985, p. 40-42.

In virtue of energy-related cost reduction criteria, a low temperature gas flow concept has been chosen for the design development of the projected European transonic wind tunnel (ETW) facility. An attempt is presently made to ascertain whether, in wind tunnels using nitrogen that has been cooled close to ite liquefaction point, flow simulation distortions could be generated by the influence of real gas effects, local condensation, and heat transfer problems. Attention is accordingly given to ETW aircraft models' material property requirements and requisite degree of geometric accuracy, as well as the tunnel's diffuser throat design. O.C.

A85-37622#

MEASUREMENT OF WING-LEADING-EDGE HEATING RATES ON WIND TUNNEL MODELS USING THE THIN-FILM TECHNIQUE

G D. WANNENWETSCH, L. A. TICATCH, C. T. KIDD, and R. L. ARTERBURY (Calspan Corp., Arnold Air Force Station, TN) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985 12 p. USAF-sponsored research.

(AIAA PAPER 85-0972)

A test program was performed at AEDC in Hypersonic Wind Tunnel B (Mach 8) to demonstrate the feasibility of measuring wing-leading-edge heating in a continuous-flow facility with thin-film resistance thermometers applied to a glass-ceramic substrate This program was designed to demonstrate (1) the feasibility of fabricating the thin-film/glass-ceramic combination, (2) the survivability of the thin films, and (3) the accuracy of the heating measurements made with the thin-film/glass-ceramic devices. Following the demonstration test phase, an improved design for construction of an instrumented leading edge was developed. Details of the fabrication, calibration, and testing of the thin-film devices are discussed in this paper Author

A85-37644#

DEVELOPMENTS IN AEROTHERMAL TEST TECHNIQUES AT THE AEDC SUPERSONIC-HYPERSONIC WIND TUNNELS

R. K. MATTHEWS, K. W. NUTT, G. D. WANNENWETSCH, C. T. KIDD (Calspan Corp, Arnold Air Force Station, TN), and A. H. BOUDREAU (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 10 p. refs

(AIAA PAPER 85-1003)

A description of the aerothermodynamic test techniques and instrumentation available for use in the Arnold Engineering Development Center supersonic-hypersonic wind tunnels is presented. The techniques include the measurement of convective heating on model leading edges, continuous sweep heat-transfer measurements, Schmidt-Boelter gages, heat-transfer measurements on roughened surfaces, online infrared analysis, and material sample testing in transient environments. Consideration is given to the application and limitations of each technique. It is shown that a precisely defined test objective coupled with comprehensive pretest planning are essential for a successful test program. M.D.

A85-37949

KOREA'S AIR TRANSPORT - PLANNED EXPANSION

Airport Forum (ISSN 0002-2802), vol 14, April 1985, p. 61, 63, 65-67, 69, 71.

The current status and planned expansion of the airport system in the Republic of Korea (ROK) are surveyed and illustrated with photographs, maps, and drawings. The growth of the ROK economy is described; the role of the Korea International Airports Authority in administering the three largest airports (Seoul-Kimpo, Pusan-Kimhae, and Cheju) is indicated, and the new international terminal and parallel runway under construction at Kimpo to accommodate the increased traffic expected for the 1986 Asian and 1988 Olympic Games are characterized. Consideration is given to the KE maintenance facilities at Kimhae, plans for a new major airport at Cheongju by 1992, the six local airports, the centralized control exercised by the Hanjin Group, and the efforts of the ROK to obtain reciprocal air-transport agreements with neighboring states such as China. T.K.

A85-38962#
AN INTEGRAL METHOD OF WALL INTERFERENCE CORRECTION FOR LOW SPEED WIND TUNNEL
C. ZHOU (Shenyang Aeronautics and Aerodynamics Research Institute, Shenyang, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 1-9. In Chinese, with abstract in English.
The analytical solution of Poisson's equation, derived from the definition of vortex, has been applied to the calculations of interference velocities due to the presence of wind tunnel walls. This approach, called the Integral Method, allows an accurate evaluation of wall interference for separated or more complicated flows without the need for considering any features of the model. All the information necessary for obtaining the wall correction is contained in wall pressure measurements. The correction is not sensitive to normal data-scatter, and the computations are fast enough for on-line data processing. Author

A85-38968#
INVESTIGATION ON REDUCING THE FLOW NOISE OF THE 0.6 M X 0.6 M TRISONIC WIND TUNNEL
Q. YUN (China Aerodynamic Research and Development Centre, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 51-60. In Chinese, with abstract in English. refs
The 0.6 m x 0.6 m trisonic wind tunnel (FL-23) is of an intermittent blow-down type. The flow noise produced by the pressure regulating valve was very high. A significant reduction of the tunnel's flow noise has been achieved and the noise level is now among the lowest both at home and abroad, after the noise-reducing device set between the pressure regulating valve and the settling chamber was added. This paper describes the noise-reducing device and shows the flow noise characteristics before and after it was set. The flow noise characteristics are also compared with those of wind tunnels at home and abroad
Author

A85-38975#
A NEW TECHNIQUE TO BREAK DIAPHRAGMS ELECTRICALLY IN A DOUBLE-TUBE SHORT DURATION JET SIMULATION FACILITY
Y. WANG (China Aerodynamic Research and Development Center, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 97-100. In Chinese, with abstract in English.
A new technique to break a diaphragm electrically in a double-tube short-duration jet simulation facility is presented in this paper. This facility is used to simulate the jet of an oxyhydrogen engine and obtain plume data at higher altitude. The diaphragm is combined, i.e., a crossed electric fuse is held between two layers (polyester film). The test result showed that this technique is available and much better than the general technique. It can meet the requirements (rapid rupture of the diaphragms and synchronization of the rupture) and has the unique advantages: it may be used high pressure pure oxygen and hydrogen condition, avoiding the combustion and explosion, and a good-looking and repeatable petal of the diaphragm may be obtained. The present technique is suitable for other facilities, too. Author

A85-39243#
FROM MEASUREMENT UNCERTAINTY TO MEASUREMENT COMMUNICATIONS, CREDIBILITY, AND COST CONTROL IN PROPULSION GROUND TEST FACILITIES
R E SMITH, JR. and S. WEHOFER (Sverdrup Technology, Inc., Aeropropulsion Program Dept., Arnold Air Force Station, TN) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 107, June 1985, p. 165-172. refs
An overview of an engine test facility measurement evaluation program is given, and the utilization of the measurement uncertainty results are discussed The engine thrust measurement process is described, starting with the definition of measurement uncertainty. Procedures for identifying and quantifying measurement error sources are discussed, including a brief description of a propulsion test cell and engine thrust measurement system The measurement validation process, which uses unlinked measurement self-consistency checks to preclude gross error omissions, is discussed. Results and findings which evolve from the measurement uncertainty assessment are reviewed, and the principal organizational requirements for implementing a measurement uncertainty evaluation program are addressed.
C.D

A85-39274
EFFICIENCIES OF MULTIPLE-INPUT TECHNIQUES FOR AIRCRAFT GROUND VIBRATION TESTING
D L. HUNT (SDRC, Inc., Milford, OH), S. R. HURLEY, and I. B. SACHS (Lockheed-California Co., Burbank, CA) IN: Structural dynamics testing and analysis; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 9-16. refs
(SAE PAPER 841575)
The recent advances in multiple-input techniques for experimental modal analysis have given the test engineer alternatives for performing aircraft ground vibration tests (GVT). Multiple-input random excitation and polyreference analysis are two of the methods that are being used instead of the traditional sine dwell approach. The efficiency and advantages of these new methods are examined and examples of this application to recent aircraft GVT's are described. Author

A85-39706#
THE DEVELOPMENT OF A HARDWARE-IN-THE-LOOP ENGINE SIMULATION FACILITY
S. W. K. CHAN and J. R. DAVIDSON (Douglas Aircraft Co, Long Beach, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 7 p.
(AIAA PAPER 85-1293)
A generic hardware-in-the-loop engine simulation facility which is developed, based on a set of design specifications resulting from an independent research and development effort, in anticipation of rapid advances in the area of digital electronic engine controls and the need to study and verify the interaction between the airplane and engine, is described. The facility has a microprocessor-based programmable interface between the digital electronic engine control and computer simulation, which can generate and accept the analog and digital signals required by the engine control, as well as control a pneumatic system that provides simulated engine and environmental pressure inputs to the engine control. It is shown that the facility provides the airframer the capability to study engine management techniques, system integration, and verification/validation methodologies. M.D.

A85-39773#
HIGH SPEED COMPRESSOR RIG AS A STALL RECOVERY RESEARCH TOOL
C. J. SMALL and J. T. LEWIS (Unitet Technonlogies Corp., Pratt and Whitney Group, West Palm Beach, FL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Montérey, CA, July 8-10, 1985. 11 p.
(Contract F33615-79-C-2087)
(AIAA PAPER 85-1428)
An experimental investigation of post-stall phenomena exhibited by high speed axial flow compressors is presented. The test vehicle selected for this experimentation is a three-stage compressor rig which is representative of highly loaded, state of the art, military high pressure compressors. The rig and dedicated test facility were specifically designed for efficient parametric post-stall testing and provided data not available from any other source. Unconventional test procedures were implemented to control compressor boundary conditions and acquire detailed post-stall compressor data isolated from the unavoidable system effects encountered during engine testing. Data obtained have provided invaluable fundamental knowledge for the formulation of steady-state and dynamic post-stall compressor models. Author

N85-27912 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Inst. fuer Experimentelle Stroemungsmechanik.
ADAPTIVE WALL WIND TUNNELS AND WALL INTERFERENCE CORRECTION METHODS
H HORNUNG, ed. and E. STANEWSKY, ed. 1984 42 p refs
Presented at European Mech. Colloq. No. 187, Goettingen, West Germany, 15-17 Oct. 1984
(DFVLR-IB-222-84-A-37) Avail: Issuing Activity
Wind tunnel tests involving adaptive wind tunnel walls, partially open wind tunnel walls, and side wall interference were discussed. Transonic, cryogenic, and supersonic wind tunnels were described. Author (ESA)

N85-27913 Duits-Nederlandse Windtunnel, Noordoostpolder (Netherlands).
CONSTRUCTION 1976-1980: DESIGN, MANUFACTURING, CALIBRATION OF THE GERMAN-DUTCH WIND TUNNEL (DNW)
M SEIDEL, ed. 1982 137 p refs Original contains color illustrations
Avail: Issuing Activity
A low speed wind tunnel was built. It has 3 closed, interchangeable test sections with cross sectional sizes of 9.5 m x 9.5 m, 8 m x 6 m and 6 m x 6 m with maximum continuous wind speeds of at least 55, 100 and 130 m/sec respectively in the presence of a typical model, an open test section for aeroacoustic measurements (8 m x 6 m, 80 m/sec); and an air exchange system for the rapid removal of hot or contaminated gases, e.g , during tests with engine simulators or full scale engines. It has a continuous drive power of 11.5 MW plus 10% design margin to cover prediction risks. Intermittent use of overload capacity was anticipated to provide short duration maximum speeds up to 62 and 145 m/sec for the 9.5 m x 9.5 m and the 6 m x 6 m respectively. In empty test sections, relative deviation of static and dynamic pressure across the center section is + or - 0.3%, local deviation of flow direction: + or - 0.1 deg; local temperature deviation = + or - 0.5 C; turbulence: 0 1 to 0 2%. Author (ESA)

N85-27914*# National Aeronautics and Space Administration, Washington, D. C.
TEST DEVICES FOR AERONAUTICAL RESEARCH AND TECHNOLOGY
Apr. 1985 65 p Transl. into ENGLISH from "Versuchsanlagen fuer Luftfahrtforschung und Luftfahrttechnologie" Cologne, Dec. 1981 p A2-1-A2-11, B1.1-1-B1.1-3, B2.1-1-B2.1-2, B4.1-1-B4.1-10, B4.2-1-B4.2-5, and B4.3-1-B4 3-3 Transl. by The Corporate Word, Inc., Pittsburgh Original document prepared by DFVLR, Cologne
(Contract NASW-4006)
(NASA-TM-77651; NAS 1 15:77651) Avail: NTIS HC A04/MF A01 CSCL 14B
The objectives of the DFVLR in six areas are described: (1) transportation and communication systems; (2) aircraft, space technology, (4) remote sensing, (5) energy and propulsion technology; and (6) research and development A detailed description of testing devices and other facilities required to carry out the research program is given Author

N85-27915*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECT OF SUPERCONDUCTING SOLENOID MODEL CORES ON SPANWISE IRON MAGNET ROLL CONTROL
C. P. BRITCHER Jun 1985 25 p refs
(Contract NSG-7523)
(NASA-TM-86378; L-15924; NAS 1.15:86378) Avail: NTIS HC A02/MF A01 CSCL 14B
Compared with conventional ferromagnetic fuselage cores, superconducting solenoid cores appear to offer significant reductions in the projected cost of a large wind tunnel magnetic suspension and balance system. The provision of sufficient magnetic roll torque capability has been a long-standing problem with all magnetic suspension and balance systems; and the spanwise iron magnet scheme appears to be the most powerful system available. This scheme utilizes iron cores which are installed in the wings of the model. It was anticipated that the magnetization of these cores, and hence the roll torque generated, would be affected by the powerful external magnetic field of the superconducting solenoid. A preliminary study has been made of the effect of the superconducting solenoid fuselage model core concept on the spanwise iron magnet roll torque generation schemes. Computed data for one representative configuration indicate that reductions in available roll torque occur over a range of applied magnetic field levels. These results indicate that a 30-percent increase in roll electromagnet capacity over that previously determined will be required for a representative 8-foot wind tunnel magnetic suspension and balance system design.
Author

N85-27916*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
BACKGROUND NOISE MEASUREMENTS FROM JET EXIT VANES DESIGNED TO REDUCED FLOW PULSATIONS IN AN OPEN-JET WIND TUNNEL
D. R. HOAD (Army Research and Technology Labs., Hampton, Va.) and R M. MARTIN Jun. 1985 48 p refs
(Contract DA PROJ. 1L1-63309-AH-76)
(NASA-TM-86383; L-15923; NAS 1.15:86383; AVSCOM-TM-85-B-1) Avail: NTIS HC A03/MF A01 CSCL 14B
Many open jet wind tunnels experience pulsations of the flow which are typically characterized by periodic low frequency velocity and pressure variations One method of reducing these fluctuations is to install vanes around the perimeter of the jet exit to protrude into the flow Although these vanes were shown to be effective in reducing the fluctuation content, they can also increase the test section background noise level. The results of an experimental acoustic program in the Langley 4- by 7-Meter Tunnel is presented which evaluates the effect on tunnel background noise of such modifications to the jet exit nozzle. Noise levels for the baseline tunnel configuration are compared with those for three jet exit nozzle modifications, including an enhanced noise reduction configuration that minimizes the effect of the vanes on the background noise. Although the noise levels for this modified vane configuration were comparable to baseline tunnel background noise levels in this facility, installation of these modified vanes in an acoustic tunnel may be of concern because the noise levels for the vanes could be well above background noise levels in a quiet facility. Author

N85-27917# Mitre Corp., McLean, Va. Metrek Div.
AIRPORT AND AIRWAY SYSTEM COST ALLOCATION MODEL. VOLUME 7: USER'S MANUAL
J C. SCALEA Sep. 1977 66 p
(Contract DOT-FA69NS-162)
(AD-A152877; MTR-7610-VOL-7) Avail. NTIS HC A04/MF A01 CSCL 01E
This volume constitutes the user's manual for the computer program written to automate the calculations involved in the allocation of costs to the various airport and airway system users. It includes a very brief summary of the allocation methodology which is developed in detail in previous volumes. The program itself is interactive in nature and this manual contains a summary of the commands and input data formats required by the user for successful program execution. A sample terminal session is included as well as a program listing and a sample of the output.
GRA

N85-27920# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abt. Elastomechanik und Aeroelastische Stabilitaet.
THE GUST SIMULATION APPARATUS OF THE 3M X 3M LOW SPEED WIND TUNNEL OF THE DFVLR IN GOETTINGEN, WEST GERMANY
R. FREYMANN Jun. 1984 38 p refs In GERMAN; ENGLISH summary
(DFVLR-FB-85-04; ISSN-0171-1342) Avail NTIS HC A03/MF A01; DFVLR, Cologne DM 14.50
A gust simulation apparatus was fitted into a 3m x 3m low speed wind tunnel to increase the range of test possibilities. The design of the gust generating system and of the test method used for determination of the gust flow behind the gust generator is described. Graphical representations of experimentally determined gust flow distributions in the wind tunnel measuring section are shown. Author (ESA)

N85-27921# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Abt. Prozessortechnik
DATA PROCESSING ON THE ROTOR TEST STAND AT DFVLR IN BRUNSWICK: MICROPROGRAMMABLE INTERFACES AND ARRAY PROCESSOR AS KEY COMPONENTS IN A PDP 11 REAL TIME DATA ACQUISITION AND PROCESSING SYSTEM
R. SEIFERT Jan. 1985 116 p refs In GERMAN; ENGLISH summary
(DFVLR-MITT-85-03; ISSN-0176-7739) Avail NTIS HC A06/MF A01; DFVLR, Cologne DM 40 50
The construction and operation of data acquisition and processing systems on rotor test stands for studies of higher harmonic control of helicopter rotors in wind tunnels is discussed. The processing system consists of 3 MININET-coupled PDP 11 computers supported by microprogrammable PCM interfaces and by an array processor. The implementation of these components under the RSX 11 M operating system for the treatment of real time requirements, the structure of the software system, and the associated programming and testing aids are presented. Author (ESA)

N85-28919# Messerschmitt-Boelkow-Blohm G.m.b.H , Munich (West Germany).
THE ROLE OF SIMULATION
H. HUBER and P. KRAUSPE *In* AGARD Helicopter Aeromech. 35 p Apr. 1985 refs
Avail: NTIS HC A15/MF A01
The development of helicopter flight simulation has undoubtedly made considerable progress in the past decade. Due to the helicopter specific flight regime, which is essentially characterized by low altitude flying (NOE), low to moderate speeds, and distinct stability and control behavior, the simulation of rotorcraft sets high standards to the simulation quality. An overview about the various simulation techniques and their specific application during research and development work is presented. First, the details and capabilities of the round-based simulation are discussed. Stringent requirements for real-time simulation result in the use of comprehensive math models, representing the aerodynamic and dynamic complexities of rotary-wing aircraft. In addition, great effort has to be made to simulate the environmental scenario, such as visual and motional cues Advances are especially made on the field of generating and displaying visual imagery. The technique of computer generated images (CGI) and the progress achieved, e g., in the field-of-view and resolution, is demonstrated. G.L.C.

N85-28952# National Aerospace Lab., Tokyo (Japan).
FLOW QUALITY OF NATIONAL AEROSPACE LABORATORY TWO-DIMENSIONAL TRANSONIC WIND TUNNEL. PART 3: FLOW TURBULENCE LEVEL AND MEASURING METHOD
Y. O. M. SATO, H. KANDA, S. SAKAKIBARA, H. MIWA, and S. BABA 1984 29 p refs In JAPANESE; ENGLISH summary
(NAL-TR-842-PT-3; ISSN-0389-4010) Avail: NTIS HC A03/MF A01
The flow turbulence level of the NAL two dimensional transonic wind tunnel was measured with a constant temperature hot wire anemometer using a hot film probe. The fluctuation of the mass flow is within a range of 0.3%-0.45% with Mach numbers of 0.2 to 0.8 and unit Reynolds numbers of 1.8 x 10 to the 5th to 5.5 x 10 to the 5th (1/cm). The fluctuation of the total temperature was one seventh to one tenth of the mass flow fluctuation. A plain sound wave was assumed, and the noise data was measured simultaneously with the turbulence and compared with this turbulence. An attempt was made to separate the velocity fluctuation and the density fluctuation in the mass flow. The future development of this complex method is discussed. Author

N85-28953# National Aerospace Lab., Tokyo (Japan).
ON POWER EFFECIENT OPERATION OF THE 2M X 2M TRANSONIC WIND TUNNEL AT THE NATIONAL AEROSPACE LABORATORY
M SHIRAI, S NAKAMURA, M SUZUKI, A. KOIKE, K SUZUKI, and N KAMIYA 1984 25 p refs In JAPANESE; ENGLISH summary
(NAL-TR-847; ISSN-0389-4010) Avail: NTIS HC A02/MF A01
In the conventional test procedure using the 2m x 2m transonic wind tunnel, an auxiliary power unit is operated synergistically for Mach numbers near and above unity to establish the desired Mach number at the test section by suction through the perforated test section walls. The extent to which the test Mach number can be increased without the use of the auxiliary power unit was investigated. It is found that a Mach number of 1.06 is attained by adequately adjusting several geometric parameters such as diverging angle of the side walls of the test section, opening width of the diffuser flaps, width of the second throat and the flexible nozzle setting. Electric power of 7800kW can be served at Mach number 1 by using this procedure compared with the conventional procedure in which an auxiliary fan is used Mach number distributions at the test section are found to be little influenced by these adjustments E.A.K.

N85-28954# Center for Naval Analyses, Alexandria, Va. Naval Planning Manpower and Logistics Div.
THE USE OF FLIGHT SIMULATORS IN MEASURING AND IMPROVING TRAINING EFFECTIVENESS
A. J. MARCUS and L. E. CURRAN Jan. 1985 25 p
(Contract N00014-83-C-0725)
(AD-A153817; CNA-PP-432) Avail. NTIS HC A02/MF A01
CSCL 05I
This paper studies the value of the aircraft simulators as measures of training readiness. Simulator evaluations are analyzed for reserves enlisted crewmen on Navy patrol aircraft. Part-time reservists are found to have very little skill loss over time and perform as well as their full-time counterparts. Experience in the simulator produces substantial increases in subsequent flights appear to be useful measures of readiness and valuable training experience. GRA

N85-28955# Rijksluchtvaartdienst, The Hague (Netherlands).
OWEMA REPORT: A PROJECT STUDY CONCERNING THE POSSIBILITIES AND THE DESIRABILITY OF A EAST-WEST RUNWAY FOR MAASTRICHT AIRPORT (NETHERLANDS) AS A EURO-REGIONAL AIR FREIGHT CENTER [OWEMA-RAPPORT: EEN PROJECTSTUDIE OMTRENT DE MOGELIJKHEDEN EN DE WENSELIJKHEID VAN EEN OOST-WESTBAN VOOR MAASTRICHT AIRPORT ALS EUREGIONAAL VRACHTCENTRUM]
Mar. 1984 157 p refs In DUTCH
(B8476490; ISBN-90-346-02478) Avail: NTIS HC A08/MF A01

A planned runway for an airport in the southeast Netherlands is discussed. Transportation developments, the financial and exploitation possibilities, as well as the regional and environmental consequences are considered. The project is supported
Author (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.

A85-37599#
PITOT PRESSURE AND HEAT TRANSFER MEASUREMENTS IN HYDRAZINE THRUSTER PLUMES
H. LEGGE and G. DETTLEFF (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer experimentelle Stroemungsmechanik, Goettingen, West Germany) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985 9 p. Sponsorship: European Space Research and Technology Centre. refs
(Contract ESTEC-5194/82/NL/PB)
(AIAA PAPER 85-0934)

The results of heat-transfer and Pitot pressure measurements obtained in the plumes from MBB/ERNO 0.5, 2, and 5-N hydrazine-monopropellant thruster nozzles during standard pulsed and steady-state performance tests are reported and compared with the predictions of theoretical models, summarizing the reports of Legge and Dettleff (1984) and Dettleff and Legge (1985). The data are presented in graphs and shown to be in good general agreement with the freezing-surface models proposed by Legge and Boettcher (1982). Shock disturbances are detected in the near-plume flow fields of the contoured (2-N and 5-N) nozzles, with stagnation temperatures 900-1350 K, molecular weights 11-14.5, and mean effective specific-heat ratio kappa = 1.4 + or - 0.03 in the region of expansion from the stagnation chamber to the continuum plume flow. T.K

A85-38545#
INTEGRATION OF THE B-52G OFFENSIVE AVIONICS SYSTEM (OAS) WITH THE GLOBAL POSITIONING SYSTEM (GPS)
A. L. FOOTE (Logicon, Inc., Dayton, OH) and S. C. PLUNTZE (USAF, Space Div., Los Angeles, CA) IN. Institute of Navigation, National Technical Meeting, San Diego, CA, January 17-19, 1984, Proceedings . Washington, DC, Institute of Navigation, 1984, p. 201-209.

Integration of the B-52G OAS with the GPS has been accomplished by modification of existing OAS software. GPS derived position and velocity data are used to enhance the quality of the OAS inertial and dead reckoning navigation systems. The engineering design and the software development process used to implement this design are presented Author

A85-38546*#
SIMULATION AND ANALYSIS OF DIFFERENTIAL GPS
R. P. DENARO (TAU Corp, Los Gatos, CA) IN: Institute of Navigation, National Technical Meeting, San Diego, CA, January 17-19, 1984, Proceedings. Washington, DC, Institute of Navigation, 1984, p. 225-234. NASA-sponsored research. refs

NASA is conducting a research program to evaluate differential Global Positioning System (GPS) concepts for civil helicopter navigation. It is pointed out that the civil helicopter community will probably be an early user of GPS because of the unique mission operations in areas where precise navigation aids are not available. However, many of these applications involve accuracy requirements which cannot be satisfied by conventional GPS. Such applications include remote area search and rescue, offshore oil platform approach, remote area precision landing, and other precise navigation operations. Differential GPS provides a promising approach for meeting very demanding accuracy requirements. The considered procedure eliminates some of the common bias errors experienced by conventional GPS. This is done by making use of a second GPS receiver A simulation process is developed as a tool for analyzing various scenarios of GPS-referenced civil aircraft navigation. G.R.

A85-38608
DEVELOPMENT AND TESTING OF THE RPS-1000 PARACHUTE SYSTEM FOR THE MMR-06-DART METEOROLOGICAL ROCKET SYSTEM [RAZRABOTKA I ISPYTANIIA PARASHIUTNOI SISTEMY RPS-1000 DLIA METEOROLOGICHESKOI RAKETNOI SISTEMY MMR-06-DART]
M. GERNANDT, K. DRESCHER (Lindenberg, Aerologisches Observatorium, Lindenberg, East Germany), and IA. M. PSUI (Instytut Meteorologii i Gospodarki Wodnej, Warsaw, Poland) IN: Studies of the upper earth atmosphere Leningrad, Gidrometeoizdat, 1984, p. 39-47. In Russian.

The mechanical construction and technical characteristics are described for the RPS-1000 parachute system made by Polish and GDR engineers for operation in the MMR-06-DART unified meteorological rocket network. Flight test results are presented which demonstrate that the parachute system satisfies the requirement that a sonde descent velocity less than the speed of sound be provided. B.J.

A85-38610
SOLUTION OF CERTAIN TECHNICAL PROBLEMS CONNECTED WITH THE DEVELOPMENT OF THE MMR-06M METEOROLOGICAL ROCKET [RESHENIE NEKOTORYKH TEKHNICHESKIKH ZADACH, SVIAZANNYKH S RAZRABOTKOI METEOROLOGICHESKOI RAKETY MMR-06M]
V. N. ALIN, IU. K. VASILEV, and V I. TATARENKO (Tsentral'naia Aerologicheskaia Observatoriia, Dolgoprudny, USSR) IN: Studies of the upper earth atmosphere . Leningrad, Gidrometeoizdat, 1984, p. 50-54. In Russian. refs

The main technical solutions utilized in the development of the payload body of the MMR-06M meteorological rocket are outlined, with particular attention given to the choice of temperature and wind measurement schemes, the parachute system, and the aerodynamic design. The main technical characteristics of the rocket are described, and diagrams of the rocket and the payload body are presented. B.J.

A85-38775
THE IDEAS OF K.E. TSIOLKOVSKII AND PRESENT-DAY SCIENTIFIC PROBLEMS [IDEI K.E. TSIOLKOVSKOGO I SOVREMENNYE NAUCHNYE PROBLEMY]
B. M. KEDROV, ED. Moscow, Izdatel'stvo Nauka, 1984, 240 p. In Russian. No individual items are abstracted in this volume.

A selection of papers from the Tsiolkovskii Scientific Lectures XI-XII (1976-1977) is presented. Attention is given to Tsiolkovskii's ideas and to their development in present-day research in fields such as rocket and space technology, space-flight mechanics, space medicine and biology, aviation, and scientific prediction.
B.J.

11

CHEMISTRY AND MATERIALS

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

A85-37201#

EVALUATION OF NOZZLE THROAT MATERIALS FOR RAMJET ENGINES

S. SHANI, J. BARTA, I. GREENBERG, R JOSEPH, and A. PERETZ (Rafael Armament Development Authority, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 205-212 refs

Silica phenolic, sintered zirconia and zirconia-coated graphites were evaluated as ramjet nozzle-throat materials at simulated ramjet configuration and operation conditions. The test nozzles were mounted to a ramjet combustor, which burns JP-4/air/oxygen mixture. Appropriate fabrication processes for all throat inserts tested have been developed. The limits for acceptable throat erosion of silica phenolic inserts were determined in terms of combinations of total pressure and temperature and burning duration: 0.6 MPa, 2150 K and 100 sec, 0.3 MPa, 2500 K and 100 sec; 0.3 MPa, 2250 K and 200 sec, respectively. These results were obtained for a fabric orientation angle of 80 deg to the nozzle centerline, which provided the highest erosion resistance Throat inserts made of sintered zirconia and zirconia-coated graphite (with Mo intermediate layer) sustained successfully (no integrity damage and no erosion) total temperature of 2450 K at 0.6 MPa for 100 sec. The results of this study point out that the ceramics tested may be used successfully at nozzle throats, subjected to severe internal environment conditions, such as those encountered in high-performance ramjet engines. Author

A85-37339

THE PROBLEMS ARISING IN TESTING OF CARBON-BASED MATERIALS FOR STRUCTURAL COMPONENTS OF AIRFRAMES [PROBLEMY ISPYTANII UGLERODNYKH MATERIALOV DLIA ELEMENTOV KONSTRUKTSII LETATEL'NYKH APPARATOV]

N. A. ANFIMOV and IU. V. CHUDETSKII IN Hydroaeromechanics and space research . Moscow, Izdatel'stvo Nauka, 1985, p. 151-157. In Russian. refs

The processes associated with mass transfer of carbon-based composites in supersonic and hypersonic flows are identified, and the governing chemical reactions are described The procedures currently used for model testing of graphite and composite specimens are reviewed, and some suggestions are made concerning the sequence of testing. It is pointed out that the approach described allows the range of enthalpies and pressures, required for testing, to be narrowed considerably. L.T.

A85-37380

REPAIR PROCEDURES FOR COMPOSITE SINEWAVE SUBSTRUCTURE

J. D. LABOR (Northrop Corp., Hawthorne, CA) IN: National Technical Conference, 16th, Albuquerque, NM, October 9-11, 1984, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p. 119-128.

Repair procedures are described for substructure fabricated with integrally-formed caps and sinewave webs made of graphite/epoxy material. Both a mechanically-attached metal repair and a bonded composite repair were developed, installed on full-size elements, and tested to demonstrate acceptable strength. Author

A85-37381

IMPROVED RESINS FOR WET LAYUP REPAIR OF ADVANCED COMPOSITE STRUCTURE

J. R. SCOTT and C. K. MASHIBA (Boeing Co., Materials Technology Group, Seattle, WA) IN: National Technical Conference, 16th, Albuquerque, NM, October 9-11, 1984, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p. 129-135.

Increased usage of advanced composites on 767 and 757 Boeing aircraft has necessitated development of more cost-effective repair techniques for field-based repairs. Airlines have recognized the advantages of low temperature curing wet layup repair techniques, but Boeing did not authorize its use for structural repairs due to insufficient strength of typical resins in hot, wet environments. By surveying the resin manufacturers and extensively testing a wide range of resins, Boeing was able to recommend the use of two resins for interim and permanent repair of Kevlar and graphite composite structure. One resin is curable at room temperature to 1500 F, and the other curable at 200 F to 350 F. Implementation of these resins for composite repair has resulted in a significant reduction in material and processing costs, as well as aircraft downtime This paper will describe the development program conducted and review evaluation procedures and test results. It will describe changes made to the Boeing Structural Repair Manuals (SRM's) resulting from this study. Author

A85-37407

AN OVERVIEW OF STRUCTURAL REPAIR ADHESIVES

S. QUICK (Dexter Corp., Hysol Div., Pittsburg, CA) IN: National Technical Conference, 16th, Albuquerque, NM, October 9-11, 1984, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p. 671-685.

Attention is given to aircraft metallic structure and composite structure repair methods employing ambient and/or low curing temperature paste adhesive systems. Paste adhesives are considered in light of the sophistication of repair facility equipment and personnel, the service temperature of the area to be repaired, and desired adhesive physical characteristics. The adhesive systems in current use are low viscosity liquid epoxies and aromatic amines. O.C.

A85-37415*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE SUBSTITUTION OF NICKEL FOR COBALT IN HOT ISOSTATICALLY PRESSED POWDER METALLURGY UDIMET 700 ALLOYS

F. H. HARF (NASA, Lewis Research Center, Cleveland, OH) Metallurgical Transactions A - Physical Metallurgy and Materials Science (ISSN 0360-2133), vol. 16A, June 1985, p. 993-1003. refs

Nickel was substituted in various proportions for cobalt in a series of five hot-isostatically-pressed powder metallurgy alloys based on the UDIMET 700 composition. These alloys were given 5-step heat treatments appropriate for use in turbine engine disks. The resultant microstructures displayed three distinct sizes of gamma-prime particles in a gamma matrix. The higher cobalt-content alloys contained larger amounts of the finest gamma-prime particles, and had the lowest gamma-gamma-prime lattice mismatch. While all alloys had approximately the same tensile properties at 25 and 650 gamma C, the rupture lives at 650 and 760 C peaked in the alloys with cobalt contents between 12.7 and 4.3 pct. Minimum creep rates increased as cobalt contents were lowered, suggesting their correlation with the gamma-prime particle size distribution and the gamma-gamma-prime mismatch. It was also found that, on overaging at temperatures higher than suitable for turbine disk use, the high cobalt-content alloys were prone to sigma phase formation. Author

A85-37484* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FIBERS FOR STRUCTURALLY RELIABLE METAL AND CERAMIC COMPOSITES
J. A DICARLO (NASA, Lewis Research Center, Ceramics Systems Branch, Cleveland, OH) Journal of Metals (ISSN 0148-6608), vol. 37, June 1985, p. 44-49. refs

In their current state of development, commercially available reinforcing fibers fail to meet the requirements formulated for metal or ceramic matrix composites of sufficient strength and toughness. Attention is presently given to criteria for high strength and toughness in metal and ceramic matrix composites, as well as the approach adopted in fiber evaluation as a result of studies at the NASA Lewis Research Center. Two areas of special interest have been strength improvement in large diameter boron fibers for tough, impact-resistant boron/aluminum composites, and the evaluation of SiC fibers as reinforcement in tough ceramic-matrix composites with service temperatures of the order of 1400 C.
O.C.

A85-37495
A METHOD FOR THE EVALUATION OF THE BOUNDARY LUBRICATING PROPERTIES OF AVIATION TURBINE FUELS
J. W HADLEY (Shell Research, Ltd., Thornton Research Centre, Chester, England) Wear (ISSN 0043-1648), vol. 101, Feb. 1, 1985, p. 219-253. Research supported by the Ministry of Defense of England. refs

In the late 1960s and early 1970s, a lubrication-related malfunction of aviation fuel systems was observed. Thus, it was found, for instance, that some types of aircraft axial piston pumps occasionally suffered premature lubricity failures when operated on particular Jet A-1 fuels The problems were allegedly related to the poor boundary lubricating properties of some fuels then in use. For an investigation and solution of these problems, a suitable test method for evaluating aviation fuel lubricity was needed. Available mechanical lubricity test methods were found to be unsuited for the particular problems involved, and a new test procedure had to be developed. The basis for this development was provided by the Amsler machine which was found to give promising results. However, further improvements were found to be necessary to give satisfactory performance over a wide range of fuels. The various stages of the development are discussed.
G.R.

A85-38748
LOW TEMPERATURE CREEP AND FRACTURE OF NEAR ALPHA TITANIUM ALLOYS
W J EVANS (Royal Aircraft Establishment, Farnborough, Hants., England) IN: Creep and fracture of engineering materials and structures; Proceedings of the Second International Conference, Swansea, Wales, April 1-6, 1984 Part 1 . Swansea, Wales, Pineridge Press, 1984, p 395-406. refs

Creep at low temperatures has been recognized for some considerable time. In general, however, other than the nuisance value it posed for component tolerancing it was considered to be unimportant. The introduction of the near alpha titanium alloys changed this belief since it was found that under certain conditions low temperature creep could lead to the premature failure of components. The paper uses creep and dwell data obtained on the titanium alloy IMI685 to illustrate how microstructure and stress affect deformation and failure behavior at room temperature. On this basis, a general purpose model of the phenomenon is constructed and related to available data on the near alpha alloy IMI829. Finally, a Weibull analysis of the data is used to account for the behavior of a model component, thereby removing uncertainties about the inservice integrity of these materials
Author

A85-38749
THE INFLUENCE OF MICROSTRUCTURE ON THE TEMPERATURE-DEPENDENT FLOW PROPERTIES OF TI-6AL-4V
C. G. SHELTON (Cambridge University, Cambridge, England) and B. RALPH (Cardiff, University College, Cardiff, Wales) IN: Creep and fracture of engineering materials and structures; Proceedings of the Second International Conference, Swansea, Wales, April 1-6, 1984. Part 1 . Swansea, Wales, Pineridge Press, 1984, p. 407-418. Research supported by Inco, Ltd. and Science and Engineering Research Council. refs

Two different microstructures in a commercial Ti-6Al-4V alloy have been generated by forging at two temperatures, 1073 and 1243 K. Subtle differences in the phase populations and the initial dislocation substructure have been detected by microscopy. The mechanical properties over a wide range of temperature (293-973 K) and strain rate (0.0003/s-28/s) have been measured and the microstructures again investigated.
Author

A85-38874
DISSIPATIVE PROPERTIES OF INHOMOGENEOUS MATERIALS AND SYSTEMS [DISSIPATIVNYE SVOISTVA NEODNORODNYKH MATERIALOV I SISTEM]
A P. IAKOVLEV Kiev, Izdatel'stvo Naukova Dumka, 1985, 248 p. In Russian. refs

Results of experimental studies of the dissipative properties of laminates, fiber composites, and materials with local inclusions are reviewed. Particular attention is given to the effect of component characteristics and service-related factors (e.g., the type and volume fraction of components, the shape and size of inclusions, the cyclic deformation amplitude, and temperature) on the dissipative properties of inhomogeneous materials, such as nodular cast iron Engineering methods are presented for determining the vibration decrement of layered rods, rods with single- and two-layer coatings, and unidirectional fiber composites.
V L.

A85-39101
THE 'SOLUTION-LARGE MOLECULES' METHOD FOR CALCULATING THE EQUILIBRIUM COMPOSITION OF HETEROGENEOUS SYSTEMS [METOD 'RASTVOR - BOL'SHIE MOLEKULY' DLIA RASCHETA RAVNOVESNOGO SOSTAVA GETEROGENNYKH SISTEM]
V. E. ALEMASOV, Z KH. GRUZDEVA, A. A. DREGALIN, and A. F. DREGALIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 6-9. In Russian.

A refined method for calculating the equilibrium composition of heterogeneous systems is presented which combines the advantages of the large-molecule method and of the model of an ideal solution of condensed phases. It is shown that the new method provides better convergence and requires less computational effort than either of the above approaches. Results are presented for the combustion products of O2 + BeH2 fuel.
V.L.

A85-39175
THE BONDING OF MATERIALS FOR PROPULSION SYSTEMS [LE COLLAGE DES MATERIAUX POUR PROPULSEURS]
E. H. SUBRENAT (Societe Europeenne de Propulsion, Paris, France) (L'Atelier de Construction de Tarbes and l'Association pour le Developpement de l'Information Scientifique et Technique dans le Bassin de l'Adour, Colloque sur la Mecanique et la Metallurgie, 5th, Tarbes, France, Mar. 14-16, 1984) Materiaux et Techniques (ISSN 0032-6895), vol. 73, Apr.-May 1985, p. 179-187. In French.

The various types of adhesives, their properties and applications in joining components, and techniques used in their development to the point of acceptance in aircraft are surveyed. The bonding agents are selected on the basis of the parts to be joined, e.g., a thick joint with a large surface area or a thin joint with a small surface area, in situ, setting, for carbon composites, etc Epoxies are the most commonly used adhesives, with different products requiring various treatment times and temperatures for polymerization and different surface preparation The resulting bonds are characterized by the flexibility, stability at specific temperatures, resistance to shearing and pulling, and fatigue life The rheological properties are determined by the viscosity, thixotropy, lifetime on the shelf and the curing duration. Industrial procedures employed for bonding Al alloys, stainless steel and Ti are discussed. M.S.K.

A85-39228

FRACTURE BEHAVIOR OF GLASS-CLOTH/POLYESTER COMPOSITE LAMINATE AT LOW TEMPERATURE

D XU, R. LIU, J. XIA, J. ZHAO (University of Science and Technology of China, Hefei, People's Republic of China), and W. SHEN (Huazhong University of Science and Technology, Wuhan, People's Republic of China) Journal of Reinforced Plastics and Composites (ISSN 0731-6844), vol. 4, April 1985, p. 205-211.

By means of experimental technique, the fracture toughness, fracture mechanism, and strength limit of glass-cloth/polyester composite laminate (GPCL) at low temperature (77 K) are studied. The strength limit of GPCL is found to be 39.34 kg/sq mm at 300 K and 59.41 kg/sq mm at 77 K, thus indicating that the value of the strength limit at low temperature is 1.5 times as large as the value at ambient temperature. To reveal the properties of GPCL, the fracture toughness and fracture phenomenon of net matrix material and matrix with some bunches of glass fiber are also examined. M.D

A85-39284* Garrett Turbine Engine Co , Phoenix, Ariz.

PROGRESS IN THE UTILIZATION OF AN OXIDE-DISPERSION-STRENGTHENED ALLOY FOR SMALL ENGINE TURBINE BLADES

T. G. BEATTY and P. P. MILLAN (Garrett Turbine Engine Co., Phoenix, AZ) IN: Advanced aerospace materials technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 1-9. refs
(Contract NAS3-20073)
(SAE PAPER 841512)

The conventional means of improving gas turbine engine performance typically involves increasing the turbine inlet temperature; however, at these higher operational temperatures the high pressure turbine blades require air-cooling to maintain durability. Air-cooling imposes design, material, and economic constraints not only on the turbine blades but also on engine performance. The use of uncooled turbine blades at increased operating temperatures can offer significantly improved performance in small gas turbine engines. A program to demonstrate uncooled MA6000 high pressure turbine blades in a GTEC TFE731 turbofan engine is being conducted. The project goals include demonstration of the advantages of using uncooled MA6000 turbine blades as compared with cast directionally solidified MAR-M 247 blades. Author

A85-39291

MATERIAL EVALUATION OF SECOND-GENERATION COMPOSITES FOR TRANSPORT WING APPLICATION

J. HARPER-TERVET and G. HULL (Lockheed-California Co., Burbank, CA) IN: Advanced aerospace materials technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 93-101. refs
(SAE PAPER 841520)

Second generation, or toughened, epoxy resin systems are under consideration for use on a large composite primary structural part such as a wing. A method of evaluating the properties of these materials, while at the same time considering design, structural and manufacturing requirements has been developed. Processability requirements for toughened epoxy resin systems have been established. Cost efficient manufacturing methods, such as pultrusion, have been investigated and found to be a feasible production method for composite structure The use of pultrusion as a fabrication method for partially staged parts to be co-cured at a later date is being evaluated. Author

A85-39339* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FEASIBILITY STUDY OF THE WELDING OF SIC

T. J. MOORE (NASA, Lewis Research Center, Cleveland, OH) American Ceramic Society, Communications (ISSN 0002-7820), vol. 68, June 1985, p C-151 to C-153. refs

In a brief study of the feasibility of welding sintered alpha-SiC, solid-state welding and brazing were investigated. Joint quality was determined solely by microstructural examination Hot-pressure welding was shown to be feasible at 1950 C. Diffusion welding and brazing were also successful under hot isostatic pressure at 1950 C when boride, carbide, and silicide interlayers were used. Furnace brazing was accomplished at 1750 C when a $TiSi_2$ interlayer was introduced Author

A85-39492

FRACTURE TOUGHNESS OF ADHESIVELY BONDED JOINTS

F. FLASHNER, S KENIG, I. G. ZEWI, and H. DODIUK (Ministry of Defence, Haifa, Israel) Engineering Fracture Mechanics (ISSN 0013-7944), vol. 21, no. 5, 1985, p. 997-1004. refs

Using uniaxial loading of Mode I type and biaxial loading of combined Mode I and Mode II, the fracture toughness of an epoxy film adhesive is investigated under conditions of both ambient as well as elevated temperature and high humidity Experimental results show that the resistance to crack growth decreases by a calibration of temperature and humidity for both uniaxial and biaxial loading and that increased temperature alone is not harmful up to 70 C for crack growth. In comparison to uniaxial mode loading, the most pronounced effect on the critical energy release rate parameter is shown by mixed mode loading, and the combined effect of biaxial load, temperature, and water results in a drastic decrease in fracture toughness of the film adhesive. M.D.

A85-39598

ASSESSMENT OF DAMAGE TOLERANCE IN COMPOSITES

E DEMUTS (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), R. S. WHITEHEAD, and R. B DEO (Northrop Corp., Aircraft Div., Hawthorne, CA) (USAF, U.S. Army, Westland Helicopters, Ltd., et al., International Conference on Structural Impact and Crashworthiness, Imperial College of Science and Technology, London, England, July 16-20, 1984) Composite Structures (ISSN 0263-8223), vol. 4, no. 1, 1985, p 45-58. USAF-sponsored research. refs

Tolerance of carbon epoxy coupons to processing and normal service damage is examined experimentally for built-up panels representing multispar and multirib wing designs It is found that low-velocity impact damage is more severe than damage in holes, delaminations, or porosity, and leads to losses in compression strength from 58 to 73 percent. It is shown that the complexity provided by built-up three-spar panels significantly enhances their static compression strength as compared to the corresponding coupon strength. Fatigue strength, on the other hand, can be considerably improved by stitching. L.T.

A85-39600

DAMAGE TOLERANCE OF COMPOSITE CYLINDERS

M. J. GRAVES (Boeing Military Airplane Co., Seattle, WA; MIT, Cambridge, MA) and P. A. LAGACE (MIT, Cambridge, MA) (Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 12-15, 1983) Composite Structures (ISSN 0263-8223), vol. 4, no. 1, 1985, p. 75-91. refs
(Contract F33615-77-C-5155)

The fracture of pressurized graphite/epoxy cylinders was investigated and their damage tolerance assessed. The cylinders were 610 mm long and 305 mm in diameter and were fabricated from Hercules A370-5H/3501-6 prepreg fabric in quasi-isotropic four-ply configurations: (0, 45)s and (45, 0)s. The cylinders were slit in the longitudinal direction and the critical notch sizes for three pressure levels were determined. Experiments on coupons of similar construction loaded in tension were previously conducted. The critical flaw sizes for the cylinders were well predicted from the flat coupon data corrected for the effects of curvature In addition, circumferentially wrapped unidirectional plies of Hercules

AS1/3501-6 tape of various stacking sequences were used as selective reinforcement on several (0, 45)s cylinders. These reinforcing plies did change the path of damage but did not prevent catastrophic failure. Author

A85-39640#
COMBUSTION STUDIES OF METALLIZED FUELS FOR SOLID FUEL RAMJETS
A. GANY (Technion - Israel Institute of Technology, Haifa, Israel) and D. W. NETZER (U.S. Naval Postgraduate School, Monterey, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 8 p. Research supported by the U.S. National Research Council. refs
(Contract N60530-85-WR-30011)
(AIAA PAPER 85-1177)
Combustion phenomena of highly metallized, boron containing, solid fuels in solid fuel ramjets (SFRJ) were studied by means of high speed photography using a windowed two-dimensional SFRJ combustor. The experiments indicated the existence of a gas phase diffusion flame of the volatile fuel ingredients within the boundary layer above the fuel surface. It was also revealed that material is often emitted from the surface in the form of large pieces and segments. Flow impingement on the surface may cause surface heating and glowing by chemical reactions, which promote the high speed ejection of hot particles and the disintegration and emittance of large glowing segments and pieces from the fuel surface layer to the gas stream. Author

A85-39645#
BORON SLURRY FUEL ATOMIZATION EVALUATION
J. J. LIPINSKI, E. B. COLEMAN, and B. R. HEATH (Garrett Turbine Engine Co., Phoenix, AZ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p. refs
(Contract F33615-82-C-0123)
(AIAA PAPER 85-1184)
The atomization of boron slurry fuel was studied experimentally by spraying it into a coflowing low-velocity airstream at atmospheric pressure. The object of the testing was to determine if a spray could be produced of a quality that would promote high combustion efficiency in a boron-slurry-fueled gas turbine combustor. Testing was conducted with two slurry formulations and three different atomizer configurations. Laser diffraction was used to characterize the spray droplet size distribution. A plain-jet airblast atomizer was found to produce a uniform spray while exhibiting no plugging problems. Measured droplet average diameters for this atomizer were found to be close to the size expected for the liquid component of the fuel alone, as predicted by fuel atomizer correlations found in the literature. The width of the size distribution, however, was somewhat greater than is typical of liquid fuel sprays produced by conventional gas turbine atomizers. Author

A85-39662*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HIGH-TEMPERATURE EROSION OF PLASMA-SPRAYED, YTTRIA-STABILIZED ZIRCONIA IN A SIMULATED TURBINE ENVIRONMENT
R. F. HANDSCHUH (NASA, Lewis Research Center; U.S. Army Propulsion Laboratory, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 13 p. Previously announced in STAR as N85-13045. refs
(AIAA PAPER 85-1219)
A series of rig calibration and high temperature tests simulating gas path seal erosion in turbine engines were performed at three impingement angles and at three downstream locations. Plasma sprayed, yttria stabilized zirconia specimens were tested. Steady state erosion curves presented for 19 test specimens indicate a brittle type of material erosion despite scanning electron microscopy evidence of plastic deformation. Steady state erosion results were not sensitive to downstream location but were sensitive to impingement angle. At different downstream locations specimen surface temperature varied from 1250 to 1600 C (2280 to 2900 F) and particle velocity varied from 260 to 320 m/s (850 to 1050 ft/s). The mass ratio of combustion products to erosive grit material was typically 240. Author

A85-39676#
COMBUSTION INSTABILITY SUSTAINED BY UNSTEADY VORTEX COMBUSTION
E. E. ZUKOSKI (California Institute of Technology, Pasadena, CA) and D. A. SMITH AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985 10 p. refs
(Contract AF-AFOSR-80-0286)
(AIAA PAPER 85-1248)
The determination of an internal feedback mechanism which leads to combustion instability inside a small scale laboratory combustor is presented in this paper During combustion instability, the experimental findings show that a large vortical structure is formed at an acoustic resonant mode of the system. The subsequent unsteady burning, within the vortex as it is convected downstream, feeds energy into the acoustic field and sustains the large resonant oscillations. These vortices are formed when the acoustic velocity fluctuation at the flameholder is a large fraction of the mean flow velocity. The propagation of these vortices is not a strong function of the mean flow speed and appears to be dependent upon the frequency of the instability. Continued existence of large vortical structures which characterize unstable operation depends upon the fuel-air ratio, system acoustics, and fuel type. (Author)

A85-39727#
PROPELLANT OPTIONS FOR LONG DURATION, HIGH ALTITUDE UNMANNED AIRCRAFT
J. E. BORETZ (TRW Inc., Applied Technology Div., Redondo Beach, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 5 p. refs
(AIAA PAPER 85-1326)
Two of the main objectives in the development of high-performance unmanned aircraft are related to the achievement of long duration flight and an operation at high altitudes. The characteristics of typical propulsion devices for achieving the considered performance objectives are shown along with the properties of fuels and gases. It is found that the determination and optimization of a specific engine combustion process involves a complex combination of propellant characteristics, fuel injector characteristics, and combustion chamber design features However, an initial figure of merit can be established by examining some of the fuel properties which will impact remotely piloted vehicle (RPV) endurance and altitude. G.R.

A85-39744#
THE EFFECT OF COATINGS ON THE THERMOMECHANICAL FATIGUE LIFE OF A SINGLE CRYSTAL TURBINE BLADE MATERIAL
K. R BAIN (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 7 p. Research supported by General Motors Corp.
(AIAA PAPER 85-1366)
The effect of a protective coating on the cyclic fatigue life of an advanced single crystal turbine blade alloy under thermomechanical fatigue cycling was investigated. Thermomechanical fatigue cycling combines both mechanical strain controlled cycling and temperature cycling to better simulate the actual temperature/strain environment in a modern gas turbine engine. The application of a coating for increased corrosion and/or oxidation protection may result in a reduction in the number of strain/temperature cycles to initiate a critical crack which leads to failure. The effect of a coating in TMF was to reduce the TMF lives of the alloy, but a cross-over occurred between the two coatings. The overlay coating resulted in longer lives at the higher strain ranges while the aluminide coating performed better at lower strain ranges. Author

A85-39763#

COMBUSTION TECHNOLOGY - A NAVY PERSPECTIVE

A. J. CIFONE and E. L. KRUEGER (U.S. Navy, Naval Air Propulsion Center, Trenton, NJ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 7 p.
(AIAA PAPER 85-1400)

Navy combustor and augmentor trends are examined and related technology levels are assessed. Specific R & D needs such as advanced materials, improved liner cooling schemes, high Mach number diffuser design, fuel injector design methodologies, high-temperature augmentor performance and operability, fuel compatibility, and improved usable analytical techniques, are discussed. Consideration is given to the need to pursue specific combustion system technology features and their ramifications. M.D.

A85-39913#

STATE OF THE ART AND RESEARCH NEEDS OF PULSATING COMBUSTION

B. T. ZINN (Georgia Institute of Technology, Atlanta, GA) American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec. 9-14, 1984. 7 p Research supported by the Gas Research Institute. refs
(ASME PAPER 84-WA/NCA-19)

A review of the historical background of pulsating combustion engines is presented, reflecting on the principles of operation of the quarter wave, Helmholtz, and Rije-type combustors. The advantages of pulsating combustion are outlined, including the effects of pulses on convective heat transfer at the walls of the engine and faster oxidation rates. The discussion also covers the effects of acoustic oscillation on the production of nitrogen oxides, carbon monoxide, hydrocarbons, sulfur dioxide, and soot during the combustion. In addition, thermal efficiency of such engines is examined. Finally, a summary of the state-of-the-art of the field and of its future needs is given. L.T.

N85-27975 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensbereich Flugzeuge.

INTEGRAL PROFILE METHOD FOR PRODUCTION OF CARBON FIBER SHEETS [FERTIGUNG INTEGRAL PROFILVERSTAERKTER CFK-SCHALEN]

J. KLENNER Nov 1984 29 p In GERMAN
(MBB/LFA34/CFK/PUB/006) Avail: Issuing Activity

Carbon-fiber subassembly structural resistance and applicability are demonstrated by static and dynamic tests. The production techniques and quality control process for economical line production are presented. Carbon fiber use in aircraft primary structures is recommended for weight reduction Author (ESA)

N85-27976 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).

HEAT RESISTANT CARBON FIBER REINFORCED PLASTICS (CFRP) HARDENING EQUIPMENT [TEMPERATURBESTAENDIGE G]

K. LEDWA and J. KLENNER Nov. 1984 19 p In GERMAN
(MBB/LFA33/CFK/PUB/007) Avail: Issuing Activity

Hardening equipment made of CFRP for aircraft structures was tested. Five systems were chosen after a survey of laminating and surface resins. Tests of these systems lead to a production concept for a heat resistant CFRP hardening apparatus for cylindrical integral profile-stiffened fuselage side shells. The production concept is described. The test results meet expectations with respect to quality as well as to costs and throughput time Temperature resistance, dimensional stability, and surface finishing are excellent; the measured shrinkage is 0.5%. Author (ESA)

N85-27992# Naval Postgraduate School, Monterey, Calif.

AN INVESTIGATION INTO THE SOOT PRODUCTION PROCESSES IN A GAS TURBINE ENGINE M.S. Thesis

A. L. LOHMAN Sep. 1984 52 p
(AD-A152710) Avail: NTIS HC A04/MF A01 CSCL 21B

This thesis details an investigation into the nature of soot production in a gas turbine combustor. The goal was to obtain axial temperature profiles and soot size distributions inside an Allison T63-A-5A combustor. The present temperature probe and gas sampling apparatus were able to acquire data. Results from these initial tests suggested some preliminary conclusions. First of all, flatter temperature profiles were possibly indicative of fuels with lower aromatic content. Also, soot size along the centerline of the combustor did not appear to change appreciably. Soot itself seemed to be composed of 0.1 micron spherical particles prone to agglomeration. Relatively large, puff-like structures observed on sample collection filters were apparently artifacts of the sampling technique. Several methods of improving the apparatus were suggested GRA

N85-28109*# General Motors Corp., Indianapolis, Ind. Gas Turbine Div.

CERAMIC APPLICATIONS IN TURBINE ENGINES Final Report

H. E. HELMS, P. W. HEITMAN, L. C LINDGREN, and S. R. THRASHER Oct. 1984 268 p refs
(Contract DEN3-17; DE-AI01-77CS-51040)
(NASA-CR-174715; DOE/NASA/0017-6; NAS 1.26:174715; EDR-11442) Avail: NTIS HC A12/MF A01 CSCL 11B

The application of ceramic components to demonstrate improved cycle efficiency by raising the operating temperature of the existing Allison IGI 404 vehicular gas turbine engine is discussed. This effort was called the Ceramic Applications in Turbine Engines (CATE) program and has successfully demonstrated ceramic components. Among these components are two design configurations featuring stationary and rotating caramic components in the IGT 404 engine. A complete discussion of all phases of the program, design, materials development, fabrication of ceramic components, and testing-including rig, engine, and vehicle demonstation test are presented. During the CATE program, a ceramic technology base was established that is now being applied to automotive and other gas turbine engine programs. This technology base is outlined and also provides a description of the CATE program accomplishments. Author

N85-28127*# Colorado School of Mines, Golden. Dept. of Chemistry and Geochemistry.

JET FUEL INSTABILITY MECHANISMS Final Technical Report, 1 Aug. 1981 - 31 Mar. 1985

S R. DANIEL 31 Mar. 1985 104 p refs
(Contract NAG3-197)
(NASA-CR-175856; NAS 1.26:175856) Avail. NTIS HC A06/MF A01 CSCL 21D

The mechanisms of the formation of fuel-insoluble deposits were studied in several real fuels and in a model fuel consisting of tetralin in dodecane solution. The influence of addition to the fuels of small concentrations of various compounds on the quantities of deposits formed and on the formation and disappearance of oxygenated species in solution was assessed. The effect of temperature on deposit formation was also investigated over the range of 308-453 K. G.L.C.

N85-28129# Boeing Military Airplane Development, Seattle, Wash.

FUEL FREEZE POINT INVESTIGATIONS Final Report, Sep. 1982 - Mar. 1984

L. A. DESMARAIS and F. F. TOLLE Wright-Patterson AFB, Ohio AFWAL Jul. 1984 286 p
(Contract F33615-82-C-2262)
(AD-A152801; D180-28285-1; AFWAL-TR-84-2049) Avail: NTIS HC A13/MF A01 CSCL 21D

The objective of this program was to conduct a detailed assessment of the low temperature environment to which USAF aircraft are exposed for the purpose of defining a maximum acceptable fuel freeze point and also to define any operational changes required with the use of a high freeze point fuel. A previous study of B-52, C-141, and KC-135 operational missions indicated that the -58 C freeze point specification was too conservative Based on recommendations resulting from the previous program, several improvements in the method of analysis were made, such as: expansion of the atmospheric temperature data base, the addition of ground temperature analysis, the addition of fuel freezing analysis to the one-dimensional fuel temperature computer program, and the examination of heat transfer in external fuel tanks, such as pylon or tip tanks The B-52, C-141, and KC-135 mission were analyzed again, along with the operational missions of two tactical airplanes, the A-10 and F-15; -50C was determined to be the maximum allowable freeze point for a general purpose USAF aviation turbine fuel. Higher freeze points can be tolerated if the probability of operational interference is acceptably low or if operational changes can be made. Study of atmospheric temperatures encountered for the missions of the five study aircraft indicates that a maximum freeze point of -48 C would not likely create any operational difficulties in Northern Europe GRA

N85-29045 Department of the Air Force, Washington, D.C.
LAMINATED THERMOPLASTIC RADOME Patent
E. E. GREENE, inventor (to Air Force) 19 Mar 1985 7 p
Supersedes AD-D009637
(AD-D011664; US-PATENT-4,506,269;
US-PATENT-APPL-SN-382070; US-PATENT-CLASS-343-872)
Avail: US Patent and Trademark Office CSCL 17I

This patent discloses an improved rain resistance radome C-sandwich wall which is constructed of thermoplastic polycarbonate material The cores are either posts or tubes and are bonded to the skins with polyurethane. The percentage of core material to air is adjusted by electrical tuning to make the optimum dielectric value for use in the gigahertz radar frequency range. GRA

N85-29052# Oak Ridge National Lab., Tenn.
CERAMIC TECHNOLOGY FOR ADVANCED HEAT ENGINES PROJECT Semiannual Progress Report, Apr. - Sep. 1984
M C. MATTHEWS Feb. 1985 117 p refs
(Contract DE-AC05-84CR-21400)
(DE85-008755; ORNL/TM-9497) Avail: NTIS HC A06/MF A01

Significant accomplishments in fabricating ceramic components for the DOE, NASA, and DOD advanced heat engine programs have provided evidence that the operation of ceramic parts in high-temperature engine environments is feasible. An assessment of needs was completed, and a five-year project plan was developed with extensive input from private industry in order to develop the industrial technology base required for reliable ceramics for application in advanced automotive heat engines. The project approach includes determining the mechanisms controlling reliability, improving processes for fabricating existing ceramics, developing new materials with increased reliability, and testing these materials in simulated engine environments to confirm reliability Although this is a generic materials project, focus is on structural ceramics for advanced gas turbine and diesel engines, ceramic bearings and attachments, and ceramic coatings for thermal barrier and wear applications in these engines. DOE

N85-29053# Oak Ridge National Lab., Tenn.
CERAMIC COATINGS FOR HEAT ENGINE MATERIALS: STATUS AND FUTURE NEEDS
W. J. LACKEY, D. P. STINTON, G. A. CERNY, I. L. FEHRENBACHER, and A C SCHAFFHAUSER Dec. 1984 116 p refs
(Contract DE-AC05-84OR-21400)
(DE85-008759, ORNL/TM-8959) Avail: NTIS HC A06/MF A01

The status and potential for application of ceramic coatings to diesel and turbine engine components was assessed. Properties are tabulated for numerous materials from the oxide, carbide, nitride, and boride families. Several coating deposition processes are described and compared, including plasma spraying, electron beam evaporation, sputtering, chemical vapor deposition, sol-gel, ion, and laser techniques. Zirconia thermal-barrier coatings were emphasized, but coatings for wear and erosion resistance, lubrication, chemical protection, seals, and interfaces were also addressed Coating characterization methods, particularly those for measuring adherence and defects, are reviewed It was concluded that the use of coatings will expand in the future, permitting higher performance and more reliable heat engines. DOE

N85-29054# Oak Ridge National Lab, Tenn. Metals and Ceramics Div.
CERAMIC COATINGS FOR HEAT ENGINE MATERIALS
W. J. LACKEY and D. P. STINTON 1984 4 p refs Presented at the Automotive Technol. Develop. Contractors' Coord. Meeting, Dearborn, Mich., 29 Oct 1984
(Contract DE-AC05-84OR-21400)
(DE85-005238; CONF-8410103-6) Avail: NTIS HC A02/MF A01

The status and potential for application of ceramic coatings to diesel and turbine engine components were assessed. Properties were tabulated for numerous materials from the oxide, carbide, nitride, and boride families. Promising new deposition methods and in-situ gas and solid phase characterization techniques are identified. Emphasis was placed on zirconia thermal carrier coatings, but coatings for reducing wear, erosion, and friction were also addressed. The use of coatings will expand in the future and permit higher performance and more reliable heat engines. DOE

N85-29066# Technische Univ., Berlin (West Germany). Inst. fuer Nichtmetallische Werkstoffe.
PREPARATION OF SINTERACTIVE SILICON NITRIDE POWDERS Final Report, Jun. 1983
H HAUSNER, A. MARCKS, R. PEITZSCH, and G. WOETTING *Bundesministerium fuer Forschung und Technologie* Dec. 1984 93 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-84-303, ISSN-0340-7608) Avail NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 19.50

The sintering behavior of silicon nitride powders of different origin was investigated for use in gas turbine engines. The influence of powder characteristics, sintering additives and processing parameters on densification are discussed. A high-temperature dilatometer which operates up to 2300 C under a nitrogen pressure of 50 bar maximum was developed to study the sintering kinetics. Thermogravimetric investigations concerning the weight loss during sintering were performed Author (ESA)

N85-29073# Illinois Univ, Urbana. Dept. of Mechanical and Industrial Engineering.
RESEARCH TEST FACILITY FOR EVAPORATION AND COMBUSTION OF ALTERNATIVE JET FUELS AT HIGH AIR TEMPERATURES Annual Technical Report, 1 Feb. 1983 - 30 Jan. 1984
J. E. PETERS, H. KRIER, K K. KIM, R. E. COVERDILL, J. E. KIRWAN, S. C. MEISNER, and K. W. KIM 1 Mar. 1984 45 p refs
(Contract F49620-83-K-0027)
(AD-A153830; UILU-ENG-84-4001; AFOSR-85-0383TR) Avail. NTIS HC A03/MF A01 CSCL 21B

Improved gas turbine combustion performance will require the effective utilization of alternative fuels and advanced combustor concepts. Further understanding of spray combustion processes including fuel evaporation and flame propagation is required. Research is underway which features a high pressure and temperature non-vititated air system to provide air at simulated gas turbine inlet conditions. A special fuel injection system was designed to produce monodisperse sprays for the purpose of evaporation and eventual combustion experiments in our newly developed test facility. This report represents a summary of the engineering activities during the first year (of a two year contract) which was focused on the construction of a combustion test facility in which the evaporation and burning rates of jet fuels can be measured as a function of inlet conditions and fuel properties A large heat exchanger facility which supports this research can deliver continuously non-vitiated air at flowrates up to 1 kg/sec and 600 kPa at temperatures from 300 to 900K. Details of the evaporation/combustion test section are described. Also included are the design of the fuel injection system and test results of the injector showing monodisperse sprays with drop diameters of approx. 70 micrometers. GRA

N85-29074# Naval Research Lab., Washington, D. C. Combustion and Fuels Branch.
THE DISTRIBUTION OF HIGHER N-ALKANES IN PARTIALLY FROZEN MIDDLE DISTILLATE FUELS Final Report, Oct. 1982 - Sep. 1984
T. L. VANWINKLE, W. A. AFFENS, E. J. BEAL, R. N. HAZLETT, and J. DEGUZMAN 10 Apr. 1985 39 p refs
(AD-A153940; AD-E801121; NRL-8869) Avail: NTIS HC A03/MF A01 CSCL 21D

In conjunction with continuing studies on the effect of composition on the freezing points of middle distillate fuels, attention was directed to partially frozen fuels. The crystals and residual liquid from partially frozen JP-5 and DFM fuel samples derived from both petroleum and shale were separated from each other and collected by means of the NRL liquid-solid separator apparatus (LSS) at several temperatures below the freezing points of the original samples. The original fuel samples, the solid material (precipitate), and liquid (filtrate) were characterized by gas chromatography (GC). The filtrate data were straightforward. As expected, Van't Hoff plot of the n-alkanes concentrations (log concentrations vs reciprocal absolute temperature) formed straight lines, and their slopes demonstrated the importance of the higher n-alkanes in fuel crystallization at cold temperatures. The precipitate data presented some problems of interpretation since it was observed that the waxy crystal precipitate matrix entrapped significant amounts of liquid (filtrate). The data on the solids which were obtained by these methods demonstrated that the higher n-alkanes play the key role in fuel crystallization at low temperatures, concentrating as much as tenfold in the crystallized solids compared to the liquid. Also, it was clearly shown that the n-alkanes form the major part, up to least 95% by weight in some fuels, of the solid crystals formed. GRA

N85-29100# Joint Publications Research Service, Arlington, Va.
LIGHTNING-SAFE CARBON FIBER COMPOSITE FOR AIRBUS TAIL UNIT
In its West Europe Rept.: Sci. and Technol. (JPRS-WST-84-032) p 25-26 25 Sep. 1984 Repr. from Frankfurt. Zeitung/Blick Durch die Wirtschaft (Franfurt am Main), 1 Aug. 1984 p 6
Avail: NTIS HC A03/MF A01

Airplanes with large-area structures of graphite-fiber composite materials (CFK) fly with absolute safety even in storms. This was demonstrated during a recent series of lightning strike tests on an Airbus-A310 vertical tail spar of the Airbus material developed and built by Messerschmitt-Boelkow-Blohm GmbH (MBB) in Hamburg and Stade. The 300,000 volt lightning bolts were generated in the Institute for Plasma Physics at the University of Hannover. Lengthy studies by MBB and test measurements on CFK samples in the Institute for Plasmas Physics show how to design for safety from lightning strikes. The tests on the CFK vertical tail spar include direct effects such as holes in the material and melted rivets and indirect effect such as the coupling of the electromagnetic energy of the lightning into the aircraft's electronic circuits. Damage is shown to be mimimal. E.R.

N85-29105# Joint Publications Research Service, Arlington, Va.
DFVLR RESEARCH IN ALUMINUM-LITHIUM ALLOYS Abstract Only
In its West Europe Rept.: Sci. and Technol. (JPRS-WST-84-035) p 25-26 29 Oct. 1984 Transl. into ENGLISH from Frankfurter Zeitung/Blick Durch Die Wirtsch. (Frankfurt/Main), 16 Aug. 1984 p 1
Avail: NTIS HC A04/MF A01

The youthful metal aluminum is receiving competition from modern composite materials such as graphite-fiber reinforced plastics whose specific strengths (strength per unit of weight) can be higher than modern high-strength aluminum alloys. Of course, the strength of composite materials is strongly directional, but materials applications frequently do not require strength isotropy. Thus, with such composite materials, designers can undercut the already low specific weight--2.8 grams per cubic centimeter-of modern high-strength aluminum alloys and lower the weight of aircraft structures. This translates into fuel savings, an attractive offering since the climb in fuel prices in the 1970s. A Boeing study in this area forecasts that the weight fraction of aluminum will decrease during the next decade from today's approximately 80 percent to 10 percent while the weight fraction of composite materials will increase from today's approximately 3 percent to 65 percent G.L.C.

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.

A85-37074
FASTENERS FOR COMPOSITE STRUCTURES EXAMINED
J. H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 5, June 1985, p. 8-14.

Recognizing the trend toward composite primary structures in the aerospace industry, mechanical fastener manufacturers reexamined fastener designs with a view to a better performance match with the novel airframe designs. Increased loadbearing area has emerged as the primary strategy for composite joint performance improvement, increasing clamp loads while minimizing the possibility of crushing damage or delamination around the fastener hole. Attention is given to the design details and performance characteristics of the proprietary fastener designs designated 'Maxifoot rivet', 'Composi-Lok II', 'Olympic-Lok rivet', and 'Huck-Clinch rivet'. O.C.

A85-37177#
EXPERIMENTAL DETERMINATION OF THE EFFECT OF NONLINEAR STIFFNESS ON THE VIBRATION OF ELASTIC STRUCTURES
G. MAYMON (Ministry of Defence, Armament Development Authority, Tel Aviv, Israel; Georgia Institute of Technology, Atlanta, GA) and L. W. REHFIELD (Georgia Institute of Technology, Atlanta, GA) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 1-7. refs

A method for the determination of the coefficient of non-linearity of a geometrical non-linear elastic system is proposed. The method is based on measuring the 'jump-down' points which exist in geometrically non-linear systems. A plot of the amplitude squared vs. the frequency squared at the amplitude 'jump-down' points for several excitation levels yields a straingth line whose slope is related to the coefficient of no -linearity. The method is demonstrated on a simple elastic system - a clamped clamped beam - and excellent results are obtained from theoretical analysis, experimental static tests and the suggested dynamic test. The experiments also validate the theoretical model of a cubic stiffness relationship.s The 'jump-down' points are shown to be experimentally well defined, and the value of the coefficient of non-linearity determined by the method is insensitive to the accuracy of many 'hard to measure' parameters. Author

A85-37181#

INFLUENCE OF FIGHTER AIRCRAFT LOAD SPECTRUM VARIATIONS ON FATIGUE CRACK INITIATION AND GROWTH

E. REINBERG (Israel Aircraft Industries, Ltd., Engineering Div., Tel Aviv, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 31-35.

Experimental and analytical studies of spectrum sensitivity effects are reported. A typical high performance fighter aircraft load spectrum was used as a baseline. The spectrum variations ranged from realistic variations, that might be expected among operational aircraft, to variations to investigate spectrum development and test procedures. Tests represented crack initiation and growth out of an open or a fastener filled hole in aluminum alloy 2014-T6 specimens It was found that changes caused by any spectrum variation are similar (but not identical) in both fatigue life and crack growth life. The most pronounced effects on fatigue performance were caused by usage changes omission (elimination) of low peaks and truncation of high peaks The least pronounced effects on fatigue performance were due to load sequence changes and introduction of load markers. The analytical study revealed that the FATLIFR program, used in crack initiation analysis, gives slightly unconservative predictions. The sensitivity of the predictions to low peaks was very poor, the CRACKS4 program predictions of crack growth were good for such spectrum changes as mild usage, low peak omission and negative load truncation. Author

A85-37186#

CRACK GROWTH ANALYSIS IN MULTIPLE LOAD PATH STRUCTURE

D. SHALEV (Israel Aircraft Industries, Ltd., Engineering Div , Tel Aviv, Israel) IN Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 64-66 refs

An analytical method for crack growth rate in multiple load path structure is presented, when one of the load path element is cracked. A load redistribution occurs due to stiffness change The method is based on establishing an effective stiffness which accounts for this phenomenon. The Effective stiffness is achieved by using energy considerations before cracking and during crack growth. The paper describes the implementation of the effective stiffness within finite element analysis. The result is a ratio between the stress before and after cracking. That ratio is applied on stress intensity and for the residual strength calculation when compared to net-section yielding. A test was performed on a typical aircraft splice element and a comparison was made between the analytical results and test data. Author

A85-37187#

A PROGRAM FOR COMPUTERIZED STRUCTURAL RESIZING OF AIRCRAFT STRUCTURE SUBJECT TO STRENGTH AND LOCAL PANEL BUCKLING CRITERIA UNDER MULTIPLE LOADING

J. BURVIN, A. AMAR, Z ZAPHIR (Israel Aircraft Industries, Ltd., Tel Aviv, Israel), and M. BARUCH (Israel Aircraft Industries, Ltd., Tel Aviv; Technion - Israel Institute of Technology, Haifa, Israel) IN. Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 67-77. refs

A computerized resize procedure based on a practical fully stressed design of aircraft structure subject to local panel buckling and strength criteria under multiple loading conditions is presented. The modified structure is reanalyzed and updated internal loads are calculated. Material strength, minimum gauge and allowable stress for tension along with local panel buckling interaction curves are considered in computing margins of safety. This iterative process is repeated until these margins of safety become positive for a given load envelope. The iterative resizing algorithm is a practical, automated approach to deal with large scale structures under multiple loading conditions subjected to various design constraints Its application on various wing structure configurations shows that it can provide a practical tool for obtaining efficient aircraft structures Program STAIRS which was developed i this study incorporates the resize algorithm as well as pre and post analysis subprograms. Author

A85-37192#

CRITICAL FLUTTER PARAMETERS OF ORTHOTROPIC RECTANGULAR FLAT PANELS WITH IN-PLANE LOADS

L. BEINER (Negev, University, Beersheba, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 115-120.

A flutter analysis of flat, rectangular orthotropic panels with in-plane stresses is performed for two different types of boundary conditions using Galerkin's method Variation of the critical speed parameter is obtained in a simple form, common to both types of boundary conditions, for an extensive range of parameters It is shown that the critical speed parameter increases with the orthotropicity ratio, the chord-to-span ratio, and the stresswise in-plane tensile stress, and is higher for clamped panels than for their simply-supported counterparts C D.

A85-37216

SUBSONIC MULTIPLE-JET AERODYNAMIC WINDOW

W. MASUDA, Y. MAEDA (Nagaoka, Technological University, Nagaoka, Japan), and Y. SHIRAFUJI (Mitsubishi Electric Corp , Shizuoka, Nagaoka, Technological University, Nagaoka, Japan) Review of Scientific Instruments (ISSN 0034-6748), vol. 56, May 1985, p 677-681. refs

An experimental apparatus, which simulates a subsonic multiple-jet aerodynamic window, is fabricated and aerodynamic characteristics of the single-curved jet and the multiple-curved jets are studied. The effect of the window configuration on the quantity representing the power consumption is evaluated experimentally. Within the range of the present experiments, it is shown that the magnitude of the power consumption of the multiple-jet aerodynamic window can be made less than that of the single-jet scheme, if at least three stages of jets are utilized. It is also shown that the design of the window configuration is important to reduce the power consumption and to obtain the stable operation of multiple-curved jets. Author

A85-37472

REDUCING THE EFFECTS OF RIVET HOLES ON FATIGUE LIFE BY ADHESIVE BONDING

J Y MANN, R. A. PELL, R. JONES, and M. HELLER (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) Theoretical and Applied Fracture Mechanics (ISSN 0167-8442), vol 3, May 1985, p. 113-124. refs

Rivet holes are potential sites for fatigue-crack initiation in aircraft structures Several methods for improving the life of such details were investigated including coating the surface of the hole with adhesive, cold-expansion of the holes, the insertion of close-fit rivets, and the use of adhesively-bonded rivets. Of the various techniques examined, only that involving adhesively-bonded rivets provided any significant improvements in fatigue life It resulted in a reduction in the fatigue-crack propagation rate of about 50 percent compared with that for specimens incorporating open holes. A finite-element analysis indicated that adhesive bonding significantly reduces both the local-stress concentration at the hole and the stress intensities at the crack tips, thus retarding crack initiation and reducing fatigue-crack propagation rates. However, the effective reduction in stress intensity resulting from bonding (about 17 percent) is much less than the 50 percent predicted by the finite-element analysis. This discrepancy is attributed mainly to shortcomings in the model for defining the characteristics and behavior of the adhesive. Author

A85-37625#

EXPERIMENTAL RESEARCH ON THE EFFECT OF SEPARATION FLOW ON ABLATION IN SUPERSONIC TURBULENT FLOW

H. YINDA (China Aerodynamics Research and Development Center, Mianyang, Sichuan, People's Republic of China) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 5 p. refs (AIAA PAPER 85-0975)

The development of a ground-test capability for simulating heating and pressure profile of the steps and cavities on a reentry vehicle surface, in order to study heat shield surface ablation phenomena is discussed. By means of an experimental technique which uses a flat-plate specimen containing steps and cavities placed at a small angle in a supersonic arc-heated flow, the ablation phenomena and surface temperature are examined The results obtained, as well as a description of the facility, test method, model design, instrumentation, and its calibration are presented. The experiment is carried out in a CARDC arc heater whose operating conditions are 1-2 MPa of the arc chamber pressure and 4.2-12.6 MJ/Kg of the total enthalpy. It is shown that with the proper parameters, the ablation data can be corrected. M.D.

A85-37706

DYNAMIC GAS TEMPERATURE MEASUREMENT SYSTEM

D. L. ELMORE and W. B. WATKINS (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) ISA Transactions (ISSN 0019-0578), vol. 24, no. 2, 1985, p. 73-82.

The objective of this effort was to develop a gas temperature measurement system with compensated frequency response of 1 kHz and capability to operate in the exhaust of a gas turbine combustor. The concept selected for detailed development was a thermocouple probe with thermo-elements of two different diameters. The severity of the test environment required sensor elements with length-to-diameter ratios of approximately 15. Transient thermal conduction effects were identified as important for this sensor design; a preliminary finite-element conduction model quantified the errors expected by neglecting conduction A compensation method was developed to account for effects of conduction and convection. This method was verified in analog electrical simulations and used to compensate dynamic temperature data from a laboratory combustor and a gas turbine engine. Detailed data compensations are presented. Analysis of error sources in the method was done to derive confidence levels for the compensated data. Author

A85-38069

DYNAMIC BEHAVIOUR OF COLD WIRES IN HEATED AIRFLOWS (T IN THE RANGE FROM 300 TO 600 K)

C. PETIT, P. PARANTHOEN, J. C. LECORDIER, and P. GAJAN (Rouen-Haute Normandie, Universite, Mont-Saint-Aignan, Seine-Maritime, France) Experiments in Fluids (ISSN 0723-4864), vol. 3, no. 3, 1985, p. 169-173. refs

A theoretical and experimental investigation of cold wire frequency response is presented for the case of heated airflows (T less than 600 K). Experiments using an external heating technique have been carried out for sensors in different flow situations. Particular attention has been paid to the influence of temperature on cold wire transfer function characteristics (time-constant and plateau level). Author

A85-38169#

EXPLOSIVE FORMING OF LOW CARBOON STEEL SHEET INTO A STEPPED DISC SHAPE

S. BALASUBRAMANIAM, S. SARVAT ALI, and E. S. BHAGIRADHA RAO (Defence Metallurgical Research Laboratory, Hyderabad, India) Defence Science Journal (ISSN 0011-748X), vol. 34, July 1984, p. 235-256. refs

This paper deals with the explosive forming of deep drawing quality steel into a two stepped disc type shape. An attempt has been made to predict the forming parameters from theoretical considerations by equating the disc shape with an equivalent dome Results of forming this shape in a single-stage vis-a-vis forming in two-stages are compared. Author

A85-38233

HOVERCRAFT SKIRT DESIGN AND MANUFACTURE

R. L. WHEELER and A. N KEY (British Hovercraft Corp., Ltd., Cowes, Isle of Wight, England) Future, Spring 1985, p. 8-17.

A development history is presented for the skirt designs of large hovercraft, with attention to the design methodology and verification techniques employed to arrive at performance improvements over several design generations. The air flow and mechanical interactions among the various constituents of the skirt are noted for the spectrum of sea state and maneuvering conditions that are encountered by hovercraft of English Channel ferry type. The constitution of an integrated CAD/CAM design and fabrication process for hovercraft skirts is detailed. O.C.

A85-38352#

STRUCTURAL OPTIMIZATION

Y. HIRANO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 32, no. 360, 1984, p. 9-14. In Japanese. refs

Structural optimizaton in aircraft design is analyzed and illustrated with special emphasis given to the minimum weight problem. The direct optimization method includes the one-direction and direct searching techniques and the gradient method. The indirect optimization method includes techniques such as: fully stressed design, general repeating method, and simultaneous mode design. A mathematical analysis of the indirect method is provided. S.H

A85-38403

SELECTING THE CORRECT BEARING CAN IMPROVE AVIONIC INSTRUMENT PERFORMANCE

M. HOARD (Kaydon Corp., Muskegon, MI) Defense Systems Review and Military Communications, vol 3, no. 4, 1985, p. 36, 38, 39

The performance level and reliability of avionic sensing/scanning devices are primarily dependent on the properties of the bearing that supports their moving elements; this also holds true for gimbals in inertial guidance systems, radar navigation, and target acquisition/fire control systems. Standard thin section bearings are best suited for avionic instrumentation, since they are characterized by very small races and rolling elements with respect to diameter. Attention is presently given to nearly universally applicable bearing designs, together with their properties and comparative advantages. O.C.

A85-38510

FLOW SEPARATION FROM THE LEADING EDGE OF AN AIRFOIL AND THE EFFECT OF ACOUSTIC PERTURBATIONS ON THE SEPARATED FLOW [OTRYV POTOKA OT PEREDNEI KROMKI PROFILIA I VLIIANIE NA NEGO AKUSTICHESKIKH VOZMUSHCHENII]

V. V. KOZLOV PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), Mar.-Apr. 1985, p. 112-115. In Russian refs

The structure of the separated flow at the leading edge of a symmetrical airfoil is investigated by thermoanemometry in a low-turbulence subsonic wind tunnel. It is shown that the superposition of an acoustic field leads to a reattachment of the boundary layer and an elimination of global flow separation. The hysteresis effect of the acoustic field on the reattachment of the separated boundary layer is examined V.L.

A85-38536#

DESCRIPTION AND TEST METHODS FOR A FREQUENCY OUTPUT ACCELEROMETER

A. M. GOGIC and R. B. PETERS (Sundstrand Data Control, Inc., Instrument Systems Div., Redmond, WA) IN: Institute of Navigation, National Technical Meeting, San Diego, CA, January 17-19, 1984, Proceedings . Washington, DC, Institute of Navigation, 1984, p. 108-117.

A vibrating beam accelerometer is described as representative of a newly emerging class of frequency output sensors. The output characteristics of these sensors are inherently digital in nature and generally nonlinear. Their digital nature requires that interfaces be defined entirely in digital terms, and that these interfaces be carefully thought out so as not to introduce unnecessary problems related to sampling noise, resolution, and aliasing. Nonlinearity requires modeling in a microprocessor for most applications and also introduces a potential for input rectification if not handled correctly. In addition, the fact that the input is acceleration means that vibration isolators are not generally practical, and rather wide band inputs must be accommodated. Methods are described for measuring the characteristics of these sensors, and for efficient conversion of their outputs to high accuracy digital words, corrected for the effects of nonlinearity and temperature. Author

A85-38600

DETERMINATION OF THE OPTIMUM LUBRICANT CHANGE PERIOD FOR THE JOINTS OF THE LANDING GEAR OF AIRCRAFT [OPREDELENIE RATSIONAL'NOI PERIODICHNOSTI SMENY SMAZKI V SHARNIRAKH SHASSI LETATEL'NYKH APPARATOV]

V. S. UGRIUMOV and B. G. BEDRIK Khimiia i Tekhnologiia Topliv i Masel (ISSN 0023-1169), no. 5, 1985, p. 35, 36. In Russian

An approach to the determination of the optimum lubrication period for the joints of landing gear is presented whereby the service life of a lubricant is determined on the basis of the maximum permissible friction coefficient To determine the service life of a lubricant, the lubricant is tested under conditions simulating real friction pairs. For convenience, the lubrication period can also be determined from specially prepared nomograms. As an example, such a nomogram is presented for the lubricant TsIATIM-201. V.L.

A85-38918#

FATIGUE-CRACK PROPAGATION IN AIRCRAFT DURALUMIN SHELL STRUCTURES [ROZWOJ PEKNIEC ZMECZENIOWYCH W LOTNICZYCH KONSTRUKCJACH POWLOKOWYCH Z DURALU]

W. BLAZEWICZ Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol. 40, March 1985, p 10-14. In Polish. refs

An empirical method for calculating fatigue-crack length in Duralumin sheet components under service loads is presented The method requires the determination of the magnitude and sequence of occurrence of individual service loads. The formulation of successive crack-length increments is based on a modified stress intensity factor. B.J.

A85-38973#

EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER DISTRIBUTION INSIDE THE GAP OF A FLAT PLATE-FLAP COMBINATION IN A SHOCK TUNNEL

G. TANG (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China) Acta Aerodynamica Sinica, no. 2, 1985, p. 88-92. In Chinese, with abstract in English. refs

A85-39003#

SIMPLIFIED IMPLICIT BLOCK-BIDIAGONAL FINITE DIFFERENCE METHOD FOR SOLVING THE NAVIER-STOKES EQUATIONS

E. VON LAVANTE (Texas A&M University, College Station, TX) and V. S. V. LYER AIAA Journal (ISSN 0001-1452), vol. 23, July 1985, p. 1130-1132 refs

The simplified implicit block-bidiagonal finite difference method is proposed in order to overcome the numerical instability problems associated with the solution of two-dimensional Navier-Stokes equations when solved by the MacCormack (1981) algorithm. This novel method involves the use of the spectral formal form in the block-bidiagonal system of equations, and is demonstrated, in light of application in several flow cases, to improve computational efficiency by a factor of 3. Since viscous effects are, however, overestimated, the method requires a postprocessor employing the full implicit MacCormack scheme to redefine the boundary layer part of the solution. Numerical instabilities are avoided through the use of a nearly converged solution as the initial profile. O.C.

A85-39061

ACQUISITION OF DETAILED HEAT TRANSFER BEHAVIOR IN COMPLEX INTERNAL FLOW PASSAGES

D. E. METZGER, R. S. BUNKER, and C. S. FAN (Arizona State University, Tempe, AZ) IN: Advances in aerospace propulsion, *Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984* . Warrendale, PA, Society of Automotive Engineers, Inc , 1984, p 47-53. refs

(SAE PAPER 841503)

Flow passages associated with internal cooling of high temperature engine components, especially those in gas turbine engines, frequently have very complex surface geometries. The flow channels usually are roughened to enhance heat transfer rates, and often incorporate sharp turns. The acquisition of detailed local heat transfer coefficient distributions over complex surface geometries is often extremely difficult or prohibitively expensive using conventional techniques. A relatively new method of acquiring heat transfer coefficients through use of surface coatings that have precise melting points is described. As an example of the use of the technique, it is applied to the study of the effect of various rib roughness patterns on heat transfer through 90 deg turns in a rectangular cooling channel. Author

A85-39062

INSTRUMENTATION FOR GAS TURBINE RESEARCH IN SHORT-DURATION FACILITIES

M G DUNN, G. LUKIS, M. URSO, R J HIEMENZ, R. L. ORSZULAK, and N. J. KAY (Arvin/Calspan Advanced Technology Center, Buffalo, NY) IN: Advances in aerospace propulsion; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 55-67. refs

(Contract F33615-81-C-2017; F33615-79-2075; F33615-76-C-2092)

(SAE PAPER 841504)

This paper presents a detailed description of instrumentation and data recording techniques currently in use at Calspan in the performance of gas turbine related research in short-duration facilities. By short-duration is meant total test times on the order of 20 milliseconds with the requirement of sampling rates in the range of 20 kHz to 2 MHz Typical data records obtained as part of this research are presented to illustrate their application. Author

A85-39117

A STUDY OF THE THERMAL INERTIA OF A THERMOCOUPLE EXPOSED TO SHORT TEMPERATURE PULSES AT HIGH REYNOLDS NUMBERS [ISSLEDOVANIE TEPLOVOI INERTSII TERMOPARY PRI KRATKOVREMENNYKH IMPUL'SAKH TEMPERATURY I POVYSHENNYKH CHISLAKH REINOL'DSA]

A. B. BEREZOVSKII and I. I. VLASOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1985, p. 77-79 In Russian

A method for the dynamic testing of thermal transducers is described which is based on the use of a 'slow-compression' wind tunnel. The general design of the wind tunnel and the test procedure are briefly discussed, and test results are presented for a thermocouple used in the temperature transducer of a turbofan engine. The results cover the pressure range 0 7-1.5 MPa, the temperature range 280-420 K, and the flow density range 10-160 kg/(sq m s) V.L.

A85-39131

CHARACTERISTICS OF A TWO-DIMENSIONAL TURBULENT JET IN A BOUNDED SLIPSTREAM [KHARAKTERISTIKI PLOSKOI TURBULENTNOI STRUI V OGRANICHENNOM SNOSIASHCHEM POTOKE]

S. K. VORONOV, T. A. GIRSHOVICH, and A. N. GRISHIN (Moskovskii Aviatsionnyi Institut, Moscow, USSR) Inzhenerno-Fizicheskii Zhurnal (ISSN 0021-0285), vol. 48, June 1985, p. 904-911. In Russian. refs

A method for computing a two-dimensional turbulent jet injected at a right angle into a channeled flow is presented, taking into account the rarefaction behind the jet. The conditions at the front jet boundary are approximated using a solution to a displacement flow problem and data available on the flow around elliptical bodies. The boundedness of the flow and the jet velocity to stream velocity ratio are found to have a considerable effect on the jet trajectory; the axial velocity distribution in the jet, the nondimensional velocity profiles, and the back boundary of the stream, however, are not affected noticeably by these parameters. Analytical results are corroborated by experimental data for a two-dimensional jet in free and bounded flows, exhibiting complete qualitative and partial quantitative agreement. L.T.

A85-39165

AIRPLANE MOUNTED ACCESSORY GEARBOX DESIGN

V. CUNNINGHAM (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Starting systems technology; Proceedings of the Aerospace Congress and Exposition, Long Beach, CA, October 15-18, 1984 . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 105-115.
(SAE PAPER 841605)

The characteristics required for the definition, development, and acquisition of a satisfactory Airframe-Mounted Accessory Gearbox are discussed. The areas of gearbox design that are covered include the housing, mounting pads, driveshaft, oil pumps, lubrication and cooling, types and sizes of bearings, and the resonance, balance, widths, class of gears, as well as gear scoring and gear teeth backlash. Oil filters, seals, and screens are addressed along with relief valves and sumps. Tests for load, attitude, speed, heat rejection, and for the altitude and attitude of vent systems are briefly discussed. The control of oil flow rate and of oil flow to gears and bearings are addressed. C.D

A85-39170

EXPLICIT FORMULATION FOR A HIGH PRECISION TRIANGULAR LAMINATED ANISOTROPIC THIN PLATE FINITE ELEMENT

C. JEYACHANDRABOSE and J. KIRKHOPE (Carleton University, Ottawa, Canada) Computers and Structures (ISSN 0045-7949), vol. 20, no 6, 1985, p. 991-1007 refs

An efficient formulation of the stiffness matrix is presented for a high precision triangular laminated anisotropic thin plate finite element The formulation is baed on the classical lamination theory which is reviewed briefly. The stiffness matrix is obtained simply by pre and post multiplication of a few basic matrices, which are presented explicitly. It is believed that this formulation is almost an order of magnitude faster than those available for similar order elements. In addition, the present element formulation is readily applicable as a thin flat shell element. A complete listing of FORTRAN subroutines is presented for the users, to ease implementation of the algorithm Author

A85-39240

THE FLOW PAST TWO CYLINDERS HAVING DIFFERENT DIAMETERS

A. J. BAXENDALE, I. GRANT (Heriot-Watt University, Edinburgh, Scotland), and F. H. BARNES (Edinburgh, University, Edinburgh, Scotland) Aeronautical Journal (ISSN 0001-9240), vol. 89, April 1985, p 125-134. Research supported by the Science and Engineering Research Council of England. refs

The present investigation is concerned with the flow about two circular cylinders aligned parallel to each other and perpendicular to the flow, taking into account the case in which the diameter of the upstream cylinder is half that of the downstream cylinder. The experiments were performed in an open-circuit wind tunnel. The working section of the tunnel is 1 4 m long, and is octagonal in cross section with the opposite faces 0.46 m apart. The tunnel produces a uniform flow with a free-stream turbulence of less than 1 percent at 10 m/s. Measured data are presented with the aid of graphs for the case in which the cylinders are in tandem and for the case in which they are found in a staggered arrangement. Attention is given to the pressure distributions around a cylinder, the positions of the stagnation point, the Strouhal numbers, and the drag and lift coefficients. G.R.

A85-39450

NONSTATIONARY DEFORMATION OF STRUCTURAL ELEMENTS AND THEIR OPTIMIZATION [NESTATSIONARNOE DEFORMIROVANIE ELEMENTOV KONSTRUKTSII I IKH OPTIMIZATSIIA]

S. S. KOKHMANIUK, A. S. DMITRIEV, G. A. SHELUDKO, A. N. SHUPIKOV, and L. G. ROMANENKO Kiev, Izdatel'stvo Naukova Dumka, 1984, 188 p In Russian. refs

The problem of the nonstationary oscillations of deformable systems with unilateral and bilateral coupling between their elements is investigated. In particular, attention is given to the stress-strain analysis of beams, single- and multi-layer plates, and shells under gradually increasing or abruptly applied moving loads and under inertialess loading. Optimum design problems for such structures are examined, and the structural factors contributing to a stress and weight reduction in elastic bodies are discussed. V.L.

A85-39459

SPECTRAL ANALYSIS OF OPTIMAL AND SUBOPTIMAL GYRO MONITORING FILTERS

J. I. GALDOS (MIT, Lexington, MA) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-21, May 1985, p. 372-378. refs

Gyro monitoring filters are used to estimate and correct gyro drift rates of local-level inertial navigation systems. Conventional gyro monitoring filters are usually designed based on a simplified model of gyro drift rate. Furthermore, the effectiveness of these filters - and of many filters of the 'Kalman' type - is often measured in terms of the root mean square (rms) criterion in contrast to the spectral content criterion typical of classical Wiener filtering theory. This paper has two objectives: to propose a gyro monitoring filter which is based on a more detailed model of gyro drift rate, and to propose a method of filter performance evaluation which uses as criterion a measure of the spectral content of the error process. The proposed gyro monitoringg filter is shown to have improved spectral contents resulting in superior navigation performance for the gyro error models used in the calculations (comparable to commercial-grade aircraft gyros). Author

A85-39605#

INFLUENCE OF THE BLOCKAGE RATIO ON THE EFFICIENCY OF SWIRL GENERATION WITH VANE SWIRLERS

E KILIK (California State University, Long Beach, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 6 p. refs
(AIAA PAPER 85-1103)

Four swirlers, two with flat and two with curved vanes, have been experimentally tested and compared for two blockage ratios in order to determine the influence of the blockage ratio on the aerodynamic characteristics of the downstream recirculation region and the pressure drop through the swirlers. To this end, pressure drop and flow field measurements have been made for each swirler in the issuing isothermal free swirling jets. Hot-wire anemometry and a five-hole pressure probe have been used for the measurements. Results show that the pressure drop increases with increasing blockage ratio for a fixed mass flow rate. However, the recirculation region becomes larger and stronger and the reverse mass flow rate increases Author

A85-39619#

EFFECTS OF INLET PRESSURE FLUCTUATIONS ON AXIAL FLOW COMPRESSORS - SOME EXPERIMENTAL AND THEORETICAL RESULTS

D. K. DAS (New York, State University, Utica, NY) and A. TRIPPI (Pisa, Universita, Pisa, Italy) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p. refs
(AIAA PAPER 85-1135)

The effects of unsteady inlet flow on the dynamic response of a multistage axial flow compressor have been studied both theoretically and experimentally. Results from experimental tests carried out at different compressor operating points and pulsation frequencies are presented. The experimental data are then used to validate a mathematical model for the dynamic behavior of the compressor. Author

A85-39643#

FUEL DROPLET SIZE MEASUREMENTS WITH A LASER DOPPLER INTERFEROMETER

J. R. TAYLOR (General Electric Co., Aircraft Engine Business Group, Evendale, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p. refs

(AIAA PAPER 85-1182)

It is pointed out that the injection and atomization of liquid fuel into a gas turbine combustion system plays a major role in many key aspects of combustion system performance. Fuel droplet diameters represent one of the parameters which determine the burning rate. The present investigation is concerned with a commercially available laser Doppler interferometer which has been used by an American manufacturer of aircraft engines to measure fuel droplet size distributions downstream of several different fuel injectors and combinations of fuel injectors and combustor dome swirl cups. The considered instrument has a very small sample volume, which permits measurements of droplet size distributions and droplet Sauter Mean Diameters (SMD) at a large number of discrete points in the spray pattern. The design and the principles of operation of the droplet sizing interferometer (DSI) are discussed along with alignment procedures, test configurations, and test results. G.R.

A85-39742#

QUANTITATIVE EVALUATION OF TRANSIENT HEAT TRANSFER ON AXIAL FLOW COMPRESSOR STABILITY

R. A. CRAWFORD (Tennessee, University, Tullahoma, TN) and A. E. BURWELL (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 10 p. refs

(AIAA PAPER 85-1352)

An essential factor for acceptable engine performance and safety in the case of an aircraft gas turbine engine is the stable operation of the compression system. A number of basic research programs were conducted to investigate the influence of transient heat transfer effects on axial flow compressor stability. The results of these programs led to the conclusion that sound theoretical models predict a significant influence of transient heat transfer on compressor stability. However, no transient turbine engine data were available to validate model predictions. The present investigation utilizes high quality transient turbine engine data to quantify and support the reported conclusion. Attention is given to core compressor thermal energy storage, standard stability tests for gas turbine engines, transient mass flow calculations, transient heat transfer calculations, blade heat transfer flux, heat transfer results, and a comparison. G.R.

A85-39780*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

NUMERICAL CALCULATION OF SUBSONIC JETS IN CROSSFLOW WITH REDUCED NUMERICAL DIFFUSION

R. W. CLAUS (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 11 p. Previously announced in STAR as N85-25263. refs

(AIAA PAPER 85-1441)

A series of calculations are reported for two, subsonic jet in crossflow geometries The parametric variation examined are the lateral spacing of a row of jets. The first series of calculations corresponds to a widely space jet geometry, S/D = 4, and the second series corresponds to closely spaced jets, S/D = 2. The calculations are done with alternate differencing schemes to illustrate the impact of numerical diffusion. The calculated jet trajectories agreed well with experimental data in the widely spaced jet geometry, but not in the closely spaced geometry. E.A.K.

A85-39796*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

TRANSIENT TECHNIQUE FOR MEASURING HEAT TRANSFER COEFFICIENTS ON STATOR AIRFOILS IN A JET ENGINE ENVIRONMENT

H. J GLADDEN and M P. PROCTOR (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 12 p. Previously announced in STAR as N85-25794 refs

(AIAA PAPER 85-1471)

A transient technique was used to measure heat transfer coefficients on stator airfoils in a high-temperature annular cascade at real engine conditions. The transient response of thin film thermocouples on the airfoil surface to step changes in the gas stream temperature was used to determine these coefficients In addition, gardon gages and paired thermocouples were also utilized to measure heat flux on the airfoil pressure surface at steady state conditions. The tests were conducted at exit gas stream Reynolds numbers of one-half to 1.9 million based on true chord. The results from the transient technique show good comparison with the steady-state results in both trend and magnitude. In addition, comparison is made with the STAN5 boundary layer code and shows good comparison with the trends. However, the magnitude of the experimental data is consistently higher than the analysis. Author

A85-39797#

DEVELOPMENT OF A NONINTERFERENCE TECHNIQUE FOR MEASURING TURBINE ENGINE ROTOR BLADE STRESSES

H. T JONES (Sverdrup Technology, Inc, Arnold Engineering Development Center, Arnold Air Force Station, TN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 21st, Monterey, CA, July 8-10, 1985. 6 p

(AIAA PAPER 85-1472)

A technique for noninterference measurement of turbine engine rotor blade stresses is being developed as an alternative to conventional strain-gage measurement systems. The noninterference blade stress-measurement technique senses blade-tip deflections and infers blade stresses by using blade-tip-deflection to stress-conversion algorithms. Blade-tip sensors, mounted on the periphery of the rotor stage, sense blade-tip passing of all blades in the stage. The resultant signals are processed to extract integral and nonintegral-type blade vibration information. A full-scale noninterference stress measurement system is being developed to incorporate improvements identified during testing of single-stage prototype systems. The full-scale system will have multistage capability and allow blade-tip measurements in both the cold and hot sections of turbine engines. Author

A85-39873#

AN INVESTIGATION OF HIGH PERFORMANCE, SHORT THRUST AUGMENTING EJECTORS

T. YANG, T. JIANG (Clemson University, Clemson, SC), D. R. PITTS (Tennessee, University, Knoxville, TN), and F. NTONE American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec. 9-14, 1984. 8 p. Research supported by the South Carolina Energy Research and Development Center. refs

(Contract N00167-81-C-0087)

(ASME PAPER 84-WA/FE-10)

The design of air-to-air, thrust augmenting ejectors having short curved wall diffusers utilizing boundary layer control is discussed. The design is achieved by an inverse method which uses the vorticity at the diffuser inlet as a flow parameter in the analysis. Three diffusers having ejector length-to-mixing chamber diameter ratios of approximately 6.1 and mixing chamber inlet area-to-primary nozzle area ratios of 20:1 and 40:1 were designed and tested. A new high level of performance was analytically predicted and achieved experimentally Comparisons between predicted and observed performances, velocity distributions and pressure distributions are presented Author

A85-39878#
VERTICAL PLATE FIN WITH CONJUGATED FORCED CONVECTION-CONDUCTION TURBULENT FLOW
C.-K CHEN (National Cheng Kung University, Tainan, Republic of China), J. W. CLEAVER (Liverpool, University, Liverpool, England), and F.-S. LIEN American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec 9-14, 1984. 6 p. refs
(ASME PAPER 84-WA/HT-8)

Numerical calculations of local heat transfer coefficients are presented for steady turbulent forced convection flow over a vertical plate fin. The local heat transfer coefficient is solved with the convective boundary layer equations of fluid and the heat conduction equation of fin, simultaneously. The eddy-diffusivity formulas used by Cebeci and Smith (1974) are utilized to model the Reynolds stresses. An implicit finite difference method is employed. The results of local heat transfer coefficient and local heat flux are found to be irregular near the transition region. The overall heat transfer rate, the local heat transfer coefficient, the local heat flux and the fin temperature are presented for Pr=0.7 (air) and various values of Nc. Author

A85-39888#
INFLUENCE OF DOWNSTREAM DISTANCE ON SIMPLEX ATOMIZER SPRAY CHARACTERISTICS
N. K RIZK and A. H. LEFEBVRE (Purdue University, West Lafayette, IN) American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec. 9-14, 1984 7 p. refs
(ASME PAPER 84-WA/HT-25)

An examination is made of the effects of variations in fuel-injection pressure and distance downstream from the nozzle on the spray characteristics of simplex swirl atomizers. Both mean drop size and drop-size distribution are measured using a commercial particle sizer as well as a conventional light-scattering technique. Evidence is presented to show that although fuel evaporation and droplet coalescence may be contributing factors, the observed variation in spray characteristics with distance downstream of the nozzle is due mainly to the different relative velocities that exist between drops of different size and the surrounding air. The results obtained by the two techniques employed in drop-size measurement are compared and show good agreement Author

A85-39897#
APPLICATION OF BOUNDARY ELEMENT METHOD TO HEAT TRANSFER COEFFICIENT MEASUREMENTS AROUND A GAS TURBINE BLADE
Y NAKATA and T. ARAKI (Toshiba Corp., Toshiba Research and Development Center, Kawasaki, Japan) American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec 9-14, 1984. 10 p. refs
(ASME PAPER 84-WA/HT-69)

Boundary-element method (BEM) with the complete linear element is developed and applied to the steady-state measurements for local heat-transfer coefficients (htc) around a gas turbine blade, especially on actual engine conditions. In the steady-state two-dimensional heat-conduction problem with convective heat-transfer boundary conditions, the solution for the inverse-mixed problem is formulated generally by BEM, where local htc or even fluid temperature may be assigned unknown at any boundary nodal point. Then, the new data-analysis technique for local htc measurements is proposed in which htc on the outside of a hollow blade is computed by BEM from measured blade temperatures on the outer surface, and several measurement simulations are demonstrated to investigate the estimation accuracy. The local htc distribution estimated with about 30 thermocouples has lain within the range of + or - 10 percent compared with the distribution that ought to be. Author

A85-39898*# Rensselaer Polytechnic Inst., Troy, N. Y.
HEAT TRANSFER INVESTIGATION IN THE JUNCTION REGION OF CIRCULAR CYLINDER NORMAL TO A FLAT PLATE AT 90 DEG LOCATION
H. T. NAGAMATSU (Rensselaer Polytechnic Institute, Troy, NY) and J. N. HINCKEL (Instituto de Estudos Avancados, Sao Jose dos Campos, Sao Paulo, Brazil) American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec. 9-14, 1984. 7 p. refs
(Contract NSF MEA-80-06806; NAG3-292)
(ASME PAPER 84-WA/HT-70)

External heat-transfer rates were measured on a flat plate in the junction region of a circular cylinder mounted normal to the plate at a location 90 deg from the stagnation point. This configuration simulates the junction of the shroud with gas-turbine vanes. Heat-transfer results are presented for laminar, transition, and turbulent boundary layers for a Mach number of 0 14 with gas temperatures of approximately 750 deg R over a flat plate at room temperature. The measurements were made in air for a unit Reynolds number, Re/cm, range of 11,000 to 58,000. Heat-transfer measurements were conducted in the 70-ft long, 4-in. diameter shock tube. A shock-wave reflection technique was used to produce a flow Mach number of 0.14. Thin-film platinum heat gages were mounted on the flat plate and along the line of the stagnation point of the cylinder to measure the local heat flux in the junction region. The experimental heat-transfer data were correlated with the laminar and turbulent boundary-layer theories for the flat plate. With the cylinder the heat fluxes on the flat plate were greatly increased in the junction region compared to the heat flux for the plate alone. Author

A85-39899#
THE TRANSPIRED TURBULENT BOUNDARY LAYER IN VARIOUS PRESSURE GRADIENTS AND THE BLOW-OFF CONDITION
D. P. GEORGIOU and J. F. LOUIS (MIT, Cambridge, MA) American Society of Mechanical Engineers, Winter Annual Meeting, New Orleans, LA, Dec. 9-14, 1984. 8 p refs
(Contract E(49-18)-2295)
(ASME PAPER 84-WA/HT-71)

Experimental data are reported from studies of the cooling effectiveness and conditions leading to blow-off in transpiration cooling (TC). The TC configuration used featured a sintered bronze plate in a hot blowdown wind tunnel Cooled air was pumped through the plate and data were gathered with calorimeters downstream of a piece of sandpaper which tripped the boundary layer Pressure taps were also used. Local pressure gradient effects were small, but local accelerations reduced the cooling effectiveness The downstream Stanton numbers were sensitive to the upstream coolant-injection ratio. Increasing the injection rate had, at best, only a small effect on the local heat flux. M.S.K.

N85-27946*# Cleveland State Univ., Ohio.
UNSTEADY FLOW IN MULTISTAGE TURBINES Abstract Only
S P SURAMPUDI *In* NASA. Lewis Research Center Struct. Integrity and Durability of Reusable Space Propulsion Systems p 37-38 May 1985 refs
Avail. NTIS HC A09/MF A01 CSCL 20D

The development of an efficient model for the response of a multistage turbine to either a total pressure or total temperature distortion is discussed. Each turbine blade row is modeled as an actuator disk and is often used to describe the flow through turbine and compressor blade rows. The flow approaching the blade row is assumed to be subsonic and inviscid. The distortion occurs at upstream infinity and is in the form of total pressure or total temperature. A solution was found to unsteady Euler equations by using a finite volume method. With prescribed inlet and boundary conditions flow variables such as density, pressure, and velocities can be calculated at cell centers in the entire flow region. The inlet and exit of the blade row coincide with lines of constant. E.A.K.

N85-27947*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
UNSTEADY HEAT TRANSFER DUE TO TIME-DEPENDENT FREE STREAM VELOCITY Abstract Only
R. S. R. GORLA and A. AMERI *In* NASA. Lewis Research Center Struct. Integrity and Durability of Reusable Space Propulsion Systems p 39-40 May 1985 refs
Avail: NTIS HC A09/MF A01 CSCL 20D

The present work was undertaken in order to study the unsteady combined convection from a horizontal circular cylinder to a transverse flow. A coordinate perturbation method is used to transform the governing set of partial differential equations into a system of ordinary differential equations The free stream time-dependent velocity was assumed to be sinusoidal and the boundary layer response due to both low as well as high frequencies of oscillation will be studied Currently numerical solutions are being obtained for the distribution of the unsteady Nusselt number and the friction factor. Author

N85-28140# National Aerospace Lab., Amsterdam (Netherlands).
THE APPLICATION OF NUMERICAL CONTROL (NC) IN MANUFACTURING WIND TUNNEL MODELS
1983 14 p In DUTCH; ENGLISH summary Sponsored by Netherlands Agency for Aerospace Programs
(B8580078) Avail: NTIS HC A02/MF A01

A numerically controlled milling machine with an accuracy of 0.01 to 0.02 mm adapted to the manufacturing of wind tunnel models, and a three axis measuring machine with an accuracy of 0.01 mm and a resolution of 0 05 mm on which models can be measured quickly and accurately are described. A procedure in which a given plasticine model is measured by the measuring machine to obtain the coordinates for models without numerical data is outlined. Author (ESA)

N85-28159# Joint Publications Research Service, Arlington, Va.
PROPULSION EFFICIENCY OF VIBRATING BODIES IN SUBSONIC GAS STREAM Abstract Only
M N. KOGAN and M. V. USTINOV *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-85-004) p 83 15 May 1985 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Zhidkosti i Gaza (Moscow), no. 4, Jul. - Aug. 1984 p 128-132 Original language document was announced in IAA as A85-10111
Avail: NTIS HC A06/MF A01

An axisymmetric body in a subsonic gas stream, namely an airfoil periodically deforming without loss of symmetry and change of length, is examined from the standpoint of thrust-power relation. The corresponding surface-time integrals for the drag force and the propulsion power are formulated in a cylindrical system of coordinates and evaluated, assuming a potential flow of the gas with small perturbations by the body. A time-independent source distribution density term is added to this time-dependent solution to insure a positive airfoil cross-sectional area. The maximum theoretical efficiency, or minimum power for given thrust, is calculated on this basis and the shape of the body is sought for which the real efficiency will approach the maximum theoretical one as closely as possible. Making the length of the body invariable in time leads to a discretely varying drag coefficient. Author

N85-28191*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MICROWAVE RESPONSES OF THE WESTERN NORTH ATLANTIC
J. M. STACEY and M. A. GIRARD 15 Feb. 1985 35 p refs Original contains color illustrations
(Contract NAS7-918)
(NASA-CR-175888; JPL-PUB-85-12; NAS 1.26:175888) Avail. NTIS HC A03/MF A01 CSCL 20N

Features and objects in the Western North Atlantic Ocean - the Eastern Seaboard of the United States - are observed from Earth orbit by passive microwaves. The intensities of their radiated flux signatures are measured and displayed in color as a microwave flux image. The features of flux emitting objects such as the course of the Gulf Stream and the occurrence of cold eddies near the Gulf Stream are identified by contoured patterns of relative flux intensities. The flux signatures of ships and their wakes are displayed and discussed. Metal data buoys and aircraft are detected. Signal to clutter ratios and probabilities of detection are computed from their measured irradiances. Theoretical models and the range equations that explain passive microwave detection using the irradiances of natural sources are summarized. Author

N85-28266# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
PROCEEDINGS OF THE 9TH US AIR FORCE AND THE FEDERAL REPUBLIC OF GERMANY DATA EXCHANGE AGREEMENT MEETING, VISCOUS AND INTERACTING FLOW FIELD EFFECTS
A. W. FIORE Aug. 1984 313 p Meeting held at Silver Spring, Md., 9-10 May 1984
(AD-A153020) Avail: NTIS HC A14/MF A01 CSCL 20D

The 9th U.S Air Force/Federal Republic of Germany Data Exchange Agreement Meeting entitled Viscous and Interacting Flow Field Effects was sponsored by the Air Force Flight Dynamics Laboratory. It was held on the 9th and 10th of May, 1984 at the Naval Surface Weapons Center in Silver Spring Maryland. This report contains the detailed proceedings of that meeting It contains both theoretical and experimental results concerning a great variety of topics in the area of boundary layer research The speed range extends from subsonic to hypersonic Mach numbers. The types of boundary layers reported include laminar, transitional, and turbulent in the presence of attached and/or separated conditions. B.W.

N85-28276# Transamerica Delaval, Inc., Santa Monica, Calif. Biphase Energy Systems.
FLOW CHARACTERISTICS OF A PARTIALLY SUBMERGED LIQUID PICKUP Final Report
D. BARTZ 17 Feb. 1984 156 p refs
(Contract DE-AC03-80ER-10687)
(DE85-008744; DOE/ER-10687/T2) Avail. NTIS HC A08/MF A01

The technology for two-phase power production is discussed. The Biphase turbine is a state-of-the-art two-phase turbine with many potential advantages, including low cost, high efficency, high torque, and simplicity: The potential exists for substantial performance improvements DOE

N85-28328# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
HEATING PARAMETER ESTIMATION USING COAXIAL THERMOCOUPLE GAGES IN WIND TUNNEL TEST ARTICLES M.S. Thesis
N. T. CAHOON Dec. 1984 132 p
(AD-A153039; AFIT/GAE/AA/84D-3) Avail. NTIS HC A07/MF A01 CSCL 09B

A heat energy balance is applied to a coaxial thermocouple gage for parameter estimation in wind tunnel test articles. This method can significantly reduce wind tunnel test costs and time. Modifications to the data reduction program HEATEST (HEATing ESTimation) are made. The programs allows for transient test techniques to be used as well as assuming an isothermal wall. A non-linear convective heat transfer coefficient model may also be used Data is generated to test the new program. Temperature profiles throughout the thermocouple gage were good and were compared with changes in time step, thermocouple length, and number of discrete node points. The estimation of the convective heat transfer coefficient and thermal conductivity were excellent. GRA

N85-28379# Argonne National Lab., Ill.
CERAMIC TURBOCHARGERS: A CASE STUDY OF A NEAR-TERM APPLICATION OF HIGH-STRENGTH CERAMICS
R. P. LARSEN and L. R. JOHNSON Aug. 1984 22 p refs
(Contract W-31-109-ENG-38)
(DE85-006495; ANL/CNSV-47) Avail: NTIS HC A02/MF A01

The most likely near term, high volume application of structural ceramics in heat engines is in turbocharger rotors. These will be the first mass produced ceramic components applicable to both gasoline and diesel engines. The principal objective is to estimate relative costs of ceramic turbocharger rotors vs conventional metal rotors. Thus the focus is on the economics, manufacturing, marketing strategies, and benefits related to the introduction and use of ceramic turbochargers, rather than on the detailed technical issues surrounding the microstructure and processing aspects of the new ceramic technologies. The use of ceramics first in rotors and later in other turbocharger components was significant impacts on cost, size, performance, and overall market growth of turbos are given. DOE

N85-28380# Argonne National Lab., Ill. Center for Transportation Research.
FUTURE OF CERAMIC TURBOCHARGERS: PROMISES AND PITFALLS
R. P. LARSEN Nov. 1984 8 p refs Presented at the 22nd Automotive Technol. Develop. Contractors' Coordination Meeting, Dearborn, Mich., 29 Oct. - 2 Nov. 1984
(Contract W-31-109-ENG-38)
(DE85-006209; CONF-8410103-9) Avail: NTIS HC A02/MF A01

The turbocharger is the most likely near term application of a mass produced ceramic component applicable to both gasoline and diesel engines. A ten fold increase in turbocharger use is projected for the US market over the next eight years, and the total worldwide demand at the end of that time will exceed six million units per year. Ceramic turbochargers are expected to play a significant role in that growth. Overall turbocharger costs could decline as much as 50% during the next eight years, largely due to the use of ceramics, and ceramic turbochargers which could capture more than 75% of the total market The difficulties of mass producing ceramic rotors and other components are discussed as a primary pitfall to the introduction and development of this advanced technology. DOE

N85-28430# National Aerospace Lab , Amsterdam (Netherlands). Structures and Materials Dept.
ENGINEERING SIGNIFICANCE OF FATIGUE THRESHOLDS AND SHORT FATIGUE CRACKS FOR STRUCTURAL DESIGN
R. J. H WANHILL 1 Feb. 1984 15 p refs Presented at 2nd Intern. Conf on Fatigue and Fatigue Thresholds, Birmingham, England, Sep. 1984
(NLR-MP-84001-U; B8561153; AD-B090358L) Avail. NTIS HC A02/MF A01

The significance of fatigue thresholds and short fatigue cracks for engineering structures with respect to design philosophy (safety and durability, the anticipated service loads and nondestructive inspection (NDI)) are examined. Examples for spacecraft payloads, aircraft structures (including landing gear and jet engines), offshore and littoral structures, thick-walled pressure vessels, wind turbines, power generating equipment and ship propellers are given. Author (ESA)

N85-28431# National Aerospace Lab , Amsterdam (Netherlands). Structures and Materials Div.
FRANGIBILITY OF OBSTACLES AT AIRPORTS
J. F. M. WIGGENRAAD 30 Jan. 1984 14 p refs Presented at Intern. Conf. and Exposition on Struct. Impact and Crashworthiness, London, 16-20 Jul. 1984
(NLR-MP-84002-U; B8561154; AD-B090357L) Avail: NTIS HC A02/MF A01

The idea that design requirements for the frangibility of obstacles at airports can be developed if empirical relations can be established between the damage to aircraft resulting from a collision and the energy necessary to disconnect (part of) the obstacle and to subsequently accelerate it is discussed This approach is analogous to a procedure followed with success in the case of bird impacts. A modular structure with easily breakable joints and low fragment mass is advocated. Author (ESA)

N85-28432# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
RESEARCH ON STRUCTURES AND MATERIALS
1983 40 p refs Sponsored by Netherlands Agency for Aerospace Programs Original contains color illustrations
(B8580080) Avail: NTIS HC A03/MF A01

Research on aircraft loads, structures, and materials is described Fatigue load monitoring in service; fatigue life prediction under service loading conditions; analysis of fatigue crack propagation, and development of standardized fatigue load spectra are discussed. Buckling and post-buckling behavior of stiffened structures; deformations in crack tip zones; strength of cracked structures; and experimental deformation analysis are treated. Evaluation of advanced aluminum alloys; high temperature materials; composite materials; adhesive bonded joints; fracture; environmental fatigue; stress corrosion; and high temperature corrosion are summarized. Author (ESA)

N85-29116# National Aerospace Lab., Amsterdam (Netherlands). Technical Group ETW.
CRYOGENIC TEST TECHNOLOGY, 1984
R. J. NORTH, D. SCHIMANSKI, and J. P. HARTZUIKER, ed. Apr. 1985 28 p refs
(AGARD-AR-212) Avail: NTIS HC A03/MF A01

This report reviews the new information available on cryogenic test technology since the report of the Converters' Group on Cryogenic Test Technology was written in 1981 The present position is summarized. The major events since the Converters' report have been the completion and commissioning of the National Transonic Facility (NTF), the suspension of further work on the Douglas 4-WT blowdown tunnel, the conversion of ONERA T2 for cryogenic operation, the steady progress with the DF-LP KKK, and the slow but positive progress with the ETW project, including installation of the pilot tunnel PETW. B.W.

N85-29150*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ELECTRO-EXPULSIVE SEPARATION SYSTEM Patent Application
L. A HASLIM and R. D LEE, inventors (to NASA) 31 May 1985 51 p
(NASA-CASE-ARC-11613-1; NAS 1.71:ARC-11613-1; US-PATENT-APPL-SN-739792) Avail: NTIS HC A04/MF A01 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. Void 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. NASA

N85-29186# Wisconsin Univ., Madison. Mathematics Research Center.
HYPERBOLIC PHENOMENA IN THE FLOW OF VISCOELASTIC FLUIDS Technical Summary Report
D. D. JOSEPH Jan. 1985 93 p
(Contract DAAG29-80-C-0041; DAAG29-82-K-0051)
(AD-A153533; MRC-TSR-2782) Avail: NTIS HC A05/MF A01 CSCL 20D

This paper treats the problem of hyperbolicity, change of type and nonlinear wave propagation in the flow of viscoelastic fluids. Rate equations for fluids with and without instantaneous elasticity are derived and discussed The equations of fluids with instantaneous elasticity are hyperbolic in unsteady flow and can change type in steady flow. The wave speeds depend on velocities and stresses. Some estimates of wave speeds into states of rest are given. For many of the popular models of fluids the vorticity is the field variable which changes type. The vorticity of all fluids with instantaneous elasticity can change type in motions which perturb rigid ones Experiments and analysis exhibiting vorticity of changing type are exhibited. The linearized viscoelastic problem is governed by equations having the properties of a telegraph equation. The damping is small when the fluid is very elastic. Elastic fluids have a long memory, a large time (Weissenberg number) for relaxation. The damping is rapid when the relaxation time is small even when the flow is very supercritical. It is shown that steady flow around a body is of transonic type. The linearized problem for flow over a flat plate is reduced to an integral equation for the vorticity distribution on the plate. GRA

N85-29313# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Inst. fuer Strukturmechanik.
STRUCTURAL ANALYSIS
Nov. 1984 365 p refs In GERMAN and ENGLISH Colloq. held at Brunswick, 4 Jun. 1987 Report will also be announced as translation (ESA-TT-917)
(DFVLR-MITT-84-21; ISSN-0176-7739) Avail: NTIS HC A16/MF A01, DFVLR, Cologne DM 95

Coupling of tension and torsion in rods; field consistency in finite element analysis; buckling and post-buckling behavior of shallow shells; optimization of axially compressed carbon fiber reinforced plastic cylinders, a substructure technique applied to fracture mechanics of composites; stress intensity factors as indicators of crack propagation in unidirectional laminates; and static aeroelastic phenomena of composite wings are discussed.

N85-29314# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany)
RESEARCH ON STRUCTURAL ANALYSIS AT THE DFVLR, BRUNSWICK
B GEIER *In* DFVLR Struct. Anal. p 9-40 Nov. 1984 refs In GERMAN; ENGLISH summary
Avail. NTIS HC A16/MF A01; DFVLR, Cologne DM 95

The science of structural mechanics is reviewed, emphasizing computational problems in aerospace research. Lightweight construction with composite materials is defined as the central topic. In an assessment of the present state of the art, it is concluded that a very satisfactory situation is achieved in the analysis of linear problems, but not in the solution of nonlinear problems and in structural optimization. Author (ESA)

N85-29321# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst fuer Strukturmechanik.
THE STATIC AEROELASTICITY OF A COMPOSITE WING
M PIENING *In its* Struct. Anal. p 319-364 Nov. 1984 refs In GERMAN; ENGLISH summary
Avail: NTIS HC A16/MF A01; DFVLR, Cologne DM 95

A procedure for parametric investigations of the static-aeroelastic behavior of anisotropic wings with average to large aspect ratio was developed. By exploiting the directional stiffness properties of a composite material, coupling of bending and torsional deformations can be achieved. This can be used to influence the spanwise lift distribution, the internal structural forces, and the permissible flying speeds limited by the aeroelastic behavior of the wing Static divergence can be avoided and forward wing sweep can be realized. The differential equations describing the aeroelastic behavior of a beamlike wing structure are solved by applying the multiple shooting method. Examples show the effects of fiber orientations on lift distributions of a composite wing. Author (ESA)

N85-29325# Aeronautical Research Labs., Melbourne (Australia).
DESCRIPTION AND ILLUSTRATION OF THE USE OF CRACKS IV
C. S DENTRY Aug. 1984 62 p
(AD-A153543; ARL/STRUC-TM-389) Avail: NTIS HC A04/MF A01 CSCL 20K

This Memorandum provides an explanation of the procedure required to implement the computer program CRACKS IV for the calculation of crack growth rates. The procedure is illustrated by means of sample calculations. Author (GRA)

13

GEOSCIENCES

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

A85-37720
FURTHER OBSERVATIONS OF X-RAYS INSIDE THUNDERSTORMS
M. MCCARTHY and G. K PARKS (Washington, University, Seattle, WA) Geophysical Research Letters (ISSN 0094-8276), vol. 12, June 1985, p. 393-396.
(Contract NSF ATM-83-00164; NSF ATM-84-07143)

A control and an X-ray detector were flown into thunderstorms in 1984. The X-ray detector found statistically significant radiation flux increases in the energy range from 5 to over 110 keV for time intervals of several seconds each. Simultaneously, the control detector showed no statistically significant changes. The X-ray flux is sometimes seen to increase prior to observed lightning discharges and then return to background levels within 0.1 seconds of a lightning flash initiation. The temporal development of these X-ray bursts is discussed and related to inferring the scale size of the X-ray emitting regions. Author

A85-39213#
AIRCRAFT PERFORMANCE IN A JAWS MICROBURST
W. FROST (Tennessee, University; FWG Associates, Inc., Tullahoma, TN), H.-P. CHANG (Tennessee, University, Tullahoma, TN), J. MCCARTHY, and K L. ELMORE (National Center for Atmospheric Research, Boulder, CO) (Conference on Radar Meteorology, 21st, Edmonton, Alberta, Canada, September 19-23, 1983, Preprints, p. 630-637) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 561-567 NSF-NOAA-supported research. Previously cited in issue 12, p. 1774, Accession no. A85-28776. refs
(Contract DOT-FA01-82-Y-10513)

A85-39218#
MODEL OF THE WIND FIELD IN A DOWNBURST
S. ZHU (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China, Toronto, University, Toronto, Canada) and B ETKIN (Toronto, University, Toronto, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 595-601. refs

The downburst weather phenomenon produces a flow like that of a jet directed vertically downward at the ground The resulting velocity field near the ground has been modeled as a classical ideal fluid flow generated by a suitable singularity distribution The resulting model of horizontal, lateral, and vertical winds near the ground is quite realistic, and very useful for investigating landing and takeoff of airplanes under downburst conditions. It can be used both for analysis and on-line real-time simulations. Author

A85-39526* New Mexico Inst. of Mining and Technology, Socorro.
NIGHTTIME OBSERVATIONS OF THUNDERSTORM ELECTRICAL ACTIVITY FROM A HIGH ALTITUDE AIRPLANE
M. BROOK, C. RHODES (New Mexico Institute of Mining and Technology, Socorro, NM), O. H. VAUGHAN, JR. (NASA, Marshall Space Flight Center, Huntsville, AL), R. E ORVILLE, and B. VONNEGUT (New York, State University, Albany, NY) (National Science Foundation, International Conference on Atmospheric Electricity, 7th, Albany, NY, June 4-8, 1984) Journal of Geophysical Research (ISSN 0148-0227), vol. 90, June 30, 1985, p. 6111-6120. refs
(Contract NAS8-32893; NAS8-33380; NAS8-33817; N00014-80-C-0312; N00014-84-K-0069; F19628-78-C-0007; NSF ATM-79-21080; NSF ATM-80-26533)
Observations of nocturnal thunderstorms from three aerial cameras flown at an altitude of 20 km and at an airspeed of 200 m/s are analyzed and compared with previous ground-based observations. Both diffuse illumination in the cloud and unobscured segments of lightning channels a kilometer or longer in clear air around and above the cloud are observed. A similarity is noted to exist between the airborne and the ground-based lightning spectra registered It is further asserted that discrimination between cloud-to-ground and intracloud flashes and the counting of ground strokes can be achieved through the use of optical pulse pairs identified with leader return-stroke events in the cloud-to-ground flashes studied. L.T.

N85-28450# Naval Weapons Center, China Lake, Calif.
NAVY GEOTHERMAL PLAN
Dec. 1984 21 p
(AD-A152478; AD-E900438; NWC-TP-6612) Avail: NTIS HC A02/MF A01 CSCL 08G
Domestic geothermal resources with the potential for decreasing fossil fuel use and energy costs exist at a significant number of Navy facilities. The Geothermal Plan is part of the Navy Energy R and D Program that will evaluate Navy sites and provide a technical, economic, and environmental base for subsequent resource use. One purpose of the Program will be to provide for the transition of R and D funded exploratory efforts into the resource development phase. GRA

N85-28458# Sandia Labs., Albuquerque, N Mex.
FIELD TEST REPORT OF THE DEPARTMENT OF ENERGY'S 100-KW VERTICAL AXIS WIND TURBINE
R. O. NELLUMS Feb 1985 61 p refs
(Contract DE-AC04-76DP-00789)
(DE85-008475; SAND-84-0941) Avail: NTIS HC A04/MF A01
Three second generation Darrieus type vertical axis wind turbines of approximately 120 kW capacity per unit were installed in 1980-1981. Through March 1984, over 9000 hours of operation had been accumulated, including 6600 hours of operation on the unit installed in Bushland, Texas. The turbines were heavily instrumented and have yielded a large amount of test data. Test results of this program, including aerodynamic, structural, drive train, and economic data are presented. Among the most favorable results were an aerodynamic peak performance coefficient of 0.41; fundamental structural integrity requiring few repairs and no major component replacements as of March 1984; and an average prototype fabrication cost of approximately $970 per peak kilowatt of output. A review of potential design improvements is presented. DOE

N85-28463# Department of Energy, Washington, D. C. Wind Technology Div.
A 5-YEAR RESEARCH PLAN, 1985-1990. WIND ENERGY TECHNOLOGY: GENERATING POWER FROM THE WIND
Jan. 1985 35 p refs
(DE85-008427; DOE/CE-T11) Avail: NTIS HC A03/MF A01
The Department of Energy's current view of the research requirements for wind energy technology is presented. The goal of the Federal Wind Energy Program is to conduct research to establish a technology base and to support industry in confirming the viability of wind energy as an energy supply alternative. The federal program plan for achieving the good is outlined, and activities planned for fiscal years 1985 through 1989 are described. The four main features of the strategy are: (1) to identify how improvements in wind technology can be achieved; (2) to provide a framework for research and development activities; (3) to provide a management plant to ensure that progress is attained; and (4) to recognize the critical importance of an effective partnership between government and industry. DOE

N85-28471# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany) Inst. fuer Physik der Atmosphaere.
INVESTIGATION OF AIR POLLUTION IMPACT IN EASTERN BAVARIA: MEASUREMENT RESULTS FROM AUGUST AND SEPTEMBER, 1984
D. PAFFRATH, W PETERS, and J. LIDL Jan 1985 137 p refs In GERMAN; ENGLISH summary
(DFVLR-FB-85-03; ISSN-0171-1342) Avail: NTIS HC A07/MF A01; DFVLR, Cologne DM 29
Measurement results of the spatial distribution of SO2, NO, O3 and particles, obtained using aircraft and vans, are presented. The distribution of impact of the various components in relation to meteorological conditions and the influence of local pollution sources is discussed. Author (ESA)

N85-29364*# Toledo Univ., Ohio
WAKE EFFECTS ON THE AERODYNAMIC PERFORMANCE OF HORIZONTAL AXIS WIND TURBINES
A. A. AFJEH Aug. 1984 176 p refs
(Contract NCC3-5, DE-AI01-76ET-20320)
(NASA-CR-174920; DOE/NASA/0005-1; NAS 1 26:174920)
Avail. NTIS HC A09/MF A01 CSCL 10A
Success of vortex theories in the performance analysis of horizontal axis wind turbines depends greatly upon accurate specification of the geometry of the vortex wake. Two analysis methods were developed, a new simplified free wake method (SFW) and a prescribed wake method. An earlier wake model of helicopter rotors is extended for wind turbine applications, the fast free wake method (FFW). The FFW was accomplished by partitioning the flow field downstream of the rotor into three regions: (1) the near wake, modeled as a series of straight vortex lines, (2) the intermediate wake, modeled as a number of vortex rings; and (3) the far wake, taken to be a semi-infinite cylindrical wake. In the SFW, a new wake model is proposed. The model assumes that the wake is composed of an intense tip vortex and a diffused inboard wake, consistent with the experimentally observed wake of hovering helicopters. It is assumed that the vortex formation was almost immediate as opposed to the actual gradual rolling-up of the tip vortex. The method is demonstrated by assuming that the wake expansion can be represented by an analytical expression. E.A.K.

N85-29432*# National Aeronautics and Space Administration, Washington, D C.
CONTRIBUTIONS ON THE SUBJECT OF LONGITUDINAL MOVEMENTS OF AIRCRAFT IN WIND SHEARS Ph.D. Thesis - Technischen Univ., 1983
P. KRAUSPE Jun. 1985 228 p refs Transl. into ENGLISH of German Thesis p 1-233 Original language document was announced in IAA as A84-45526 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASW-4004)
(NASA-TM-77837; NAS 1.15:77837) Avail: NTIS HC A11/MF A01 CSCL 04B
The effect of downburst-type wind shears on the longitudinal dynamic behavior of an unguided aircraft is simulated numerically on the basis of published meteorological data and the flight characteristics of an A300-B passenger jet. The nonlinear differential equations of the aircraft motion are linearized by conventional methods, and the wind effects are introduced via the linear derivatives of the wind components referred to the wind gradients to obtain simplified technical models of the longitudinal

response to all possible types of constant-gradient wind shears during the first 20-60 sec. Graphs, maps, and diagrams are provided, and a number of accidents presumed to have involved wind shears are analyzed in detail. (IAA)

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.

A85-37198#
FIRST-ORDER FEEDBACK STRATEGIES FOR VARIABLE SPEED PLANAR PURSUIT-EVASION GAMES
H. G. VISSER and J. SHINAR (Technion - Israel Institute of Technology, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 165-178. refs

A variable speed planar non-linear pursuit-evasion game between two aircraft is analyzed using a singular perturbation technique. Based on the experience with a singular perturbation dynamic model for a one-sided optimal control version of a planar interception, a singular perturbation model is formulated by including velocity dynamics in the 'reduced-order' problem. Analytic first order corrections are developed and incorporated in the feedback control strategies of both pursuer and evader. Both zeroth-order and first-order singular perturbation approximations are compared with the exact open-loop solution The results obtained in the numerical examples are satisfactory and encouraging. Additional experiments are required to determine the entire domain of validity of the first-order SP algorithm. The resulting computatinal algorithm is attractive for both ground based simulation and airborne implementation Author

A85-37211#
INTEGRATED CADCAM - AN APPROACH FOR ADVANCED COMPOSITE PRIMARY AIRCRAFT STRUCTURE
T. R. LOGAN (Boeing Commercial Airplane Co., Seattle, WA) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 309-317 refs

This paper surveys integrated CADCAM systems for advanced composite application and reviews an integrated CADCAM project to support advanced composite primary structure development. That interactive computer graphic approach is based on integrated system architecture and database design. Development moves through a classical system life cycle but is supplemented by pilot system development and evaluation as a precursor to production system definition. The survey outlines development steps and discusses experience gained to date during the pilot portion of the project, as well as longer range goals. Author

A85-37396
ROBOTIC DRILLING OF ACRYLIC WINDSHIELDS AND CANOPIES FOR FIGHTER AIRCRAFT
L C. CRISLER (McDonnell Aircraft Co., St. Louis, MO) IN: National Technical Conference, 16th, Albuquerque, NM, October 9-11, 1984, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p. 417-427.

This paper describes a robot drilling cell which is used to drill large assemblies such as windshields and canopies of fighter aircraft The cell was developed by McDonnell Douglas Corporation under an Air Force funded contract entitled 'Advanced Robotic System Technologies and Applications, Task C' The drilling cell is off-line programmed with MCL (Manufacturing Control Language), driven with a microprocessor based hierarchical control system, and utilizes vision, tactile, and discrete sensors. Subjects that will be addressed will include the multiple level control system, the material handling and parts presentation methods, the automatic cell calibration and diagnostic systems, and each of the cell devices such as the robot, drill motors, end effector, vision system, and tactile sensors. Author

A85-39551#
NEW CONCEPTS IN CONTROL THEORY, 1959-1984 (DRYDEN LECTURESHIP IN RESEARCH)
A. E. BRYSON, JR. (Stanford University, Stanford, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, July-Aug. 1985, p 417-425. Previously cited in issue 06, p. 723, Accession no. A84-17920. refs

A85-39563#
A MISSILE DUEL BETWEEN TWO AIRCRAFT
B. JARMARK (Saab-Scania AB, Linkoping, Sweden) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, July-Aug. 1985, p. 508-513. refs

A delicate differential game is formed by two aircraft performing a long-range missile duel. The duel starts for each aircraft with a semiaggressive phase until the launch of the missile, when a pure evasion commences. In numerically solving the nonlinear differential game problem, an optimization algorithm is used consisting of a modified first-order differential dynamic programming method combined with an effective convergence-control technique. The three-dimensional spatial motion of point mass vehicles with realistic models is treated. The results of optimizing the problem point out the potential of new tactics. If the vehicles are free to maneuver in altitude, the contributions from the missiles will dominate the outcome of the game. Of particular importance is the desirable ability to enter the game at a higher altitude than that of the opponent. Author

A85-39564*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A MULTILOOP ROBUST CONTROLLER DESIGN STUDY USING SINGULAR VALUE GRADIENTS
J. R. NEWSOM (NASA, Langley Research Center, Loads and Aeroelasticity Div., Hampton, VA) and V MUKHOPADHYAY (Joint Institute for Advancement of Flight Sciences, Hampton, VA) (Guidance and Control Conference, Gatlinburg, TN, August 15-17, 1983, Collection of Technical Papers, p. 173-180) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, July-Aug. 1985, p. 514-519 Previously cited in issue 19, p. 2891, Accession no. A83-41677. refs

A85-39565#
TIME-DOMAIN STABILITY ROBUSTNESS MEASURES FOR LINEAR REGULATORS
R. K. YEDAVALLI (Stevens Institute of Technology, Hoboken, NJ), S. S. BANDA, and D. B. RIDGELY (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, July-Aug 1985, p. 520-524. refs
(Contract AF-AFOSR-83-0139, F33615-84-K-3606)

The stability robustness aspect of linear systems is analyzed in the time domain. A bound on the perturbation of an asymptotically stable linear system is obtained to maintain stability using Liapunov matrix equation solution The resulting bound is shown to be an improved upper bound over the ones recently reported in the literature. The proposed methodology is then extended to Linear Quadratic (LQ) and Linear Quadratic Gaussian (LQG) regulators. Examples given include comparison with an aircraft control problem previously analyzed. Author

N85-28708*# National Aeronautics and Space Administration, Washington, D. C.

ADDING COMPUTATIONALLY EFFICIENT REALISM TO MONTE CARLO TURBULENCE SIMULATION

C. W. CAMPBELL May 1985 21 p refs
(NASA-TP-2469; M-485; NAS 1.60:2469) Avail: NTIS HC A02/MF A01 CSCL 12B

Frequently in aerospace vehicle flight simulation, random turbulence is generated using the assumption that the craft is small compared to the length scales of turbulence The turbulence is presumed to vary only along the flight path of the vehicle but not across the vehicle span. The addition of the realism of three-dimensionality is a worthy goal, but any such attempt will not gain acceptance in the simulator community unless it is computationally efficient. A concept for adding three-dimensional realism with a minimum of computational complexity is presented. The concept involves the use of close rational approximations to irrational spectra and cross-spectra so that systems of stable, explicit difference equations can be used to generate the turbulence. Author

N85-28712# National Aerospace Lab., Amsterdam (Netherlands).

OPERATIONS RESEARCH

1983 15 p In DUTCH; ENGLISH summary Sponsored by Netherlands Agency of Aerospace Programs
(B8561897) Avail: NTIS HC A02/MF A01

Research projects were carried out to improve the effectiveness and safety of civil and military aircraft operations Quantitative methods such as (computer) simulations (either on a deterministic or statistical basis), network planning, and linear programming are used. Intercontinental and continental civil aircraft traffic; air traffic in the vicinity of airports; and ground traffic at airports are discussed. Military flight path measurements, low level and ground attack missions, and electronic countermeasures are discussed. Author (ESA)

N85-29099# Joint Publications Research Service, Arlington, Va

MBB EXPANDS CADAM SYSTEM FOR A 320 PROGRAM

In its West Europe Rept.: Sci. and Technol. (JPRS-WST-84-032) p 23-24 25 Sep. 1984 Transl. into ENGLISH from Flug Rev. (Stuttgart), Aug. 1984 p 82-83
Avail: NTIS HC A03/MF A01

The use of computers in aircraft design in West Germany is discussed Monitor screens are used extensively in computer aided design or the European Airbus. Time gain in drafting and drafting modifications is an important feature. E.R.

N85-29686*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EXTRACTION OF AERODYNAMIC PARAMETERS FOR AIRCRAFT AT EXTREME FLIGHT CONDITIONS

K. W. ILIFF May 1985 24 p refs Presented at the AGARD Symp. on Unsteady Aerodyn. Fundamentals and Appl. to Aircraft Dyn., Goettingen, West Germany, 6-9 May 1985
(NASA-TM-86730; H-1290; NAS 1.15:86730; AGARD-PAPER-24) Avail: NTIS HC A02/MF A01 CSCL 12B

The maximum likelihood estimator has been used to extract stability and control derivatives from flight data for many years. Most of the literature on aircraft estimation concentrates on new developments and applications, assuming familiarity with basic concepts. This paper briefly discusses the maximum likelihood estimator and the aircraft equations of motion that the estimator uses. The current strength and limitations associated with obtaining flight-determined aerodynamic coefficients in extreme flight conditions is assessed. The importance of the careful combining of wind tunnel results (or calculations) and flight results and the thorough evaluation of the mathematical model is emphasized The basic concepts of minimization and estimation are examined for a simple computed aircraft example, and the cost functions that are to be minimized during estimation are defined and discussed. Graphic representations of the cost functions are given to help illustrate the minimization process. Finally, the basic concepts are generalized, and estimation of stability and control derivatives from flight data is discussed. 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.

A85-37209#

INTERACTION BETWEEN ACOUSTICS AND SUBSONIC DUCTED FLOW IN A RAMJET CONFIGURATION

E. GUTMARK (Southern California, University, Los Angeles, CA) and K. C. SCHADOW (U.S Navy, Naval Weapons Center, China Lake, CA) IN: Israel Annual Conference on Aviation and Astronautics, 26th, Haifa, Israel, February 8, 9, 1984, Collection of Papers . Haifa, Israel, Technion - Israel Institute of Technology, 1984, p. 289-296. refs

A subsonic ducted air flow was studied experimentally using a hot-wire anemometer and a high frequency response pressure transducer. The experiments were performed in three stages. A free jet, a jet discharged into an open and closed duct and a forced jet in a closed duct. The shear layer instability frequencies associated with the initial vortex shedding, first vortex merging, and jet-column instability were identified in the unforced cases. Subsequently, the interaction of the jet flow with the first longitudinal pressure mode excited in the acoustic cavity was studied. The highest response of the jet flow to the acoustic wave was obtained when the forcing frequency matched the local most amplified frequency, for example, the first vortex merging frequency in the initial shear layer or the preferred jet frequency at the end of the potential core. Author

A85-37583#

AN IMPROVED PROCEDURE FOR CALCULATING THE AEROTHERMODYNAMIC PROPERTIES OF A VITIATED AIR TEST MEDIUM

E. S. POWELL (Calspan Corp., Arnold Air Force Station, TN) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 20th, Williamsburg, VA, June 19-21, 1985. 12 p. refs
(AIAA PAPER 85-0913)

The work reported is the development of an analytic procedure for the prediction of the aerothermodynamic properties of a test medium composed of the products of combustion of a hydrocarbon in air. The analytic forms chosen to represent the properties are based on results from statistical thermodynamics. The parameters in the analytic forms are evaluated using a generalized least-squares technique. The major steps in the development of the procedure are discussed The results are shown to be accurate in comparison to the best available data base, internally consistent, and acceptable for modest extrapolations. The numerical results are specific to one facility, but the approach is applicable to any similar facility. Application of the procedure developed will allow aerodynamic data obtained in a vitiated air test medium to be analyzed with confidence. Author

A85-37898* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

POWER SPECTRAL DENSITY OF SUBSONIC JET NOISE

K. B M. Q. ZAMAN and J. C. YU (NASA, Langley Research Center, Hampton, VA) Journal of Sound and Vibration (ISSN 0022-460X), vol. 98, Feb. 22, 1985, p. 519-537. refs

The power-spectrum density (PSD) of the far-field noise of a subsonic unheated axisymmetric jet is investigated by analysis of about 80 sets of published noise spectra and of spectra obtained using 12.7 and 25.4-mm-diameter compressed-air jets at exit velocities 66 and 104 m/s and 67 and 91 m/s, respectively, in the NASA Langley anechoic flow facility. The results are presented in tables and graphs and characterized in detail. Findings reported include Strouhal-number scaling of the PSD at theta = 30 deg or more, scaling with the product of the Helmholtz number and the Doppler factor at theta less than 30 deg, best collapse at source convection Mach number 0.5, variation of PSD amplitude as U to the 6.5th at theta = 90 deg, and no sharp PSD-amplitude variation at any critical Reynolds number. T.K.

A85-38432
AERODYNAMIC SOUND GENERATION CAUSED BY VISCOUS PROCESSES
F OBERMEIER (Max-Planck-Institut fuer Stroemungsforschung, Gottingen, West Germany) Journal of Sound and Vibration (ISSN 0022-460X), vol. 99, March 8, 1985, p. 111-120. refs

A theoretical investigation of the effects of viscosity on aerodynamic sound generation by unheated low Mach-number flow is discussed. By means of the method of matched asymptotic expansions, which allows for a consistent estimation of the order of magnitude of each term in the hydrodynamic flow field as well as in the sound field, an analytical solution in terms of a multipole expansion is derived. The physical interpretation of the mathematical outcome of various theories by Morfey (1976), Kempton (1976), Hardin, and Kambe and Minota (1983) is compared and re-examined. M.D.

A85-39220#
NOISE OF COUNTER-ROTATION PROPELLERS
D. B. HANSON (United Technologies Corp., Aircraft Systems Dept., Windsor Locks, CT) Journal of Aircraft (ISSN 0021-8669), vol. 22, July 1985, p. 609-617. Previously cited in issue 01, p 73, Accession no. A85-10856 refs

A85-39349
THE BATTLE AGAINST NOISE IN INDUSTRY [BOR'BA S SHUMOM NA PROIZVODSTVE]
E. IA. IUDIN, ED. Moscow, Izdatel'stvo Mashinostroenie, 1985, 400 p. In Russian. No individual items are abstracted in this volume.

The physiological effects of noise in manufacturing plants and other industrial facilities are discussed, and several common noise abatement methods are described. Consideration is given to the acoustic properties of three types of noise which are present in industrial plants: aerohydrodynamic noise; mechanical noise; and electromagnetic noise. Among the specific noise abatement techniques discussed are: sound isolation by means of noise-absorbant screens, insulation or noise-emitting media; and acoustic interference The use of earplugs and external ear protectors for protection of individual workers in noisy work environments is also considered. I.H.

N85-28784 Department of the Air Force, Washington, D.C.
OPTICAL SYSTEM FOR MEASURING SHADOWGRAPH DATA Patent
E. O COLE and V. H. YETERIAN, inventors (to Air Force) 19 Feb. 1985 11 p Supersedes AD-D009952
(AD-D011642; US-PATENT-4,500,206,
US-PATENT-APPL-SN-434671; US-PATENT-CLASS-356-376)
Avail: US Patent and Trademark Office CSCL 17H

An optical system for measuring azimuth and elevation angular data for making a shadowgraph of an object under study is discussed. The system includes a pair of scaled assemblies which are secured together perpendicular to each other, with each of the scaled assemblies having degree markings thereon. An object under study, such as a scale model of an aircraft, is positioned within an imaginary sphere formed by the two scaled assemblies Azimuth and elevation angular measurements are then obtained by the use of laser systems as the model aircraft is rotated within the imaginary sphere of the ring assemblies. GRA

N85-28916# Loughborough Univ of Technology (England).
ROTORCRAFT NOISE
J. B. OLLERHEAD *In* AGARD Helicopter Aeromech. 38 p Apr. 1985 refs
Avail: NTIS HC A15/MF A01

The mechanisms of rotor noise generation are reviewed including methods for noise prediction and low noise design. Attention is focussed on the subjective effects of helicopter noise and the consequent requirements for statutory noise regulation. The economic and operational implications are discussed. G L.C.

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.

A85-37950#
COSTS AND TARIFF LEVIES IN AIR TRANSPORTATION [COSTES Y TARIFACION EN EL TRANSPORTE AEREO]
R. MONTERO MORENO (Iberia Lineas Aereas de Espana, Madrid, Spain) IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Feb. 1985, p. 27-33. In Spanish.

An evaluation is made of the factors which uniquely enter into the assessment of commercial air transportation tariff rates by regulatory bodies. Attention is given to such measures of commercial productivity as seats/route, seats/km, and yield and load factors. A brief historical account is given of the evolution of aeronautical tariffs, and a comparative account is given of the international and national tariff practices currently encountered; the latter are with reference to Spain. O C.

A85-39369
AIR TRANSPORT DEREGULATION - THE US EXPERIENCE AND ITS APPLICABILITY TO EUROPE
I. M. STELZER (National Economic Research Associates, Inc, England) (Institute of Air Transport, Symposium, Paris, France, May 1984) Aerospace (UK) (ISSN 0305-0831), vol. 12, June-July 1985, p. 18-22. refs

An assessment is conducted for the thesis that 'American-style deregulation', involving free market entry and competitively determined fare structures, can as successfully be applied to Europe as it has been to the U.S In addition to evaluating the fare reductions effected by U.S. deregulatory experience, attention is given to deregulation's effect on quality and variety of services, operating costs and efficiencies, profitability, and safety. The benefits derived to date from partial deregulation measures by the British and Dutch, and the prospects for European Economic Community acceptance of a deregulatory program, are discussed. O.C.

N85-28871# National Aerospace Lab., Amsterdam (Netherlands).
TECHNICAL SERVICES AT NLR
1983 19 p refs
(B8561898) Avail: NTIS HC A02/MF A01

The organization and activities of the technical design department, technical projects department, and workshops of the Netherlands National Aerospace Laboratory are outlined. Author (ESA)

N85-29838# Air Force Logistics Management Center, Gunter AFS, Ala.
AUTOMATED MAINTENANCE SYSTEM TEST PROGRAM INCREMENT VI PRODUCTION SCHEDULING Final Evaluation Report
L. J. CHAMBERS Oct. 1984 45 p
(AD-A153694; AD-F630669; AFLMC-LM760720) Avail. NTIS HC A03/MF A01 CSCL 05I

The purpose of this report is to document evaluation results of automated production scheduling processes within the Automated Maintenance System (AMS). The processes were developed and tested at Dover AFB, Delaware. Maintenance management functions affected by AMS Increment includes scheduling and tracking of reparable parts and items requiring calibration. Workcenters affected at the time of the appraisal included all Avionics Maintenance shops, the Avionics Reparable Processing Center (RPC), and the Field Maintenance Environmental Systems Shop. This report contains the evaluation methodology, findings and recommendations for future program development. GRA

N85-29839# Air Force Logistics Management Center, Gunter AFS, Ala.
DEPLOYABLE CORE AUTOMATED MAINTENANCE SYSTEM (DCAMS)
D. M. CRIPPEN, S. E. ALTEN, and J. K. SHAW Aug. 1984 17 p
(AD-A153695; AD-F630671; AFLMC-LM831215) Avail: NTIS HC A02/MF A01 CSCL 15E

We examined hardware requirements for development of a Deployable Core Automated Maintenance System (DCAMS). Our six alternatives covered the spectrum from a mainframe computer, the Tactical Shelter System, to the Air Force standard microcomputer, Zenith Z-100. Criteria used for the evaluation looked at ease of maintenance, survivability, physical characteristics, transportability, and compatibility with CAMS We recommend using a microcomputer network to best satisfy the hardware requirement for DCAMS. Since DCAMS is not funded, we also recommend an interim system be developed by the AFLMC to provide limited support until DCAMS is ready. The system would be developed on the AF standard microcomputer and provide engine tracking, scheduled maintenance requirements, and aircraft status information. GRA

N85-29841# Naval Postgraduate School, Monterey, Calif.
USING INCENTIVES TO IMPROVE MAINTAINABILITY M.S. Thesis
L. FARNEN, JR. Dec. 1984 93 p
(AD-A153792) Avail: NTIS HC A05/MF A01 CSCL 05A

The objective of this thesis was to determine if contract incentives were appropriate for use in Dept. of Defense contracts for the purpose of motivating defense contractors to improve the maintainability of weapon systems under design. To accomplish the objective it was necessary to review the components of maintainability to determine appropriate targets for the incentives and to study the concepts and issues involved in the use of incentives to motivate contractor performance The conclusions were based in part of the responses obtained during interviews conducted with Government representatives and engineering, contracting, and corporate and program management personnel from the defense industry. In addition, the incentive program in the case of the F/A-18 aircraft was reviewed and analyzed to determine the reason for its success. GRA

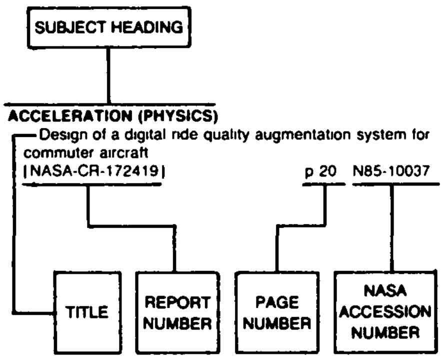
N85-29844# Politecnico di Torino (Italy). Dept. of Aerospace Engineering.
ACTIVITIES OF THE DEPARTMENT OF AEROSPACE ENGINEERING Annual Report, 1983
Apr. 1984 39 p refs
Avail: NTIS HC A03/MF A01

Research in aeronautics and astronautics; fluid dynamics and propulsion; structures and materials; and systems engineering and management is summarized. Wind tunnel tests on commercial aricraft models, incompressible, transonic, and supersonic flow tests; laser interactions, biomedical fluid dynamics; advanced composite aircraft structures; and aircraft instrumentation are discussed. Author (ESA)

SUBJECT INDEX

SUBJECT

Typical Subject Index Listing



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T

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X

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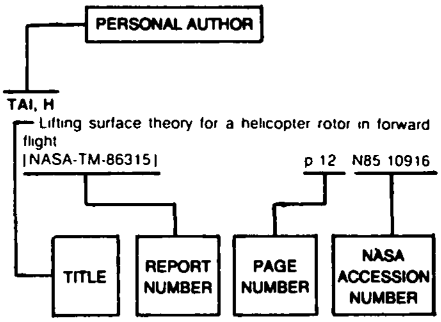

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A

B

N

O

P

Q

R

X

Y

Z

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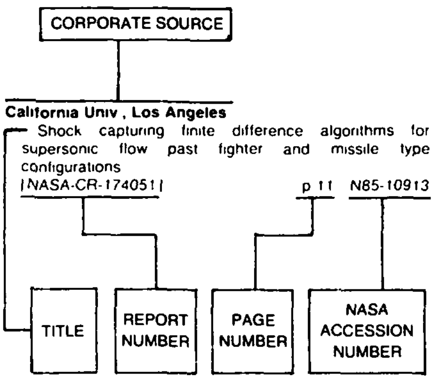

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A

B

C

D

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AERONAUTICAL ENGINEERING / *A Continuing Bibliography (Supplement 192)* OCTOBER 1985

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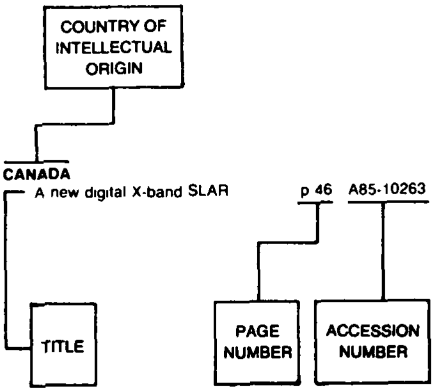

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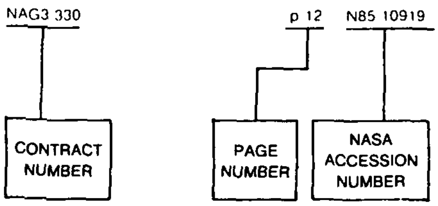

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CONTRACT

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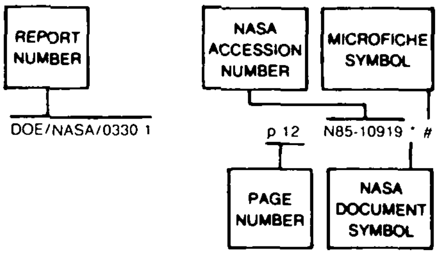

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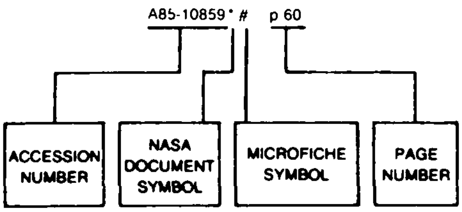

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7. Author(s)

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15. Supplementary Notes

16. Abstract

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