NASA

Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037(182)
January 1985

National Aeronautics and Space Administration

SPECIAL NOTICE ENCLOSED
NEW FOREIGN TECHNOLOGY INDEX INCLUDED IN THIS ISSUE

Aeronautical Engineering
A Continuing Bibliography with Indexes

Pages 947-1017

January 1985

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ACCESSION NUMBER RANGES

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

STAR (N-10000 Series)	N84-46526 - N84-49697
IAA (A-10000 Series)	A84-33366 - A84-35284

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SPECIAL NOTICE

FOREIGN TECHNOLOGY INDEX IN THIS ISSUE

Documents referred to in this bibliography whose country of intellectual origin is other than the United States are listed in the Foreign Technology Index (see page D-1).

A great deal of excellent scientific and technical work is done throughout the world. To the extent that U.S. researchers, engineers, and industry can utilize what is done in foreign countries, we save our resources. We can thus increase our country's productivity.

We are testing out this approach by helping readers bring foreign technology into focus. We would like to know whether it is useful, and how it might be improved.

Check below, tear out, fold, staple, and return this sheet.

Foreign Technology Index:

- ☐ Isn't useful, so should be discontinued.
- ☐ Is useful, but other sources can be used.
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NASA SP-7037(182)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 182)

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

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

NASA Scientific and Technical Information Branch 1985
National Aeronautics and Space Administration
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INTRODUCTION

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

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 475 reports, journal articles, and other documents originally announced in December 1984 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

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

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

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

An annual cumulative index will be published.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies of accessions are available at $8.50 per document. Microfiche[1] of documents announced in *IAA* are available at the rate of $4.00 per microfiche on demand. Standing order microfiche are available at the rate of $1.45 per microfiche for *IAA* source documents.

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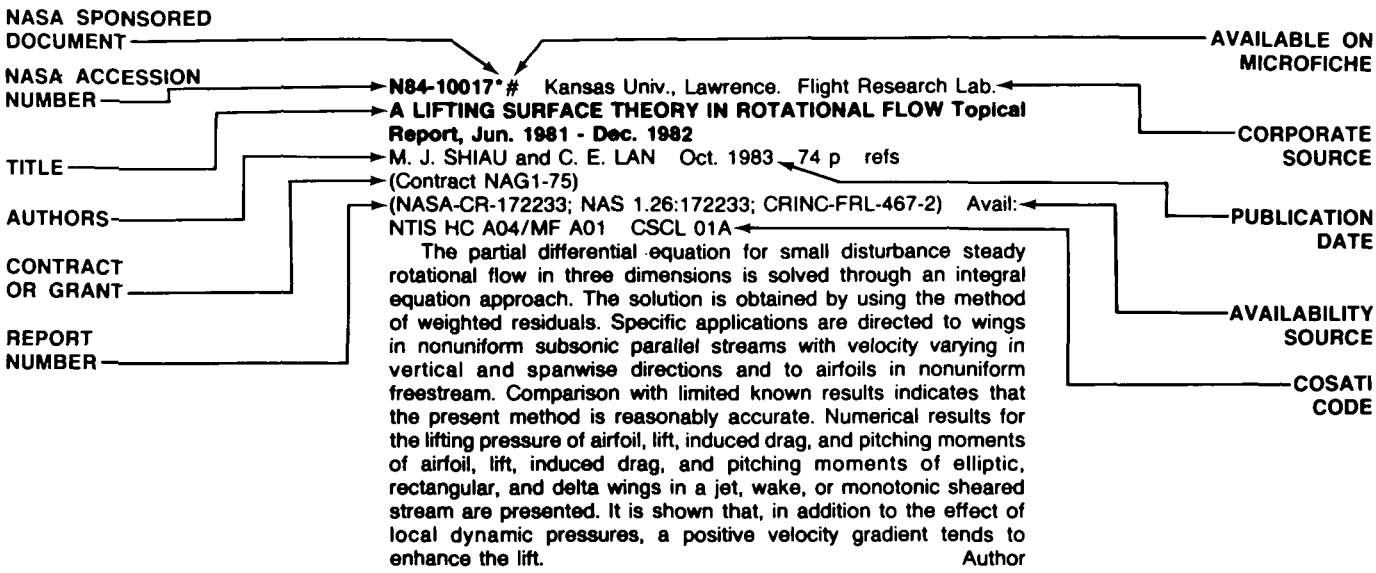

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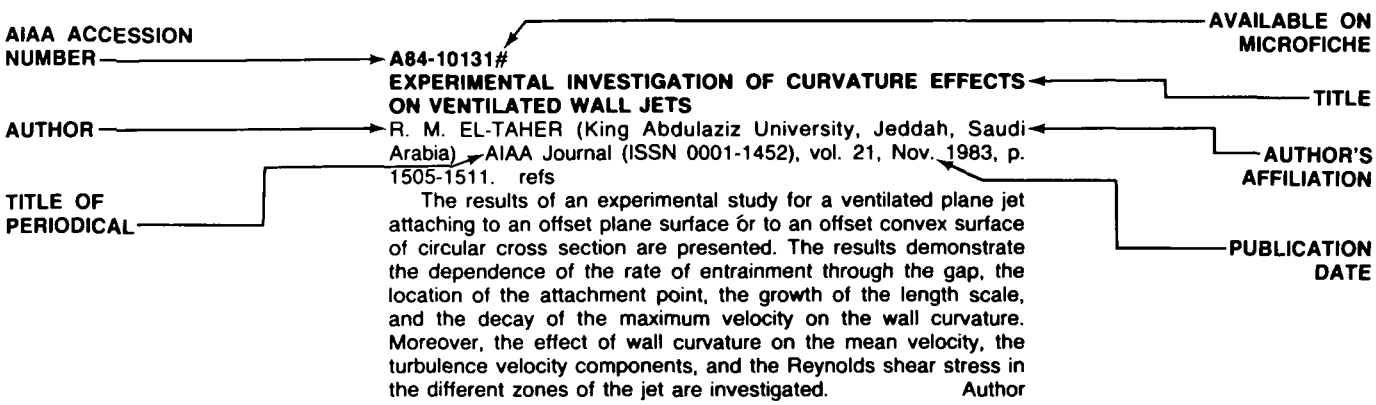

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 182)

JANUARY 1985

01

AERONAUTICS (GENERAL)

A84-46582
AIRLINE MAINTENANCE MANAGEMENT SYSTEM (AMMS)
Y. Y. CHIA (Northrop University, Inglewood, CA) IN: Simulation and modelling; Proceedings of the Eighth International Symposium, Orlando, FL, November 9-11, 1983 . Anaheim, CA and Calgary, Canada, Acta Press, 1984, p. 173-176. Research sponsored by Northrop University.

The Airline Maintenance Management System (AMMS) is a user-friendly interactive computer simulation management game offering a system-wide perspective on airline maintenance operations at the management level, and is intended to serve as an educational tool in airline maintenance managers' training for planning, organization, coordination, and operations control functions. Scheduled aircraft are described by the AMMS model as transactions which undergo maintenance on the basis of an individual aircraft maintenance schedule. O.C.

A84-46807#
AIRCRAFT DESIGN IN CANADA FROM SILVER DART TO CHALLENGER AND DASH 8
R. D. HISCOCKS (Canadian Aeronautics and Space Institute, Annual General Meeting, 31st, Ottawa, Canada, May 28, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, June 1984, p. 99-113. refs

An historical account is given of Canadian contributions to the design and development of aircraft, their powerplants, and critical components, from Turnbull's variable pitch propeller of the World War I period and the Silver Dart biplane of 1909 to the PT6 gas turbine engine and Dash 8 commuter airliner. Noteworthy aircraft development programs were the delta planform 'Arrow' supersonic fighter of 1958, of which five prototypes were built, and the CL-184 'tilt wing' VTOL experimental aircraft. O.C.

A84-46848
FLIGHT AND MECHANICAL VIBRATIONS [POLET I MEKHANICHESKIE KOLEBANIIA]
A. A. BORIN Priroda (ISSN 0032-874X), July 1984, p. 69-77. In Russian. refs

Periodic motions of the wings of natural and artificial flight bodies are examined, and the mechanisms underlying such motions are considered. Particular attention is given to the flight characteristics of birds and insects, vibrations in artificial flight bodies and the problem of flutter, flutter suppression techniques, and the question of whether periodic vibrations can be used to improve the aerodynamic characteristics of wings. L.M.

A84-47271#
HUMAN-POWERED FLIGHT
Mechanical Engineering (ISSN 0025-6501), vol. 106, Sept. 1984, p. 46-55. refs

The history of human powered flight from 3500 B.C. to the present is reviewed. Consideration is given to the evolution of design configurations, materials and propulsion concepts which have made possible the sustained flight of such aircraft as the Gossamer Albatross, Gossamer Condor, the Monarch and the Bat. Particular attention is given to the use of composite materials, Kevlar, and aluminum alloys to lighten and to stiffen airframes in order to take maximum advantage of aerodynamic capabilities of human powered aircraft. A table is provided which lists the design characteristics of the most important human powered aircraft of the last 25 years. I.H.

A84-47375
SIMULATION IN CIVIL-AVIATION PLANNING [MODELIROVANIE V PLANIROVANII GRAZHDANSKOI AVIATSII]
V. G. PINAEV, R. V. SAKACH, E. F. KOSICHENKO, and G. N. GLADYSHEVSKAIA Moscow, Izdatel'stvo Transport, 1983, 176 p. In Russian. refs

The process of planning for civil aviation is considered as a complex of interacting problems, the majority of which can be treated by mathematical formulations. Attention is given to basic economic and mathematical problems connected with forecasting, optimization of resources, simulation, and the acceptability of solutions derived from models and algorithms which are formulated to apply to civil aviation. V.L.

A84-47788
EVALUATION OF THE ENERGY EFFICIENCY OF BIRD FLIGHT [K OTSENKE ENERGETICHESKOGO SOVERSHENSTVA LETATEL'NOGO APPARATA PTITS]
A. A. BORIN and N. V. KOKSHAISKII (Akadkemiia Nauk SSSR, Institut Evolutsionnoi Morfologii i Ekologii Zhivotnykh, Moscow, USSR) Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 277, no. 2, 1984, p. 489-493. In Russian. refs

The energy efficiency of bird flight is defined as a quantitative measure of the conversion of bird muscle energy into the work of flight. The energy efficiency of bird flight is compared with the flight performance of a number of aircraft (ranging from the human-propelled Gossamer Condor to turbojet aircraft), and it is concluded that birds do not have any extraordinary advantages over aircraft with respect to energy efficiency. B.J.

A84-48250
SEA EAGLE
J. T. CAST (BBG - Bodenseewerk Geraetetechnik/British Aerospace GmbH, Ueberlingen, West Germany) Aerospace (UK) (ISSN 0530-0831), vol. 12, Sept. 1984, p. 5-11.

Some aspects of the British Sea Eagle antiship missile program are discussed. The missile is intended to come into service with British forces in the mid-eighties. The need for the missile and its general configuration are summarized, and its seeker, control, and propulsion are described. The results of the qualification, testing, and trial processes are addressed, and contract arrangements are discussed. C.D.

A84-48516
POWER FOR THE ATF - GE AND P&W PREPARE FOR BATTLE
P. TURK Interavia (ISSN 0020-5168), vol. 39, Sept. 1984, p. 895, 896.

The Advanced Tactical Fighter (ATF) engine program known as the Joint Advanced Fighter Engine (JAFE) is expected to encourage both Pratt and Whitney and General Electric in the development of advanced aerodynamics and materials, and in the design of more reliable, simpler engines with longer overhaul lives, lower maintenance manhours per flight hours, and reduced fuel consumption. Pratt and Whitney's PW5000 engine concept incorporates a two-dimensional vectored nozzle, a smaller number of compressor and turbine stages, advanced single-crystal blade designs, and possibly ceramic materials in seal areas. General Electric's GE37 is a more advanced aerodynamic concept variable cycle engine which would operate as a high bypass turbofan in subsonic flight, and pass more air through the turbine during supersonic flight. J.P.

A84-48518
DC IS GONE, BUT DOUGLAS IS BACK
B. SWEETMAN Interavia (ISSN 0020-5168), vol. 39, Sept. 1984, p. 915-917.

The conviction that the technology and design of the current MD-80 and DC-10 will still be competitive into the 1990s is the key to the Douglas Aircraft Company's planning. Financially, the planning rests on maintaining the success of the MD-80 into the late 1980s, well beyond the 300-aircraft target set when the program was launched in 1977. The aircraft, which is becoming the top-selling member of the whole DC-9 family, is of a size which has permitted a long-term increase in the production rate with several economic benefits. Greater weight, more thrust, and bigger brakes are all performance improvements which are being complemented by many minor improvements. Aircraft weight reduction from the redesign of components and the use of advanced composites is being implemented. Aerodynamic improvements including better sealing, and an extended tail cone may also contribute to greater performance. Other improvements include an advanced avionics system, and more powerful and more efficient engines. The expansion of the MD-80 family through the MD-87, and the aircraft's targets in the airline industry are discussed. Plans for an updated version of the DC-10, the MD-XXX, are also discussed, and concepts for a propfan-powered airliner are described. J.P.

A84-49390
CANADA BOOSTS RPV AND DRONE INVESTMENT
A. B. MARKOV and T. E. OLLEVIER (Defence Research Establishment Suffield, Ralston, Alberta, Canada) Defense Systems Review and Military Communications, vol. 2, Sept. 1984, p. 63-68. refs

A Canadian R&D program for the selection, development, and deployment of remotely piloted vehicles (RPVs) and drones for both land and sea combat and flight testing is discussed. Consideration is given to a number of different RTV and drone systems. Among these systems are: A low-drag radar target to be deployed from T-33 aircraft; a Tactical Aerial Target System (TATS) for small arms fire exercises; a missile distance scoring technique (BLOWPIPE); and a family of rocket boosted (ROBOT) targets for antiship missile simulation, sea-skimming target simulation, or as a look-down target for aircraft gunnery exercises. Consideration is also given to an unmanned portable control system (VEGA) and a robot telemetry system for flight test evaluation. The important design features of these systems are described in a series of photographs. I.H.

N84-33367# Societe Nationale Industrielle Aerospatiale, Paris (France). Div. Helicopteres.
CONTRIBUTION OF THE INDUSTRY TO A BETTER ADAPTATION OF HELICOPTERS TO MILITARY REQUIREMENTS [BEITRAG DER INDUSTRIE ZUR BESSEREN ANPASSUNG DES HUBSCHRAUBERS AN MILITARISCHE FORDERUNGEN]
G. PETIT 1984 23 p In GERMAN
(SNIAS-841-210-102) Avail: NTIS HC A02/MF A01

A method to determine the importance of helicopter specification parameters is explained. The problem of helicopter ability to survive in a modern fighting zone and the related consequences on the definition of a weapons systems are treated. The necessity to treat helicopters and accessories as a single integrated weapon system is explained. Author (ESA)

N84-33368# Joint Publications Research Service, Arlington, Va.
USSR REPORT: TRANSPORTATION
18 Sep. 1984 87 p refs Transl. into ENGLISH from various Russian articles
(JPRS-UTR-84-026) Avail: NTIS HC A05/MF A01

Various facets of transportation in the U.S.S.R. are discussed, including civil aviation, motor vehicles and highways, rail transportation, maritime and river shipping, fishing fleet development, and ports.

N84-33369# Joint Publications Research Service, Arlington, Va.
CIVIL AVIATION OFFICIALS REVIEW MINISTERIAL CONCERNS, GOALS
B. PANYUKOV *In its* USSR Rept.: Transportation (MPRS-UTR-84-026) p 1-10 18 Sep. 1984 Transl. into ENGLISH of Vozdushnyy Transport (Moscow), 24 Jul. 1984 p 1-2
Avail: NTIS HC A05/MF A01

Excerpts from a meeting of the Soviet Ministry of Civil Aviation are presented. The further development of civil aviation in 1985, 1986 to 1990, and the period up to 2000 was discussed. Aircraft production efficiency, air crew training, the IL-86 fleet of aircraft, and Soviet economic and social factors relating to aviation were mentioned. R.S.F.

N84-34394# Bundesanstalt fuer Flugsicherung, Frankfurt am Main (West Germany).
NOTICE FOR AIRMEN, PART 2. INDEX OF APPROVED MANUFACTURING OPERATIONS FOR AERONAUTICAL APPLIANCES ACCORDING TO PARAGRAPH 18 OF TEST PROCEDURES FOR AERONAUTICAL APPLIANCES [NACHRICHTEN FUER LUFTFAHRER, TEIL 2. VERZEICHNIS DER NACH ABSATZ 18 DER PRUEFORDNUNG FUER LUFTFAHRTGERAET (LUFTGERPO) ANERKANNTEN HERSTELLERBETRIEBE VON LUFTFAHRTGERAET]
25 May 1984 7 p refs In GERMAN
(NFL-II-38/84) Avail: NTIS HC A02/MF A01

An updated summary of approved manufacturing operations for aeronautical appliances as of 31 Dec. 1983 is presented. Author (ESA)

N84-34395# Bundesanstalt fuer Flugsicherung, Frankfurt am Main (West Germany).
NOTICE FOR AIRMEN, PART 2. INDEX OF APPROVED AERONAUTICAL ENGINEERING OPERATIONS AND OF INDEPENDENT INSPECTORS ACCORDING TO PARAGRAPH 33 OF TEST PROCEDURES FOR AERONAUTICAL APPLIANCES [NACHRICHTEN FUER LUFTFAHRER, TEIL 2. VERZEICHNIS DER NACH 33 ABSATZ DER PRUEFORDNUNG FUER LUFTFAHRTGERAET ANERKANNTEN LUFTFAHRTTECHNISCHEN BETRIEBE UND DER SELBSTAENDIGEN PRUEFER VON LUFTFAHRTGERAET]
24 May 1984 46 p refs In GERMAN
(NFL-II-39/84) Avail: NTIS HC A03/MF A01

An updated summary of approved aeronautical engineering operations and of independent inspectors as of 31 Dec. 1983 is given. Author (ESA)

N84-34396# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
FLIGHT TEST TECHNIQUES
Loughton, England Jul. 1984 367 p refs In ENGLISH and FRENCH Conf. held in Lisbon, 2-5 Apr. 1984
(AGARD-CP-373; ISBN-92-835-0359-7) Avail: NTIS HC A16/MF A01

Flight testing techniques that evaluate flight control characteristics, aerodynamic characteristics, and avionics/weapons systems are presented. The analyses cover topics such as lift and drag quantification, autopilot and navigation equipment tests, external stores flight testing, and weapons system testing and integration.

N84-34422# Joint Publications Research Service, Arlington, Va.
USSR REPORT: TRANSPORTATION
24 Sep. 1984 68 p Transl. into ENGLISH from various Russian articles
(JPRS-UTR-84-027) Avail: NTIS HC A04

Research and progress in Soviet transportation systems are reported. Topics discussed include: civil aviation, maritime and river fleets, and ports and transshipment centers.

N84-34423# Joint Publications Research Service, Arlington, Va.
ARSSR CIVIL AVIATION CHIEF ON AERFLOT'S WORK IN ARMENIA
In its USSR Rept.: Transp. (JPRS-UTR-84-027) p 1-4 24 Sep. 1984 Transl. into ENGLISH from Grazhdanskaya Aviats. (Moscow), no. 7, Jul. 1984 p 15-16
Avail: NTIS HC A04

Civil aviation in the Soviet Union was discussed. Development and construction of airports, the replacement of older model aircrafts for updated models on local air routes is outlined. Runway design and preparation for modern aircrafts and the development of local routes are examined. Progress in the different areas of civil aviation is reported. E.A.K.

N84-34424# Joint Publications Research Service, Arlington, Va.
MORE USE OF HELICOPTERS IN CONSTRUCTION WORK URGED
A. CHERNITSKIY *In its* USSR Rept.: Transp. (JPRS-UTR-84-027) p 5-7 24 Sep. 1984 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 12 Jun. 1984 p 2
Avail: NTIS HC A04

The high effectiveness of helicopter assembly work was described. It is indicated that with good organization and work preparation cost can be reduced, labor intensiveness and construction duration, and the ahead of schedule start up of projects provide an overall national economic effect which greatly surpasses the expenses of helicopter uses. E.A.K.

N84-34425# Joint Publications Research Service, Arlington, Va.
IMPROVEMENTS IN WORK OF AIRCRAFT REPAIR PLANT NO. 402
I. VOLKOV *In its* USSR Rept.: Transp. (JPRS-UTR-84-027) p 8-10 24 Sep. 1984 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 12 Jun. 1984 p 2
Avail: NTIS HC A04

Working conditions and accomplishments in an aircraft repair plant are discussed. Production effectiveness and work quality in the repair of engines for aircraft, cargo liners, and helicopters are outlined. Increasing labor productivity is emphasized. E.A.K.

02

AERODYNAMICS

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

A84-46763#
FUNDAMENTAL STUDIES ON VORTEX FLOWS
J. DELERY, E. HOROWITZ, O. LEUCHTER, and J.-L. SOLIGNAC (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 2, 1984, p. 1-24. Research supported by the Direction des Recherches, Etudes et Techniques. refs

Subsonic and supersonic flows are investigated in a study concerning vortex flows subjected to the destabilizing effect of an adverse pressure gradient. For the subsonic condition, two modes of vortex generation are considered: a vortex created by the rolling up of two vertical sheets coming from the trailing edge of two vanes mounted on a cylindrical string, and a vortex which is produced by a delta wing with an angle of attack. During supersonic flow tests, much attention is focused on the interaction between a normal shock wave and vortex whose streamwise axis is perpendicular to the shock. The data obtained on flows in subsonic and supersonic conditions, through the use of conventional pressure probes and two-color laser velocimetry, gives a description of the vortex's mean and turbulent properties which evolve toward breakdown. In both subsonic and supersonic tests, a limit on the vortex breakdown could be defined experimentally as a function of parameters measuring the intensity of the destabilizing pressure gradient, and the vortex strength. For the shock wave/vortex interaction, this limit can be predicted through the use of a no-flow model in which the Euler equations are solved by a time-marching method. J.P.

A84-46767#
FIRST CRYOGENIC TESTS OF AN AIRFOIL IN ONERA/CERT T2 WIND TUNNEL
R. MICHEL and A. MIGNOSI (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 2, 1984, p. 69-71.

The adaptation of the transonic T2 induction-driven wind tunnel at an ONERA research center for operation at low temperatures has required internal thermal insulation through the entire circuit; and to cool the flow, a liquid nitrogen injection device has been installed. Before entering the operational phase of studies on models in cryogenic flow, the cryogenic operation of the wind tunnel was maximized through the study of the establishment and stabilization of temperature, the qualification of flow qualities, and the preparation of a preliminary operation to cool the models. Currents studies involve tests of a CAST 7 airfoil subjected to different pressures and temperatures, and the determination of its aerodynamic characteristics through a range of Reynolds numbers. Two aspects are presented for the test technique: use of a gaseous nitrogen cooling device, and the use of adpative walls which are formed to simulate boundary conditions very close to those of an infinite flow field. An initial cryogenic test program has been run on the CAST 7 airfoil, some results used to confirm temperature test validity conditions are presented, and a definition of the coefficient of lift variation with the Reynolds number is obtained. J.P.

A84-46850
QUASI-THREE-DIMENSIONAL FLOW OF A GAS IN THE BLADE RING OF A TURBOMACHINE [KVAZITREKHMERNOE TECHENIE GAZA V LOPATOCHNOM VENTSE TURBOMASHINY]
A. B. BOGOD, IU. I. KIMASOV, B. I. KURMANOV, and G. L. PODVIDZ Akademiia Nauk SSSR, Izvestiia, Energetika i Transport (ISSN 0002-3310), May-June 1984, p. 145-150. In Russian. refs

The paper is concerned with steady quasi-three-dimensional flow of a nonviscous non-heat-conducting gas in the rotor and nozzle blade rings of axial-flow turbines with arbitrary hot-flow path and blade geometry. A system of equations describing the quasi-three-dimensional flow and boundary conditions are presented. The flow is calculated using Godunov's finite difference scheme, which makes it possible to analyze flows at sub-, trans-, and supersonic velocities. V.L.

A84-46878#
THE INVERSE DESIGN OF INTERNALLY COOLED TURBINE BLADES
S. R. KENNON and G. S. DULIKRAVICH (Texas, University, Austin, TX) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 4 p. Research supported by the University of Texas. refs
(ASME PAPER 84-GT-7)

The present inverse design and/or analysis method for interior coolant flow passages in internally cooled blade configurations has particular applicability to turbine blade design. It is possible to specify the temperature (or heat flux) distribution along the blade outer surface, together with the unknown, interior coolant/blade interface, by these means. The hollow blade wall thickness distribution is then found from the solution of Laplace's equation governing the temperature field within the blade's solid portion, while satisfying both (1) the boundary conditions of temperature and heat flux at the outer blade surface and (2) the specified temperature boundary condition on the evolving inner surface. Results are given for a simple, eccentric bore cross section and a realistic turbine cros section. O.C.

A84-46884#
EXPERIMENTAL STUDY OF THE FLOW FIELD BEHIND AN ANNULAR TURBINE NOZZLE GUIDE VANE WITH AND WITHOUT DOWNSTREAM ROTOR
E. BOLETIS and C. H. SIEVERDING (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-15)

An attempt is made to determine whether the measurement of the three-dimensional flow field in annular turbine nozzle guide vanes requires the installation of a rotor close behind a high hub-to-tip ratio cascade, in order to establish correct flow conditions at the cascase exit, or whether the use of an axial diffuser of a certain length is sufficient. Tests have been conducted on a low speed, low aspect ratio, high turning nozzle guide vane, exploring the flow by means of a double head, four-hole pressure probe. Results are presented in the form of contour plots and spanwise pitch-averaged distributions of losses, flow angles, and static pressure. O.C.

A84-46885#
COMPUTATION OF TRANSONIC FLOWS IN AND ABOUT TURBINE CASCADES WITH VISCOUS EFFECTS
U. K. SINGH (GEC Power Engineering, Ltd., Aerodynamics Mechanical Engineering Laboratory, Whetstone, Leics., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 5 p. Research sponsored by GEC Gas Turbines, Ltd., and Ruston Gas Turbines, Ltd. refs
(ASME PAPER 84-GT-18)

An inviscid-viscous interaction treatment has been developed to predict the flow through transonic axial turbine blade cascades. The treatment includes a trailing-edge base pressure model. This model is based on treating the area between the points of flow separation on the blade surfaces at the trailing-edge and the point of downstream confluence of the suction and pressure surface flows as a region of constant pressure. A time marching technique is used to calculate the inviscid flow and viscous flow is calculated by integral methods for laminar and turbulent boundary layers. Good agreement with experimental data has been obtained. Author

A84-46886#
NUMERICAL FLOW ANALYSIS OF FULLY THREE-DIMENSIONAL TURBINE CASCADES
M. KOYA (Ishikawajima-Harima Heavy Industries Co., Ltd., Advanced Engineering Dept., Tokyo, Japan) and S. KOTAKE (Tokyo, University, Tokyo, Japan) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-19)

In order to calculate higher subsonic or transonic flows in highly three-dimensionally twisted turbine blade cascades, the finite volume integral method of solving the governing equations is implemented for the treatment of boundary conditions and the discretization scheme. The developed scheme reduces the discretization error associated with the distorted grid configuration of highly three-dimensional blades. With the developed method, flows in three typical turbine blade cascades have been calculated. The present scheme can be applied to fully three-dimensional flow through complete turbine stages. Author

A84-46887#
DESIGN OF HIGHLY LOADED BLADE PROFILES USING AN ITERATIVE INVERSE-DIRECT COMPUTATIONAL PROCEDURE
H. MITON, H. SANKALE, and J. CHAUVIN (Aix-Maraseille II, Universite, Marseille, France) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 10 p. Research supported by the Direction des Recherches, Etudes et Techniques.
(ASME PAPER 84-GT-22)

The present transonic turbine blade design technique is based on a numerical approach that combines inverse and direct methods of flow calculation. The initial data required are the Mach vector distribution on a starting streamline and the distribution of one component of the velocity vector in the channel inlet and outlet planes. Satisfactory cascade geometries have been obtained for three cascade sections of a single, heavily loaded turbine. O.C.

A84-46888#
SOLUTION OF TRANSONIC S1 SURFACE FLOW BY SUCCESSIVELY REVERSING THE DIRECTION OF INTEGRATION OF THE STREAM FUNCTION EQUATION
Z. WANG (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-23)

In the solution of the stream function equation on an S1 relative stream surface with transonic velocities, the occurrence of two values of the density is avoided by using a method of combining

simple iteration with an integration method. In this method, the direction of integration is successively reversed, i.e., the starting line for the integration is varied from iteration to iteration. The governing equations are therefore satisfied as fully as possible during each iteration, and the procedure leads to rapid convergence. The method uses nonorthogonal curvilinear coordinates and artificial compressibility. The technique can be used to calculate transonic S1 surface flows, with either subsonic or supersonic inlet velocities. Example calculations indicate that the method is very effective. Author

A84-46889#
TRANSONIC CASCADE FLOW SOLVED BY SEPARATE SUPERSONIC AND SUBSONIC COMPUTATIONS WITH SHOCK FITTING
W. WU, C.-H. WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China), and D. YU (Beijing Industrial University; Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-24)

In the present method for the solution of the transonic flow past a plane cascade with inlet bow wave and a passage shock that extends from the leading edge all the way across the flow channel, different algorithms are respectively used for the supersonic and subsonic regions, and the aerothermodynamic relations of a connecting passage shock are satisfied. By means of Rankine-Hugoniot relations, the passage shock can be accurately determined, and a jump of aerothermodynamic quantities across the passage shock is obtained. All calculations are programmed and incorporated into a single code. Results for typical applications of the method indicate good agreement between numerical results and experimental data, including the location and shape of the passage shock wave. O.C.

A84-46891#
A QUASI-THREE-DIMENSIONAL TURBOMACHINERY BLADE DESIGN SYSTEM. I - THROUGHFLOW ANALYSIS
I. K. JENNIONS and P. STOW (Rolls-Royce, Ltd., Theoretical Science Group, Derby, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-26)

The quasi-three-dimensional turbomachine blade design and analysis system presented incorporates fully linked throughflow, blade-to-blade and blade section stacking programs. The throughflow analysis is based on a rigorous passage-averaging technique which derives the equations that area valid inside a blade row. Included in these equations are the effects of blade blockage, blade forces, blade-to-blade variations, and loss. The solution of the equations is developed for the streamline curvature method, and the contributions from these extra effects on the radial equilibrium equation are discussed. O.C.

A84-46892#
A QUASI-THREE-DIMENSIONAL TURBOMACHINERY BLADE DESIGN SYSTEM. II - COMPUTERIZED SYSTEM
I. K. JENNIONS and P. STOW (Rolls-Royce, Ltd., Theoretical Science Group, Derby, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p.
(ASME PAPER 84-GT-27)

A quasi-three-dimensional turbomachine blade design and analysis system is developed whose streamline curvature throughflow program incorporates (1) a previously developed analysis, (2) a blade section stacking program, and (3) one of a number of blade-to-blade calculation programs. Information is transferred between programs by way of a data base that enables heat transfer programs, etc, to access the results. This system is flexible enough to incorporate a number of blade-to-blade programs that can be chosen in light of a given application's unique demands. A turbine nozzle guide vane is used as an illustrative example, and experimental data are compared with results from the quasi-three-dimensional system, a fully three-dimensional program, and an unlinked two-dimensional system. O.C.

A84-46894#
COMPUTATION OF POTENTIAL FLOW ON S2 STREAM SURFACE FOR A TRANSONIC AXIAL-FLOW COMPRESSOR ROTOR
P.-M. LU and C.-H. WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-30)

A set of conservative full potential function equations governing the fluid flow along a given S2 stream surface in a transonic axial compressor rotor was obtained. By the use of artificial density and a potential function/density iteration, this set of equations can be solved, and the passage shock on the S2 stream surface can be captured. A computer program for this analysis problem has been developed and used to compute the flow field along a mean S2 stream surface in the DFVLR transonic axial compressor rotor. A comparison of computed results with DFVLR L2F measurement at 100 percent design speed shows fairly good agreement. Author

A84-46898#
A NUMERICAL STUDY OF THREE-DIMENSIONAL FLOW SEPARATION AND WAKE DEVELOPMENT IN AN AXIAL COMPRESSOR ROTOR
C. HAH (General Electric Co., Schenectady, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-34)

A computational procedure based on the compressible Reynolds-averaged Navier-Stokes equation has been developed for the viscous flow through an isolated compressor rotor. The numerical scheme is based on fully conservative control volume formulation and solves various conservation equations in fully elliptic form on the rotating coordinates fixed on the rotor. An algebraic Reynolds stress model is used to describe the turbulent transport terms. The numerical procedure has been applied to predict three-dimensional turbulent flows through two different isolated compressor rotors. The detailed quantitative comparisons with two sets of well-documented data show that the developed computational procedure predicts the viscous flow development over the blading and in the wake with the accuracy satisfactory for most engineering purposes; the computer code can be used for the guidance of advanced rotor design. Author

A84-46899#
ROTATING STALL CAUSED BY PRESSURE SURFACE FLOW SEPARATION ON CENTRIFUGAL FAN BLADES
S. MADHAVAN (Westinghouse Electric Corp., Hyde Park, MA) and T. WRIGHT (Westinghouse Fluid Systems Laboratory, West Lafayette, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-35)

In the phenomenon of rotating stall with massive flow separation on the pressure surface of a centrifugal fan blade, the stall cell rotates in the same sense as the impeller and the pressure pulsation frequency is greater than the running frequency. It is presently suggested that while the propagation mechanism involved is similar to that of the classical rotating stall due to flow separation on the suction surface, differences in causation between the two phenomena must be taken into account for the purposes of preventive treatment. Pressure surface stall has been induced through a prerotation of the inlet flow by means of inlet guide vanes, as well as the operation of the fan against low system resistance. Heuristic models are proposed for the inception and

propagation of pressure surface stall, and the models are compared with both flow field prediction computations and experimental results. O.C.

A84-46904#
AN INVISCID BLADE-TO-BLADE PREDICTION OF A WAKE-GENERATED UNSTEADY FLOW
H. P. HODSON (Cambridge University, Cambridge, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-43)

This paper describes a time-marching calculation of the unsteady flow generated by the interaction of upstream wakes with a moving blade row. The inviscid equations of motion are solved using a finite volume technique. Wake dissipation is modeled using an artificial viscosity. Predictions are presented for the rotor mid-span section of an axial turbine. Reasonable agreement is found between the predicted and measured unsteady blade surface static pressures and velocities. These and other results confirm that simple theories can be used to explain the phenomena of rotor-stator wake interactions. Author

A84-46911#
FURTHER DATA ON THE PERFORMANCE OF A RECTANGULAR DIFFUSER IN DISTORTED INLET FLOWS
F. S. BHINDER, M. M. AL-MUDHAFAR, and M. ILYAS (Hatfield Polytechnic, Hatfield, Herts., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-64)

A low aspect ratio plane wall diffuser has been tested for a variety of inlet velocity profiles and range of mean inlet Mach numbers. The inlet distortion parameter, which defines the velocity profiles quantitatively, correlates well with the performance parameters such as pressure recovery coefficient, effectiveness and diffusion efficiency. The empirical expressions for these correlations have been derived. Author

A84-46912#
PRELIMINARY STUDY ON FORWARD LOADED CASCADES DESIGNED WITH INVERSE METHOD FOR LOW PRESSURE TURBINE
K. HASHIMOTO (Kawasaki Heavy Industries, Ltd., Jet Engine Div., Akashi, Japan) and T. KIMURA (Kobe University, Kobe, Japan) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-65)

A preliminary study has been conducted on 'forward-loaded' turbine cascades in order to reduce their number or rotor density without incurring energy loss. The cascades in question were designed for typical jet engine first and second turbine stage velocity diagrams; an additional set of state-of-the-art conventional blades was also designed to these velocity diagrams for the purposes of comparison. The forward-loaded cascades exhibited lower kinetic energy loss coefficients and wider useful incidence angles over a broader range of velocities (into the high subsonic regime), by comparison with the conventional blades, despite their higher loadings. O.C.

A84-46915#
THE INFLUENCE OF DIFFERENT GEOMETRIES FOR A VANED DIFFUSER ON THE PRESSURE DISTRIBUTION IN A CENTRIFUGAL COMPRESSOR
I. TEIPEL and A. WIEDERMANN (Hannover, Universitaet, Hanover, West Germany) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-68)

Different diffuser blade geometries are considered in the present study of a centrifugal compressor's vaned diffuser flow field, with attention to shock wave development, under the assumption that the impeller speed is so great that the flow may become transonic at the impeller exit. A time-marching method is used for solving the two-dimensional Euler equations in conservative form, and a MacCormack's second order difference scheme is applied. Only the stagger angle of the blades is altered in the course of the calculations at first; different blade thickness distributions are then assessed. Wall pressure distributions, as well as fields of isobars and of constant Mach numbers, are obtained. O.C.

A84-46920#
CALCULATION OF THE THREE-DIMENSIONAL, STEADY, INVISCID FLOW IN A TRANSONIC AXIAL TURBINE STAGE
T. ARTS (Institut Von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-76)

The aim of this paper is to develop an approach to compute the three-dimensional, rotational, adiabatic, inviscid flow of a perfect gas in a transonic axial turbine stage. The time-dependent Euler equations, expressed in a cylindrical coordinate system, are solved using a time-marching method and a finite volume approach. The absolute flow is calculated in the stator, whereas the relative flow is computed in the rotor. A time-averaged blade row interaction is assumed. The method is applied to a transonic single-stage turbine. The calculated results agree well with the measured performance and three-dimensional aspects of the flow appear clearly. Author

A84-46921#
RECENT PROGRESS IN THE UNDERSTANDING OF BASIC ASPECTS OF SECONDARY FLOWS IN TURBINE BLADE PASSAGES
C. H. SIEVERDING (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 10 p. refs
(ASME PAPER 84-GT-78)

Attention is given to results obtained in the course of the last decade's experimental investigation of turbine blade passage secondary flows, in order to assess present knowledge and the nature of remaining uncertainties. Secondary flow vortex structures and their effect on endwall boundary layer characteristics and aerodynamic efficiency loss increases through straight turbine blade passages are discussed. It is noted to be essential that one establish whether leading edge vortices and their associated, three-dimensional separation lines are of only local or actually general significance, since this conditions the choice of endwall flow analysis method. O.C.

A84-46922#
A THREE-DIMENSIONAL EULER SOLVER FOR TURBOMACHINERY BLADE ROWS
D. G. HOLMES and S. S. TONG (GE Corporate Research and Development Center, Schenectady, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-79)

This paper describes a three-dimensional Euler solver for turbomachinery blade rows. The algorithm used is based on the explicit, four-step, finite volume method advocated by Jameson. Some of the issues addressed include the spatial interpolation scheme compatible with the wall boundary condition; the appropriate interpolation scheme for correctly interpolating a uniform absolute flow in a rotating coordinate system; smoothing techniques that assure global conservation; and code vectorization. The Euler solver has been tested on turbine nozzles, turbine rotors, centrifugal compressor rotors, transonic fans, and propellers, in all cases without any modification to the code or any parameter adjustment. Author

A84-46926*# United Technologies Research Center, East Hartford, Conn.
INLET BOUNDARY LAYER EFFECTS IN AN AXIAL COMPRESSOR ROTOR. I BLADE-TO-BLADE EFFECTS
J. H. WAGNER, R. P. DRING, and H. D. JOSLYN (United Technologies Research Center, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(Contract F33615-77-C-2083; NAS3-23157)
(ASME PAPER 84-GT-84)

This paper discusses experimental data measured on the blading and downstream of an isolated compressor rotor with thick inlet endwall boundary layers. The objective of the study was to compare these results with data acquired previously with thin inlet boundary layers and to assess the impact of inlet boundary layer thickness on the secondary flow. Flow visualization results showed the powerful impact of the hub corner stall and how at the same near stall flow coefficient where with thin inlet boundary layers the blade was separated at midspan, with thick inlet boundary layers it was attached. It was also shown that while secondary flow was very weak, it did produce sufficient radial redistribution to cause an apparent negative loss at the blade root. Author

A84-46927*# United Technologies Research Center, East Hartford, Conn.
INLET BOUNDARY LAYER EFFECTS IN AN AXIAL COMPRESSOR ROTOR. II - THROUGHFLOW EFFECTS
J. H. WAGNER, R. P. DRING, and H. D. JOSLYN (United Technologies Research Center, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(Contract F33615-77-C-2083; NAS3-23157)
(ASME PAPER 84-GT-85)

This paper presents results of an experimental aerodynamic study conducted in the rotating frame of reference downstream of an isolated compressor rotor with both thick and thin inlet endwall boundary layers. The paper focuses on those aspects of the data having particular significance to the assumptions and application of throughflow theory. These aspects include the spanwise distributions of static pressure and blockage, and the radial redistribution of fluid as it passes through the blade row. It is demonstrated that the main contributions to total pressure loss, blockage, and the distortion of the static pressure field were due to the hub corner stall and tip leakage. This is a significant departure from previous conclusions which looked to the endwall boundary layer and to secondary flow as major loss and blockage producing mechanisms. Author

A84-46932#
AXIAL COMPRESSOR STATOR AERODYNAMICS
H. D. JOSLYN and R. P. DRING (United Technologie Research Center, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Research supported by the United Technologies Corp. refs
(ASME PAPER 84-GT-90)

In order to arrive at design analyses that can more accurately account for three-dimensional effects in axial flow compressors, attention is given to the initial results of a detailed experimental study of the aerodynamics of the second stage of a large scale, two-stage axial compressor over a range of flow coefficients. Emphasis is given to findings for the second stator in this turbomachine, including data for airfoil and endwall flow visualization and radial-circumferential transverse measurements that are presented in the form of full span contour plots of total pressure. Also noted are the spanwise distributions of total and static pressures, axial velocity, air angles, and blockage. The effect of loading increases on the growth of the hub corner stall, and its impact on these parameters, are also noted. O.C.

A84-46971#
USE OF AN INVERSE METHOD FOR THE DESIGN OF HIGH EFFICIENCY COMPRESSOR AND TURBINE BLADES WITH LARGE CHANGE IN RADIUS
G. MEAUZE and A. LESAIN (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-167; ONERA, TP NO. 1984-28)

Time-marching computations of flows in 2-D blade cascades are extended to the case of cascades with variable radius and stream tube thickness. The case of purely radial cascades is one of the specific cases which are analyzed, and direct and inverse calculations are made with or without shock waves in subsonic or supersonic flows. Examples of the design of high efficiency airfoil optimization for radial flow compressor rotors or stators or inward flow turbine inlet guide vanes are presented. The use of inverse methods has proven to be of great help in tailoring the velocity distribution, and has led to blade designs which can be adapted to any operating condition. It is shown that a smoother velocity profile can be obtained and therefore a much safer and efficient operation can be realized by the slight modification of the blade shape while retaining thickness distribution. J.P.

A84-46976#
HOLOGRAPHIC MEASUREMENTS AND THEORETICAL PREDICTIONS OF THE UNSTEADY FLOW IN A TRANSONIC ANNULAR CASCADE
M. R. D. DAVIES and P. J. BRYANSTON-CROSS (Cambridge University, Cambridge, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Research supported by Rolls Royce, Ltd. refs
(ASME PAPER 84-GT-174)

A series of measurements have been made on a transonic annular cascade. The cascade which represents the tip section of a compressor fan blade has an inlet Mach number of 1.18. By the use of external vibrators it is possible to vibrate the blades independently in torsion simulating different interblade phase angles in order to gain an understanding of shock movement and blade loading. The results presented are made over interblade phase angles of 180 and 135 deg at a blade frequency parameter of 0.1, based on chord. The holographic data obtained shows detail of shock movement during the cycle using a miniature holocamera located within the hub of the cascade. Unsteady sidewall pressure measurements have also been obtained over the vibration cycle. The data obtained have been compared with finite element calculations. Author

A84-46979#
AN EXPERIMENTAL INVESTIGATION INTO THE EFFECT OF WAKES ON THE UNSTEADY TURBINE ROTOR FLOW
A. BINDER, W. FOERSTER, H. KRUSE, and H. ROGGE (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Antriebstechnik, Cologne, West Germany) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-178)

Detailed measurements were carried out near and within a turbine rotor using the Laser-2-Focus velocimeter. Testing was performed in a single stage cold air turbine at off-design conditions with a stator outlet Mach number of approximately 0.8. Instantaneous and averaged results of the velocity, the yaw angle, and the turbulence intensity provided information on the rotor flow field. This report describes the periodical and random unsteady effects of the stator wakes impinging on the rotor blades. In particular the constant unsteadiness contours clearly disclose the development of the wakes cut by the rotor blades. The objective of the study was to gain more insight into unsteady flow phenomena affecting losses, heat transfer, and related problems. Author

A84-46980#
BOUNDARY-LAYER TRANSITION AND SEPARATION NEAR THE LEADING EDGE OF A HIGH-SPEED TURBINE BLADE
H. P. HODSON (Cambridge University, Cambridge, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Research supported by Rolls-Royce, Ltd. refs
(ASME PAPER 84-GT-179)

The state of the boundary layers near the leading edge of a high-speed turbine blade has been investigated, in cascade, using an array of surface-mounted, constant-temperature, hot-film anemometers. The measurements are interpreted with the aid of inviscid and viscous prediction codes. The effects of Reynolds number, compressibility, incidence, and free-stream turbulence are described. In all cases, the initial development of the boundary layers was extremely complex and, even at design conditions, separation and reattachment, transition and relaminarization were found to occur. Author

A84-46984#
UNSTEADY LOSSES IN TRANSONIC COMPRESSORS
W. F. NG and A. H. EPSTEIN (MIT, Cambridge, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. USAF-supported research. refs
(ASME PAPER 84-GT-183)

A newly developed probe has been used to measure the time-resolved total temperature and pressure in a transonic compressor. The investigation revealed the presence of large fluctuations in the blade-to-blade core flow occurring at a frequency of three to four times blade passing. These variations are not steady in the rotor relative frame and are thought to be caused by unsteadiness in the rotor shock system, driven perhaps by a shed vortex in the blade wake. The loss associated with this unsteadiness is calculated and the implications for stage performance are discussed. Author

A84-46985*# General Electric Co., Cincinnati, Ohio.
LOSS REDUCTION IN AXIAL-FLOW COMPRESSORS THROUGH LOW-SPEED MODEL TESTING
D. C. WISLER (General Electric Co., Aircraft Engine Group, Cincinnati, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 10 p. refs
(Contract NAS3-20070)
(ASME PAPER 84-GT-184)

A systematic procedure for reducing losses in axial-flow compressors is presented. In this procedure, a large, low-speed, aerodynamic model of a high-speed core compressor is designed and fabricated based on aerodynamic similarity principles. This model is then tested at low speed where high-loss regions associated with three-dimensional endwall boundary layers flow separation, leakage, and secondary flows can be located, detailed measurements made, and loss mechanisms determined with much greater accuracy and much lower cost and risk than is possible in small, high-speed compressors. Design modifications are made by using custom-tailored airfoils and vector diagrams, airfoil endbends, and modified wall geometries in the high-loss regions. The design improvements resulting in reduced loss or increased stall margin are then scaled to high speed. This paper describes the procedure and presents experimental results to show that in some cases endwall loss has been reduced by as much as 10 percent, flow separation has been reduced or eliminated, and stall margin has been substantially improved by using these techniques. Author

A84-46986#
QUASI-THREE-DIMENSIONAL AND FULL THREE-DIMENSIONAL ROTATIONAL FLOW CALCULATIONS IN TURBOMACHINES
Q. WANG, G. ZHU, and C.-H. WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-185)

In the present evaluation of quasi- and fully three-dimensional numerical solutions for steady subsonic rotational flow through turbomachinery, the governing equations for the S1 and S2 blade suction surfaces are expressed in terms of general, nonorthogonal curvilinear coordinates. This feature allows them to be body-fitted without recourse to coordinate transformations, and they may then be solved by either the matrix or line-relaxation method. The results obtained for the cases of a full three-dimensional flow field in a two-stage axial compressor and in a high subsonic flow compressor stator indicate the degree of twist of the S1 surfaces, as well as the difference in the flow field between the quasi-three-dimensional and the fully three-dimensional solutions. O.C.

A84-46991*# Pennsylvania State Univ., University Park.
AN EXPERIMENTAL STUDY OF THE COMPRESSOR ROTOR BLADE BOUNDARY LAYER
M. POUAGARE, B. LAKSHMINARAYANA (Pennsylvania State University, University Park, PA), and J. M. GALMES (Pennsylvania State University, University Park, PA; SocieteEuropeenne de Propulsion, Vernon, Eure, France) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(Contract NSG-3266)
(ASME PAPER 84-GT-193)

The three-dimensional turbulent boundary layer developing on a rotor blade of an axial flow compressor was measured using a miniature 'x' configuration hot-wire probe. The measurements were carried out at nine radial locations on both surfaces of the blade at various chordwise locations. The data derived includes streamwise and radial mean velocities and turbulence intensities. The validity of conventional velocity profiles such as the 'power law profile' for the streamwise profile, and Mager and Eichelbrenner's for the radial profile, is examined. A modification to Mager's crossflow profile is proposed. Away from the blade tip, the streamwise component of the blade boundary layer seems to be mainly influenced by the streamwise pressure gradient. Near the tip of the blade, the behavior of the blade boundary layer is affected by the tip leakage flow and the annulus wall boundary layer. The 'tangential blockage' due to the blade boundary layer is derived from the data. The profile losses are found to be less than that of an equivalent cascade, except in the tip region of the blade. Author

A84-46994#
A SIMPLE METHOD FOR SOLVING THREE-DIMENSIONAL INVERSE PROBLEMS OF TURBOMACHINE FLOW AND THE ANNULAR CONSTRAINT CONDITION
X.-L. ZHAO, C.-L. SUN, and C.-H. WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-198)

A simple method based on the theoretical analysis of Wu (1950) is developed to solve three-dimensional inverse turbomachine problems. The shape of the S2m surface and the flow configuration along it are calculated from the design-specified hub and casing contours and S2m projections; the partial derivatives of the flow quantities are expressed in nonorthogonal curvilinear coordinates; the annular constraint condition implied by this procedure is defined; and techniques involving coordinate transformations and higher-order expansions are presented to determine the blade shape and the family of S2 surfaces of the solutions. Two sample

problems involving axial turbomachines are computed using a FORTRAN IV program based on this method, and the results are presented in graphs and tables. The blade shape, S1 and S2 surface distributions, and fluid properties are obtained in less than one minute of UNIVAC-1100 computer time. T.K.

A84-46995*# Army Propulsion Lab., Cleveland, Ohio.
INVESTIGATION OF THE THREE-DIMENSIONAL FLOW FIELD WITHIN A TRANSONIC FAN ROTOR - EXPERIMENT AND ANALYSIS
M. J. PIERZGA (U.S. Army, Propulsion Laboratory, Cleveland, OH) and J. R. WOOD (NASA, Lewis Research Center, Cleveland, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 13 p. refs
(ASME PAPER 84-GT-200)

An experimental investigation of the three-dimensional flow field through a low aspect ratio, transonic, axial flow fan rotor has been conducted, using an advanced laser anemometer (LA) system. Laser velocimeter measurements of the rotor flow field at the design operating speed and over a range of throughflow conditions are compared to analytical solutions. The numerical technique used herein yields the solution to the full, three-dimensional, unsteady Euler equations using an explicit time-marching, finite volume approach. The numerical analysis, when coupled with a simplified boundary layer calculation, generally yields good agreement with the experimental data. The test rotor has an aspect ratio of 1.56, a design total pressure ratio of 1.629 and a tip relative Mach number of 1.38. The high spatial resolution of the LA data matrix (9 radial x 30 axial x 50 blade-to-blade) permits details of the transonic flow field such as shock location, turning distribution, and blade loading levels to be investigated and compared to analytical results. Author

A84-46996#
SURFACE STATIC PRESSURES IN AN INLET VORTEX FLOW FIELD
W. LIU, E. M. GREITZER, and C. S. TAN (MIT, Cambridge, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(Contract F49620-82-K-0002)
(ASME PAPER 84-GT-201)

An experimental investigation of the three-dimensional flow field associated with an inlet vortex is reported. The specific configuration investigated is an inlet, in proximity to a ground plane, in crosswind. Parametric data are presented to define the regimes of vortex formation in this configuration as a function of inlet height to diameter ratio and inlet velocity ratio. The detailed static pressure distribution on the inlet is given for two quite different flow regimes: one with a strong inlet vortex and one with no inlet vortex. These new quantitative data are supplemented by flow visualization studies that allow an estimate to be made of the circulation around the inlet vortex. It is argued that the static pressure distributions in both cases can be clearly interpreted using the basic ideas of inlet vortex formation that were previously developed from (qualitative) water tunnel studies. Author

A84-46997#
A THEORETICAL MODEL FOR ROTATING STALL IN THE VANELESS DIFFUSER OF A CENTRIFUGAL COMPRESSOR
P. FRIGNE (CERAC, Ecublens, Switzerland) and R. VAN DEN BRAEMBUSSCHE (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-204)

A theoretical model for rotating stall in the vaneless diffuser of a centrifugal compressor is presented. It consists of a time-evolutive calculation of the strong interaction between the inviscid flow core and the unsteady boundary layers along the walls. It is shown that, depending on the diffuser geometry and the diffuser inlet flow angle, a transient perturbation of the outlet static pressure will generate a rotating flow pattern, if the periodicity of this perturbation corresponds to the experimentally observed number of cells. The relative rotational speed and the phase relation between the velocity and the flow angle variations are also in agreement with experimental data. Author

A84-47000#
COMMON MISCONCEPTIONS IN THE CALCULATION OF TRANSONIC FULL POTENTIAL FLOWS
G. S. DULIKRAVICH (Texas, University, Austin, TX) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. Research supported by the University of Texas. refs
(ASME PAPER 84-GT-211)

Reasons for certain inaccuracies in the majority of existing computer programs that numerically calculate transonic full potential flows are clearly exposed. Problems of post-shock oscillations, non-unique shock strengths and their locations, diverging solutions of choked nozzle flows and flows about sharp leading edges are shown to be related to widely accepted oversimplifications in the treatment of boundary conditions. Forms of numerical dissipation that are presently widely used are shown to be not fully understood and an alternative dissipation generation concept is proposed. Author

A84-47004#
AN INVESTIGATION OF THE TRANSVERSE VELOCITY PROFILE IN THE CASE OF INTERNAL VISCOUS AERODYNAMIC PROBLEMS
P. CHAVIAROPOULOS, K. D. PAPAILIOU (Athens, National Technical University, Athens, Greece), and P. KOTIDIS American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-218)

Hawthorne's (1955) classical analysis of the transverse velocity profile's development is used to separate a transverse plane velocity field into potential and rotational components. This treatment allows the reexamination of confined flows in terms of a two-zone model, where the zones are the viscous and inviscid components. Attention is given to the limitations of Hawthorne's treatment, and a parallel analysis is presented for the case of a secondary vorticity distribution that varies not only along a cascade blade's span, but circumferentially, as well. O.C.

A84-47005#
FLOW AT THE TIP OF A FORWARD CURVED CENTRIFUGAL FAN
A. GOULAS (Cranfield Institute of Technology, Cranfield, Beds., England) and B. MEALING (Hestair Duples, Ltd., Blackpool, Lancs., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-222)

Radial and circumferential component velocity profiles have been obtained at the tip of a forward curved centrifugal fan blade. A reverse flow region is noted to have formed at the hub and near the middle of the blade, between the pressure and suction sides. Near the shroud, a high velocity region was found, together with a low velocity region near the suction side. While a wake was formed along the suction side of the blade at the lower rotational speeds, blade curvature effects became more dominant at higher flow rates. Corner vortices are also found to affect the main flow by changing the turbulence intensities. O.C.

A84-47007#
ACCURACY AND CONVERGENCE CHARACTERISTICS OF STEADY TRANSONIC POTENTIAL FLOW SOLUTIONS
A. ECER, H. O. YURTSEVEN, and C. KARACA (Purdue University, Indianapolis, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(Contract AF-AFOSR-80-0258)
(ASME PAPER 84-GT-227)

The analysis of transonic potential flows in order to obtain the convergence characteristics of a relaxation scheme with the highest accuracy must take artificial viscosity effects into account. The numerical experiments presently conducted indicate that the artificial viscosity parameter must be determined as a function of local Mach number, mesh size, flow gradient, the location of a point in a supersonic pocket, the size of the supersonic pocket, and the initial solution for the iterations. The present approach has involved the comparison of solutions with different artificial viscosity values in order to determine accuracy and convergence rates. O.C.

A84-47009#
PREDICTION OF FLOW IN ROTATING DISC SYSTEMS USING THE K-EPSILON TURBULENCE MODEL
J. W. CHEW (Rolls-Royce, Ltd., Derby, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-229)

Numerical results are presented for three classes of flow: radial outflow between co-rotating disks, outflow between a stationary and a rotating disk and the flow due to a 'free' disk. Comparison of these predictions with other workers' experimental, analytical and numerical results indicates that the k-epsilon model, in its present form, may not be suitable for such flows. Author

A84-47013#
MASS FLOW LIMITATION OF SUPERSONIC BLADE ROWS DUE TO LEADING EDGE BLOCKAGE
H. STARKEN, H.-A. SCHREIBER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Antriebstechnik, Cologne, West Germany), and Y. ZHONG (Gas Turbine Establishment, Jiangyou, People's Republic of China) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-233)

The supersonic flow passing through the blade row of an axial flow compressor depends on the magnitude of the axial inlet Mach number. If the upstream stream tube is convergent, the axial Mach number remains subsonic and the unique incidence relation holds between inlet Mach number and inlet flow angle. This paper presents the influence of leading edge thickness and suction surface angle on the unique incidence and choking of supersonic blade rows. The theoretical results were experimentally verified in supersonic cascade wind tunnel tests. Author

A84-47015#
A NEW DIFFUSER MAPPING TECHNIQUE
D. JAPIKSE (Concepts ETI, Inc., Norwich, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-237)

A rigorous derivation of the K = Cpi - Cp diffuser recovery and loss equation is presented and the critical assumptions to yield this simplified relationship are critiqued. Confirmation of the equation is achieved using precise laboratory data and a new diffuser loss-map is presented which facilitates engineering diffuser design work, even when a Kline-map is unavailable. Numerous application examples for turbomachinery analysis are given. Author

A84-47016#
A FINITE ELEMENT COMPUTER CODE TO CALCULATE FULL 3-D COMPRESSIBLE POTENTIAL FLOW IN TURBOMACHINERY
D. GUNES and M. MENGUTURK (Bogazici University, Istanbul, Turkey) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-238)

A finite element computer code is presented for calculation of three-dimensional compressible flows in turbomachinery under the steady and potential flow limitations. The method used relies upon a variational statement equivalent to the classical velocity potential formulation of this problem. The solution domain is discretized by using hexahedral superelements each composed of six ten-node tetrahedral elements enabling quadratic interpolation of velocity potential. The code offers the flexibility of choosing a combination of sub-parametric and isoparametric elements. Application of the code to the Gostelow cascade, an experimental turbine stator, the first stage stator and rotor of an electric utililty axial flow turbine and finally to a mixed flow turbine rotor are presented. The validity of the results are established by comparison with the exact solution, experimental data and calculations by other numerical methods. Author

A84-47018#
CALCULATION OF HORSESHOE VORTEX FLOW WITHOUT NUMERICAL MIXING
J. G. MOORE and J. MOORE (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. Research supported by Rolls-Royce, Ltd. refs
(ASME PAPER 84-GT-241)

The usefulness of three-dimensional flow calculations has frequently been obscured by the numerical mixing present in the calculation methods. This paper describes a new method for forming the finite difference momentum equations. The new method results in well posed equations which introduce no numerical mixing. It may be used with orthogonal or non-orthogonal grids and with uniform or highly non-uniform grid spacing. The method is demonstrated by comparing it with upwind differencing on the calculation of a simple example. It is then used in an elliptic pressure-correction calculation procedure to calculate a leading edge horseshoe vortex about a Rankine half body. The results compare well with the experimental data presented in a companion paper. Author

A84-47019#
THE EFFECTS OF FREESTREAM TURBULENCE ON THE PROFILE BOUNDARY LAYER AND LOSSES IN A COMPRESSOR CASCADE
R. L. EVANS (British Columbia, Vancouver, Canada) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 5 p. refs
(ASME PAPER 84-GT-242)

The turbulent profile boundary layer on a one-foot chord compressor cascade blade has been measured with varying levels of freestream turbulence. Increased levels of freestream turbulence were found to increase the fullness of the velocity profiles, with a consequent decrease in displacement thickness and an increase in the skin friction coefficient. A small increase in freestream turbulence causes the cascade total-pressure loss to increase initially, while at the higher turbulence levels boundary layer separation was delayed, resulting in a decrease in the total-pressure loss and deviation angle. Author

A84-47020#
EXTIMA-2, AN EXPLICIT TIME-MARCHING METHOD TO CALCULATE TRANSONIC TURBOMACHINERY CASCADE FLOW
W. HOFFMANN (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Antriebstechnik, Cologne, West Germany) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 10 p. Research supported by the Deutsche Forschungsgemeinschaft. refs
(ASME PAPER 84-GT-243)

An explicit time-marching procedure to calcualte transonic turbine or compressor cascade flow has been developed. The integral unsteady Euler equations are approximated by a conservative finite volume discretization using split space operators in a predictor-corrector scheme. Results are obtained with the physical flow field geometry. At solid walls streamline differenciation is used to update boundary values in a nonorthogonal grid which is automatically generated and sectionally aligned to the boundary. Near the leading and trailing edges and at captured shock waves the computation is stabilized by a switched numerical Shuman-type filter. To minimize computing time the code is vector-optimized for use on a Cray-1/S computer. In this paper particular details of the calculation procedure are discussed and sample calculations are presented. Author

A84-47021#
COMPUTATION OF SECONDARY FLOWS IN AN AXIAL FLOW COMPRESSOR INCLUDING INVISCID AND VISCOUS FLOW COMPUTATION
F. LEBOEUF (Lyon, Ecole Centrale, Ecully, Rhone, France) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Sponsorship: Direction des Recherches, Etudes et Techniques. refs
(Contract DRET-81-437; DRET-81-503)
(ASME PAPER 84-GT-244)

A computational method for secondary flows in a compressor has been extended to treat stalled flows. An integral equation is used which simulates the inviscid flow at the wall, under the viscous flow influence. Comparisons with experimental results for a 2D stalled boundary layer, and for the secondary flow in a highly loaded stator of an axial flow compressor are presented. Author

A84-47023#
COMPARISON OF CONTROLLED DIFFUSION AIRFOILS WITH CONVENTIONAL NACA 65 AIRFOILS DEVELOPED FOR STATOR BLADE APPLICATION IN A MULTISTAGE AXIAL COMPRESSOR
H. RECHTER, W. STEINERT (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, West Germany), and K. LEHMANN (MTV Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 5 p. Research supported by the Bundesministerium fuer Forschung und Technologie.
(ASME PAPER 84-GT-246)

In their transonic cascade wind tunnel, DFVLR has done measurements on a conventional NACA 65, as well as on a controlled diffusion airfoil, designed for the same velocity triangle at supercritical inlet condition. These tested cascades represent the first stator hub section of a three-stage axial/one-stage radial combined compressor. One aspect of this project was the verification of the controlled diffusion concept for axial compressor blade design, in order to demonstrate the capabilities of some recent research results which are now available for industrial application. The stator blades of the axial compressor section were first designed using NACA 64 airfoils. In the second step, the controlled diffusion technique was applied for building a new stator set. Both stator configurations were tested in the MTU compressor test facility. Cascade and compressor tests revealed the superiority of the controlled diffusion airfoils for axial compressors. In comparison to the conventional NACA blades, the new blades obtained a higher efficiency. Author

A84-47025#
EXPERIENCE WITH AN INTEGRATED CENTRIFUGAL COMPRESSOR DESIGN PROCEDURE
G. J. HOLBROOK and J. J. BRASZ (United Technologies Corp., Carrier Research Div., Syracuse, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-249)

The present integrated centrifugal compressor design procedure consists of several phases, each of which employs progressively more complex models. The compressor's detailed geometry, after initial sizing, is determined from a one-dimensional mean streamline model and is subsequently analyzed by more complex, two-dimensional hub-to-shroud and blade-to-blade internal flow models. The one-dimensional model links the results of the preliminary sizing model with the more sophisticated, two-dimensional ones, and quickly determines a complete compressor geometry from a desired blade loading distribution and the overall performance requirements of the compressor. O.C.

A84-47026#
SIMPLIFIED METHOD FOR FLOW ANALYSIS AND PERFORMANCE CALCULATION THROUGH AN AXIAL COMPRESSOR
H. MITON, Y. DOUMANDJI, and J. CHAUVIN (Aix-Marseille I, Universite, Marseille, France) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p.
(ASME PAPER 84-GT-250)

Attention is given to the performance of a fast computation method for the flow through industrial, multistage axial compressors, yielding both blade row losses and turning characteristics by means of correlations. Equations of motion are linearized with respect to the log of the static pressure, whose variation along the radius is usually of limited extent for this type of machine. Each computing plane between blade rows combines a basic flow with constant pressure (satisfying mass flow requirements) and a perturbation flow (fulfilling radial equilibrium conditions). Sample calculation results show good agreement with a classical duct flow method, while computation time is reduced by a factor of five. O.C.

A84-47051
SEPARATED FLOW AROUND A CONIC COMBINATION OF A LOW-ASPECT-RATIO WING AND A NONSYMMETRICAL FUSELAGE [OTRYVNOE OBTEKANIE KONICHESKOI KOMBINATSII KRYLA MALOGO UDLINENIIA S NESIMMETRICHNYM FIUZELIAZHEM]
A. V. VOEVODIN TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 1-8. In Russian. refs

Steady flow around a conic combination of a low-aspect ratio wing and a fuselage that is nonsymmetrical with respect to the wing plane and has a semicircular cross-section is analyzed using ideal fluid theory. The aerodynamic characteristics of such a system in the case of flow separation from the leading edge of the wing are determined for a wide range of angles of attack and relative fuselage radii. The results obtained are compared with the characteristics of separated flow over an individual wing and a combination of a wing and a symmetrical fuselage. V.L.

A84-47052
A STUDY OF FLOW PAST STRAIGHT AND SWEPT WINGS OF HIGH ASPECT RATIOS AT TRANSONIC SPEEDS [ISSLEDOVANIE OBTEKANIIA PRIAMYKH I STRELOVIDNYKH KRYL'EV BOL'SHOGO UDLINENIIA PRI OKOLOZVUKOVYKH SKOROSTIAKH]
N. A. VLADIMIROVA TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 9-16. In Russian. refs

Transonic flow past high-aspect-ratio straight and swept wings is calculated using a specially written computer program to solve

complete equations for the velocity potential. For the types of wing investigated, distributed and integral characteristics are presented for the case where local supersonic zones and shock waves are formed on the wing surface. The computational algorithm used is briefly described. V.L.

A84-47053
AN ANALYSIS OF THREE-DIMENSIONAL FLOW PAST A PLANE SUPERSONIC AIR INTAKE IN A CONFIGURATION WITH A DELTA WING [RASCHET PROSTRANSTVENNOGO OBTEKANIIA PLOSKOGO SVERKHZVUKOVOGO VOZDUKHOZABORNIKA V KOMPONOVKE S TREUGOL'NYM KRYLOM]
S. M. BOSNIAKOV and N. KH. REMEEV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 17-25. In Russian. refs

Three-dimensional flow past a plane supersonic air intake in a configuration with a delta wing is investigated analytically and experimentally, and a computer program is developed for determining the aerodynamic characteristics of the air intake. The fields of the three-dimensional flow are obtained. The calculated results are compared with experimental data and their accuracy is estimated at 1.5 percent. V.L.

A84-47055
CALCULATION OF A THREE-DIMENSIONAL BOUNDARY LAYER IN THE VICINITY OF AN ISOLATED CRITICAL POINT [RASCHET PROSTRANSTVENNOGO POGRANICHNOGO SLOIA V OKRESTNOSTI IZOLIROVANNOI KRITICHESKOI TOCHKI]
I. V. PETUKHOV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 37-46. In Russian.

A three-dimensional boundary layer in the vicinity of an isolated critical point on a blunt body is calculated to a second approximation. A method is presented whereby the initial data can be efficiently determined for a subsequent difference calculation of the boundary layer. Equations of the boundary layer are used for the case of regular flows of an ideal gas in the presence of mass transfer. The approach proposed here can be generalized to real gases. V.L.

A84-47058
A METHOD FOR THE EXPERIMENTAL INVESTIGATION OF PLANE AND AXISYMMETRIC NONSWIRLING FLOWS BY MEANS OF A CYLINDRICAL PRESSURE HEAD OVER A WIDE RANGE OF MACH NUMBERS [METOD EKSPERIMENTAL'NOGO ISSLEDOVANIIA PLOSKIKH I OSESIMMETRICHNYKH NEZAKRUCHENNYKH TECHENII S POMOSHCH'IU TSILINDRICHESKOGO PRIEMNIKA DAVLENIIA V SHIROKOM DIAPAZONE CHISEL M]
V. N. GLAZNEV and S. G. ZAVARUKHIN TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 67-75. In Russian. refs

Two methods are proposed for calculating flow parameters from static pressure and from pressures in the inlet ports of a fixed cylindrical head. Both methods apply in the Mach range 0.4-8 and in the velocity direction range 0-360 deg. The accuracy of the methods is estimated on the basis of the available experimental data on pressure distribution over the surface of a cylinder. To illustrate the methods, measurements have been made of a field of gasdynamic parameters in an underexpanded supersonic jet incident on a plane obstacle. V.L.

A84-47062
THE EFFECT OF THE REYNOLDS NUMBER AND THE POSITION OF THE TRANSITION POINT ON TRANSONIC NONSEPARATED FLOW PAST A BODY OF REVOLUTION [VLIIANIE CHISLA REINOL'DSA I PELOZHENIIA TOCHKI PEREKHODA NA OKOLOZVUKOVOE BEZOTRYVNOE OBTEKANIE TELA VRASHCHENIIA]
V. V. VYSHINSKII TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 99-104. In Russian. refs

In the context of boundary-layer theory, the finite difference method is used to calculate transonic axisymmetric flow past a body of revolution for large Reynolds numbers and various positions of the laminar-turbulent transition point. Expressions are presented which relate distributed parameters and integral characteristics to the Reynolds number and the position of the transition point. The approach proposed here makes it possible to solve problems for nonseparated flow under various thermal conditions with allowance for wall injection and suction, surface roughness, and incoming flow turbulence. V.L.

A84-47063
THE THEORY OF TRANSONIC FLOW OF A VISCOUS GAS PAST A CORNER [K TEORII OBTEKANIIA UGLA TRANSZVUKOVYM POTOKOM VIAZKOGO GAZA]
G. L. KOROLEV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 105-109. In Russian. refs

Laminar transonic flow of a viscous gas past a slightly bent plate is investigated for large Reynolds numbers. The angle of the bend corresponds to the transition from nonseparated to separated flow. A numerical solution is presented which yields an asymptotic expression for the surface bend angle as a function of the Mach number of the incoming flow for the transition to separated flow. V.L.

A84-47064
AN APPLICATION OF A GRADIENT METHOD TO THE MINIMIZATION OF THE DRAG OF SLENDER WINGS IN SUPERSONIC FLOW [PRIMENENIE GRADIENTNOGO METODA K MINIMIZATSII SOPROTIVLENIIA TONKIKH KRYL'EV V SVERKHZVUKOVOM POTOKE]
N. N. GLUSHKOV and A. S. TIMONIN TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 110-113. In Russian.

A gradient method is proposed for determining the median surface of thin wings characterized by a minimum pressure drag in supersonic flow for a specified lifting force. The method is based on the reversibility theorem in linear theory and employs calculated pressure distributions in direct and reverse flows for obtaining a refining variation. The efficiency of the method and its good convergence to an optimum solution irrespective of the initial shape of the wing surface are demonstrated for delta wings. V.L.

A84-47065
SELECTING AN OPTIMUM WALL PERMEABILITY FOR A TRANSONIC WIND TUNNEL [VYBOR OPTIMAL'NOI PRONITSAEMOSTI STENOK TRANSZVUKOVOI AZRODINAMICHESKOI TRUBY]
V. M. NEILAND and A. V. SEMENOV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 114-118. In Russian. refs

The possibility of using a perforation coefficient, f, varying in the longitudinal direction, for eliminating the induction of flow boundaries is analyzed. The value of f is determined by comparing the velocity of gas flow over a control surface in free flow, corresponding to wind tunnel walls, with the flow rate characteristics of the perforation. An iteration process for determining an optimum wall permeability distribution along a tunnel is presented along with examples of calculations of transonic flow over axisymmetric and plane models in such an induction-free test section. Results of an experimental verification of the approach proposed here are also presented. V.L.

A84-47069
A MORE ACCURATE CALCULATION OF THE INDUCED DRAG OF A WING IN SUBSONIC FLOW USING THE METHOD OF DISCRETE VORTICES [UTOCHNENNYI RASCHET INDUKTIVNOGO SOPROTIVLENIIA KRYLA V DOZVUKOVOM POTOKE METODOM DISKRETNYKH VIKHREI]
G. N. VASILEVA, Z. S. PASHKOVA, and V. P. SAVIN TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 1-7. In Russian.

A method is proposed for obtaining more accurate determinations of the induced drag when using discrete vortices to calculate the aerodynamic characteristics of a wing. The method

involves changing the side coordinate of free end vortices. The method proposed here is compared with a method proposed in an earlier paper (muzychenko, 1970) and an exact solution for the spanwise elliptic distribution of circulation. Calculations are presented for rectangular and delta wings and a wing having a complex planform. V.L.

A84-47070
A LINEAR PROBLEM CONCERNING THREE-DIMENSIONAL SUPERSONIC AND HYPERSONIC FLOWS OVER A WING AT ANGLES OF ATTACK AND SIDESLIP [LINEINAIA ZADACHA O PROSTRANSTVENNOM SVERKHZVUKOVOM I GIPERZVUKOVOM OBTEKANII KRYLA POD UGLAMI ATAKI I SKOL'ZHENIIA]
A. I. SHCHEDRIN TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 8-20. In Russian. refs

An analysis is presented for three-dimensional supersonic and hypersonic flows at angles of attack and sideslip over the windward side of a wing whose shape is close to that of an infinite-span plane straight wing. On the basis of a general three-dimensional boundary value problem for a pressure perturbation function, flow characteristics are investigated for the limiting case of hypersonic flow where the specific heat ratios are close to unity. Asymptotic formulas are obtained which describe explicitly the effect of wing geometry and initial flow parameters on the pressure distribution pattern. V.L.

A84-47072
ASYMPTOTIC THEORY OF FLOW AROUND THE SHARP CORNERS OF A RIGID BODY PROFILE [K ASIMPTOTICHESKOI TEORII OBTEKANIIA UGLOVYKH TOCHEK KONTURA TVERDOGO TELA]
I. G. FOMINA TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 31-38. In Russian. refs

Two-dimensional flow of a viscous fluid near a wall having a large-curvature region is analyzed by using the method of matched asymptotic expansions to solve the Navier-Stokes equations for large Reynolds numbers. In particular, attention is given to the case where there is no interaction between the boundary layer and the external flow. A similarity criterion is obtained for both a viscous fluid flow and a supersonic flow. Friction distribution over the wall surface is calculated for various values of the similarity parameter. V.L.

A84-47073
INTERACTION BETWEEN A PSEUDO-SHOCK AND AN OBSTACLE [VZAIMODEISTVIE PSEVDOSKACHKA S PREPIATSTVIEM]
V. I. PENZIN TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 39-46. In Russian.

The characteristics of mixed sub- and supersonic flow (as observed in the front part of a pseudo-shock) over obstacles inside a cylindrical pipe are examined. It is shown that zones of increased pressure existing in front or behind an obstacle or resulting from the interaction between the obstacle and the pseudo-shock pressure gradient and to a reduction in the pseudo-shock length. It is also noted that the thickness of the boundary layer in front of the obstacle has a noticeable effect on its interaction with the pseudo-shock. V.L.

A84-47074
A COMPARISON BETWEEN THE LIMITING THEORETICAL CHARACTERISTICS OF SUPERSONIC GAS EJECTORS WITH ISOBARIC AND CYLINDRICAL MIXING CHAMBERS [SRAVNENIE PREDEL'NYKH TEORETICHESKIKH KHARAKTERISTIK SVERKHZVUKOVYKH GAZOVYKH EZHEKTOROV S IZOBARICHESKOI I TSILINDRICHESKOI KAMERAMI SMESHENIIA]
V. S. BAIKOV and IU. N. VASILEV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 47-57. In Russian. refs

The limiting gasdynamic parameters obtainable with gas ejectors having isobaric and cylindrical mixing chambers are compared on the basis of previously proposed theories. Ejectors with an isobaric mixing chamber are found to be more effective over a wide range of the parameters of the mixed gases, whereas ejectors with a cylindrical mixing chamber are more effective outside this region. It is also shown that the two types of ejectors essentially differ in the process of the formation of supersonic flow of a gas mixture and its transition to the subsonic region. V.L.

A84-47075
UNSTABLE INTERACTION BETWEEN AN UNDEREXPANDED SUPERSONIC JET AND A CYLINDRICAL CAVITY [NEUSTOICHIVOE VZAIMODEISTVIE SVERKHZVUKOVOI NEDORASSHIRENNOI STRUI S TSILINDRICHESKOI POLOST'IU]
G. V. NABEREZHNOV and IU. N. NESTEROV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 58-64. In Russian. refs

An analysis is made of unstable flow in a shallow round cylindrical cavity coaxial with an underexpanded supersonic jet. Data are obtained on the mode, intensity, and frequency of pressure fluctuations at the bottom of a cavity whose radius is comparable with that of the jet cross-section. Flow patterns at different moments within a single pressure pulse period are described on the basis of a numerical modeling of the unstable interaction between a jet and a cavity. V.L.

A84-47079
BODIES OF REVOLUTION WITH MINIMUM WAVE RESISTANCE IN SONIC GAS FLOW [TELA VRASHCHENIIA S MINIMAL'NYM VOLNOVYM SOPROTIVLENIEM PRI ZVUKOVOI SKOROSTI TECHENIIA GAZA]
V. V. VYSHINSKII and E. N. KUZNETSOV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 90-93. In Russian. refs

The wave resistance of the nose sections of bodies of revolution with a parabolic gneratrix in sonic incoming flow is computed for various aspect ratios of the nose section. Transonic flow is computed using a finite difference method which remains stable for the class of bodies considered here up to free-stream Mach 0.998. The generatrix shapes for bodies with minimum wave resistance are determined. V.L.

A84-47080
THE METHOD OF SEPARATION OF VARIABLES IN A PROBLEM CONCERNING THREE-DIMENSIONAL FLOW OF AN IDEAL FLUID NEAR A SHARP CORNER OF A THIN WING [METOD RAZDELENIIA PEREMENNYKH V ZADACHE O PROSTRANSTVENNOM TECHENII IDEAL'NOI ZHIDKOSTI OKOLO UGLOVOI TOCHKI TONKOGO KRYLA]
V. M. MOLCHANOV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 94-96. In Russian.

A refined version of the method of separation of variables is applied here to the problem of three-dimensional flow of an ideal fluid in a finite spherical region near a sharp corner of a thin-section wing. Results of eigenvalue and function calculations are presented. V.L.

A84-47081
POSITION OF THE CENTER OF PRESSURE ON A DELTA WING IN NONEQUILIBRIUM HYPERSONIC AIR FLOW [POLOZHENIE TSENTRA DAVLENIIA NA TREUGOL'NOM KRYLE V GIPERZVUKOVOM NERAVNOVESNOM POTOKE VOZDUKHA]
M. M. KUZNETSOV and O. IU. POLIANSKII TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 97-99. In Russian. refs

For the case of hypersonic air flow at angle of attack past a plane delta wing, the position of the center of pressure on the wing is calculated by applying the method of a thin shock layer to nonequilibrium three-dimensional gas flow described by a complex kinetic model. The results obtained are generalized, by using the binary similarity law, to a sufficiently wide class of flight conditions in the earth atmosphere. V.L.

A84-47082
THEORETICAL AND EXPERIMENTAL STUDIES OF GAS FLOW IN COLLECTORS (NOZZLES) AT LOW SUBSONIC VELOCITIES [TEORETICHESKOE I EKSPERIMENTAL'NOE ISSLEDOVANIE TECHENIIA GAZA V KOLLEKTORAKH /SOPLAKH/ PRI MALYKH DOZVUKOVYKH SKOROSTIAKH]
A. P. BYRKIN, L. I. KUDRIAVTSEVA, S. P. PONOMAREV, and V. L. IAKUSHEVA TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 100-103. In Russian. refs

Subsonic gas flows (M equal to or less than 0.3) in axisymmetric nozzles of various aspects ratios, with profiles specified by Witoszinski's (1924) formula, are investigated analytically and experimentally. In the cases considered here, satisfactory agreement is obtained between the calculated and experimentally determined longitudinal velocity distributions along the nozzle wall and axis. Flow in the nozzle is found to be essentially inhomogeneous, with negative longitudinal velocity gradients formed at the entrance and exit sections that may result in boundary layer separation. V.L.

A84-47083
THE EFFECT OF THE NONSYMMETRY OF A PLANE SUPERSONIC FLOW OF A NONVISCOUS GAS ON THE CHARACTERISTICS OF A PLANE NOZZLE UNDER STATIC CONDITIONS [VLIIANIE NESIMMETRII PLOSKOGO SVERKHZVUKOVOGO TECHENIIA NEVIAZKOGO GAZA NA KHARAKTERISTIKI PLOSKOGO SOPLA V STATICHESKIKH USLOVIIAKH]
S. V. IAGUDIN TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 104-108. In Russian. refs

The impulse and thrust characteristics of plane nozzles obtained on the basis of numerical calculations of plane flows of a nonviscous gas in nozzles with no allowance for external flow are analyzed. It is shown that the thrust characteristics of a nozzle change substantially as the nonsymmetry of flow inside the nozzle increases. A method is proposed for obtaining more information on the integral characteristics of plane nozzles during calculations. V.L.

A84-47086
AN APPROXIMATE DETERMINATION OF THE CRITICAL MACH NUMBER FROM THE CALCULATED PRESSURE DISTRIBUTION [PRIBLIZHENNOE OPREDELENIE KRITICHESKOGO CHISLA MAKHA PO RASCHETNOMU RASPREDELENIIU DAVLENIIA]
V. A BARINOV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 6, 1983, p. 1-7. In Russian.

Experimentally determined critical Mach numbers for wings and airfoil profiles corresponding to the beginning of a steep increase in drag are analyzed. It is found that there exists a relationship between the critical Mach number and a certain characteristic Mach number. An approximate method is proposed for determining the characteristic Mach number from the calculated distribution of static pressure in the subcritical region. The method relies on the strong effect of the interaction between the shock wave and the preseparation boundary layer on the increase in drag. V.L.

A84-47087
INTERACTION BETWEEN A BOUNDARY LAYER AND AN EXTERNAL FLOW IN FLOWS OVER THIN AXISYMMETRIC BODIES [VZAIMODEISTVIE POGRANICHNOGO SLOIA S VNESHNIM POTOKOM PRI OBTEKANII TONKIKH OSESIMMETRICHNYKH TEL]
V. N. TRIGUB TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 6, 1983, p. 8-17. In Russian. refs

Longitudinal flow of a viscous incompressible fluid past a cylinder is investigated for the case where the thickness of the boundary layer is comparable with the cylinder radius. It is found that slight surface roughness and surface bends can lead to the interaction between the boundary layer and external potential flow. The asymptotic structure of the interaction is determined, and a solution is obtained to the linear boundary layer problem for flow around bends. During the interaction, perturbations on thin axisymmetric bodies are shown to attenuate exponentially in the upstream direction. V.L.

A84-47090
THE INTERACTION OF WALL JETS WITH INCOMING FLOW AND WITH EACH OTHER ON A PLANE [VZAIMODEISTVIE NA PLOSKOSTI PRISTENNYKH STRUI S NABEGAIUSHCHIM POTOKOM I MEZHDU SOBOI]
N. A. KOLOKOLTSEV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 6, 1983, p. 36-45. In Russian.

An approximate method is proposed for calculating the dividing line between a wall jet on a plane and an incoming flow parallel to the plane and also the dividing line between two wall jets. The wall jets considered here are formed by an axisymmetric subsonic turbulent jet spreading on the plane. Calculated results are presented in graphical form and compared with experimental data. V.L.

A84-47097
ON THE THEORY OF A TWO-SHELL PARACHUTE [K TEORII DVUKHOBOLOCHKOVOGO PARASHIUTA]
IU. B. LIFSHITS TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 6, 1983, p. 100-102. In Russian.

The problem considered here is that of slip-free flow of an incompressible nonviscous fluid past a finite-span wing in which the spanwise distribution of thickness is represented by a periodic function. By assuming that the period-to-chord ratio is small and changes in the relative thickness of the wing are only slight, the three-dimensional problem is reduced to a two-dimensional one. This is accomplished by using the method of matched asymptotic expansions. V.L.

A84-47098
THE PERTURBATION METHOD IN THE NONLINEAR PROBLEM OF SUPERSONIC FLOW PAST DELTA WINGS [METOD VOZMUSHCHENII V NELINEINOI ZADACHE OBTEKANIIA TREUGOL'NYKH KRYL'EV SVERKHZVUKOVYM POTOKOM]
T. M. PRITULO TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 6, 1983, p. 103-108. In Russian.

Flow past wings with supersonic leading edges is analyzed, with the flow assumed to be isentropic. The analysis employs the method of perturbations with respect to the initial uniform flow behind a shock wave. This approach, used in the context of the linear theory, makes it possible to substantially improve the accuracy of the solution. The method proposed here is illustrated by examples involving wings with rhombiform and double-wedge root profiles. V.L.

A84-47100
THE EFFECT OF GASDYNAMIC AND GEOMETRICAL PARAMETERS OF FLOW IN A STEPPED PIPE ON THE BASE PRESSURE [VLIIANIE GAZODINAMICHESKIKH I GEOMETRICHESKIKH PARAMETROV TECHENIIA V STUPENCHATOI TRUBE NA DONNOE DAVLENIE]
V. I. PENZIN TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 6, 1983, p. 113-120. In Russian. refs

The base pressure in a stepped pipe is investigated experimentally as a function of Re and M numbers, boundary layer thickness, nozzle generatrix angle, and pipe expansion ratio. The base pressure is found to depend to a large degree on the Re number of turbulent flow in front of the step. The thickness of the boundary layer has only a slight effect on the base pressure for thickness-to-diameter ratios exceeding 0.2. An increase in the nozzle generatrix angle above a certain limit leads to a restructuring of flow beyond the step and to an abrupt change in the base pressure. Empirical expressions relating the base pressure to the above parameters are presented. V.L.

A84-47132#
COMPRESSOR CASCADE OPTIMIZATION BASED ON INVERSE BOUNDARY LAYER METHOD AND INVERSE CASCADE METHOD. II - AN INVERSE BOUNDARY LAYER METHOD AND WIND-TUNNEL TESTS OF OPTIMIZED COMPRESSOR CASCADE WITH HIGH LOADING
A. GOTO (Ebara Corp., Fujisawa, Kanagawa, Japan), M. SHIRAKURA (Nikkiso Co., Ltd., Tokyo, Japan), and H. ENOMOTO (Tokyo, University, Tokyo, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 27, July 1984, p. 1366-1377. refs

An aerodynamic design algorithm to optimize the two-dimensional performance of turbine compressor cascades is developed, combining a new technique for solving the inverse boundary-layer problem of the surface velocity distribution with the inverse-cascade method of Goto and Shirakura (1984). A highly loaded cascade designed using the algorithm is constructed and tested in the 50 x 25-cm working section of a low-velocity wind tunnel with concentration ratio 9.52 and upstream turbulence 1 percent. The results are presented in graphs and tables, and drawings of the profiles and a flow chart of the design algorithm are provided. Good agreement is found between predicted and measured results, and the optimized cascade is shown to have a maximum lift/drag ratio 1.4 times that of the corresponding NACA 65 cascade. T.K.

A84-47390
THE DYNAMICS OF PARACHUTE OPENING [DINAMIKA RASKRYTIIA PARASHIUTA]
S. M. BELOTSERKOVSKII, I. V. DNEPROV, A. T. PONOMAREV, and O. V. RYSEV Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), May-June 1984, p. 174-179. In Russian. refs

The parachute opening process is investigated by combining numerical methods of nonlinear aerodynamics with elasticity theory. The approach, which involves joint integration of the equations of unsteady nonlinear aerodynamics and elasticity relationships of the kind proposed by Rakhmatulin (1975), has been implemented in computer software. The aerodynamic load is determined by using the Cauchy-Lagrange integral with allowance for the flow and parachute deformation history. V.L.

A84-47482
EFFECT OF AN ENTROPY LAYER ON THE PROPAGATION OF UNSTEADY PERTURBATIONS IN A BOUNDARY LAYER WITH SELF-INDUCED PRESSURE [O VLIIANII ENTROPIINOGO SLOIA NA RASPROSTRANENIE NESTATSIONARNYKH VOZMUSHCHENII V POGRANICHNOM SLOE S SAMOINDUTSIROVANNYM DAVLENIEM]
L. A. SOKOLOV PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), May-June 1984, p. 51-53. In Russian. refs

Solutions are obtained which correspond to traveling Tollmein-Schlichting waves in which neutral oscillations with a time-constant amplitude occur. It is assumed that the wave number and frequency can take complex values. Calculations are found to agree with experimental data concerning the effect of leading-edge bluntness on the stability of a boundary layer flow with an outer supersonic stream. B.J.

A84-47484
FLOW CHARACTERISTICS OF A VIBRATIONALLY RELAXING GAS IN NOZZLES WITH A REGION OF CONSTANT CROSS SECTION IN THE THROAT AREA [OB OSOBENNOSTIAKH TECHENIIA KOLEBATEL'NO-RELAKSIRUIUSHCHEGO GAZA V SOPLAKH S UCHASTKOM POSTOIANNOGO SECHENIIA V OBLASTI GORLA]
V. A. SALNIKOV PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), May-June 1984, p. 61-66. In Russian. refs

A difference method is used to obtain numerical results for the mixed subsonic and supersonic two-dimensional or axisymmetric nonequilibrium flow of an inviscid nonheat-conducting vibrationally relaxing gas in a plane convergent-divergent nozzle with a region of constant cross section in the throat area. The gasdynamic and thermodynamic structure of the flow is analyzed, and the effect of the length of the region of constant cross section on the gas dynamics and kinetics in the transonic part of the nozzle is investigated. It is shown that flow past corner points situated at the beginning of the region of constant cross section is accompanied by a reexpansion of the flow to supersonic velocity. B.J.

A84-47554
CALCULATION OF THREE-DIMENSIONAL TURBULENT JET PROPAGATION FROM A LOBE NOZZLE IN A SLIPSTREAM [RASCHET RASPROSTRANENIIA TREKHMERNOI TURBULENTNOI STRUI IZ LEPESTKOVOGO SOPLA V SPUTNOM POTOKE]
V. I. VASILEV, S. IU. KRASHENINNIKOV, and IU. A. RUDI Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 18-22. In Russian. refs

A method for calculating a three-dimensional turbulent jet propagating from a lobe nozzle in a bounded slipstream is proposed which is based on the assumption of the potentiality of secondary flows. Calculations are carried out using a single-parameter turbulence model, and the results obtained are compared with experimental data. V.L.

A84-47565
SELECTING AIR INTAKE PARAMETERS WITHOUT TRANSITION TO SONIC VELOCITY [O VYBORE PARAMETROV VOZDUKHOZABORNIKA BEZ PEREKHODA CHEREZ SKOROST' ZVUKA]
V. I. BAZHANOV and A. A. STEPCHKOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 69-71. In Russian. refs

An optimum system of skewed shock waves is selected for supersonic flight velocities (Mach 4-6) under the condition that the total stream rotation angle behind the skewed shock waves do not exceed a certain critical value corresponding to the onset of sonic flow. The approach proposed here is illustrated by an example in which systems of skewed shock waves are calculated for Mach 6. V.L.

A84-47622
THE THEORY FOR OPTIMAL LIFTING SURFACES [TEORIIA OPTIMAL'NOI NESUSHCHEI POVERKHNOSTI]
A. N. PANCHENKOV Novosibirsk, Izdatel'stvo Nauka, 1983, 256 p. In Russian. refs

The study presented here is concerned with the optimization of the geometry of aircraft wings. The subject is treated on the basis of the acceleration potential theory, the quadrupole wing theory, and asymptotic programming, with particular attention given to an analysis of extreme-value problems in wing theory. Various methods for solving ill-posed extreme-value problems in continuum mechanics are reviewed, and the principles of the optimum design of lifting surfaces are examined. Finally, a set of application programs for the computer-aided design of airfoils is described. V.L.

A84-47631
GAS FLOW AND HEAT TRANSFER IN ZONES OF SHOCK WAVE-BOUNDARY LAYER INTERACTION [TECHENIE GAZA I TEPLOOBMEN V ZONAKH VZAIMODEISTVIIA UDARNYKH VOLN S POGRANICHNYM SLOEM]
V. IA. BOROVOI Moscow, Izdatel'stvo Mashinostroenie, 1983, 144 p. In Russian. refs

Methods and results of experimental studies of supersonic and hypersonic gas flows in zones of shock wave-boundary layer interaction, such as are frequently formed at the surfaces of flight vehicles of various types, are reviewed. In particular, attention is given to the two-dimensional interaction between a plane shock wave and a boundary layer and to flow and heat transfer at the intersection of shock waves, near an air vane, near a cylindrical obstacle and a jet injected through a lateral surface, and at the surface of wings. The physical patterns of the flows and the

magnitudes of heat fluxes in the interaction zones are presented. V.L.

A84-47777
TWO-DIMENSIONAL GAS-PARTICLE FLOW PAST THIN BODIES [PLOSKOE OBTEKANIE TONKIKH TEL POTOKOM GAZA S CHASTITSAMI]
R. R. AIDAGULOV (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 277, no. 2, 1984, p. 319-322. In Russian. refs

A theoretical study of subsonic two-dimensional gas-particle flow past a thin body is presented. In the case of flow past smooth bodies, the pressure coefficient on the body (with the exception of the tip and tail) is found to vary continuously as a function of Mach number, even at the subsonic-to-supersonic transition. B.J.

A84-47846
CHARACTERISTICS OF STEADY HYPERSONIC FLOW PAST BLUNT BODIES WITH DISCONTINUITIES OF THE GENERATRIX [OSOBENNOSTI STATSIONARNOGO GIPERZVUKOVOGO OBTEKANIIA ZATUPLENNYKH TEL S IZLOMAMI OBRAZUIUSHCHIKH]
V. D. SEROVA Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), July 1984, p. 80-85. In Russian. refs

A calculation is made of parameters in the shock layer during the hypersonic flow past blunt bodies of revolution having generatrix discontinuities. These results are compared with calculations of flow characteristics for smooth cones, and the qualitative and quantitative differences are demonstrated. Distribution curves of the Cx(x) coefficient are shown to behave in a similar manner for bodies of different families, and isobar patterns near discontinuity points are presented. Different types of singularities are shown to arise in the isobar pattern in the region of interaction of bow and internal shock waves, as well as in the interaction of discontinuities reflected from the bow wave with the body. L.M.

A84-48126#
NUMERICAL SIMULATION OF WING-FUSELAGE AERODYNAMIC INTERACTION
J. S. SHANG (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452), vol. 22, Oct. 1984, p. 1345-1353. Previously cited in issue 05, p. 582, Accession no. A83-16595. refs

A84-48127*# Old Dominion Univ., Norfolk, Va.
GOERTLER INSTABILITY OF COMPRESSIBLE BOUNDARY LAYERS
N. M. EL-HADY (Old Dominion University, Norfolk, VA; King Abdulaziz University, Jeddah, Saudi Arabia) and A. K. VERMA AIAA Journal (ISSN 0001-1452), vol. 22, Oct. 1984, p. 1354, 1355; Abridged.
(Contract NSG-1645)

The instability of the laminar compressible boundary-layer flows along concave surfaces is investigated. The linearized disturbance equations for the three-dimensional, counter-rotating, longitudinal-type vortices in two-dimensional boundary layers are presented in an orthogonal curvilinear system of coordinates. The basic approximation of the disturbance equations, which includes the effect of the growth of the boundary layer, is considered and solved numerically. Author

A84-48129*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SUPERSONIC AXISYMMETRIC FLOW OVER BOATTAILS CONTAINING A CENTERED PROPULSIVE JET
G. S. DEIWERT (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 22, Oct. 1984, p. 1358-1365. Previously cited in issue 05, p. 586, Accession no. A83-16730. refs

A84-48131#
NUMERICAL SIMULATION OF NEAR-CRITICAL AND UNSTEADY, SUBCRITICAL INLET FLOW
R. W. NEWSOME (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452), vol. 22, Oct. 1984, p. 1375-1379. Previously cited in issue 05, p. 580, Accession no. A83-16570. refs

A84-48132#
AN AUTOMATIC ADAPTIVE NUMERICAL METHOD FOR LIFTING SURFACE THEORIES
S. ANDO (Nagoya University, Nagoya, Japan) and D.-H. LEE AIAA Journal (ISSN 0001-1452), vol. 22, Oct. 1984, p. 1380-1385. refs

For problems involving numerical lifting surface calculations, comparisons of the various approximate methods do not always yield satisfactory results. This paper presents a means of determining the accuracy of any approximate method without comparisons. Moreover, it enables the optimum ratio NS/NC (number of downwash chords/number of control points in the downwash chord) to be found automatically by just doing the necessary calculations to obtain any prescribed accuracy. For this purpose, a steepest descent method and an appropriate convergence theorem are used. Although this method is applied here mainly to vortex lattice methods (VLM) for wings in steady flow, it is a universal one applicable to any efficient unsteady VLMs or mode methods. Author

A84-48135*# Science Applications, Inc., Princeton, N.J.
INTERACTIVE PHENOMENA IN SUPERSONIC JET MIXING PROBLEMS. II NUMERICAL STUDIES
S. M. DASH and D. E. WOLF (Science Applications, Inc., Princeton, NJ) AIAA Journal (ISSN 0001-1452), vol. 22, Oct. 1984, p. 1395-1404. refs
(Contract NAS1-16535)

Applications of the numerical techniques discussed in Part I of this article are presented. Fundamental wave/shear-layer interaction calculations are performed exhibiting the waves produced by high-speed turbulent mixing processes and the interactions of an expansion fan and shock wave with a developing shear layer. Calculations for an underexpanded supersonic jet into a supersonic external stream at different velocity ratios are presented which delineate betweeen weakly interactive and strongly interactive processes in the jet near field. Calculations for the multiple-cell shock structure of an underexpanded jet into still air exhibit the damping of wave intensities by the turbulence and compare quite favorably with available data. Author

A84-49083#
STRUCTURE OF LIFT-GENERATED ROLLED-UP VORTICES
R. W. STAUFENBIEL (Aachen, Rheinisch-Westfaelische Technische Hochschule, Aachen, West Germany) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 737-744. refs

A simplified model is presented for wing-shed vortex sheets. Account is taken of conservation of vortical dispersion and energy. Calculations of the kinetic energy of a vortex pair demonstrate that the rotational energy must be larger than the induced drag. A distribution of the kinetic energy is then derived. The Lamb vortex model is modified by placing reduced circulation at the center and the remaining vorticity at the larger radius. A formula is thereby derived for the maximum tangential speed. The vortical motion is then approximated by discretizing the sheet into a number of vortex filaments and modeling the motion along the convection field. The modified model is recommended for use in describing the circulation distribution during wing loading. M.S.K.

A84-49085#
SLENDER WINGS WITH LEADING-EDGE VORTEX SEPARATION - A CHALLENGE FOR PANEL METHODS AND EULER SOLVERS
M. S. HITZEL and W. SCHMIDT (Dornier GmbH, Friedrichshafen, West Germany) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 751-759. Sponsorship: Bundesministerium der Verteidigung. Previously cited in issue 05, p. 588, Accession no. A83-16790. refs
(Contract BMVG-RUEF-04)

A84-49086#
HIGH-LIFT AIRFOIL DESIGN FROM THE HODOGRAPH
M. J. COHEN (Negev, University, Beersheva, Israel) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 760-766. refs

A hodograph method is described for designing high-lift airfoils with tailored pressure distributions. Particular note is taken of flat-roof type airfoils because all airfoils exhibit equivalent pressure distributions and large pressure differentials between the lower and upper surfaces in subsonic compressible flows. The hodograph plane is defined for any two-dimensional flow in terms of the potential function and the flow coordinates. Analytical methods are defined for obtaining closure of teh airfoils, selecting the leading- and trailing-edge stagnation points and ensuring that the velocity profile does not cross over itself during formation. The design procedures aea illustrated for three different flat-roof type airfoils using formulas which can be implemented on a desk-top calculator. M.S.K.

A84-49089#
MOTION OF AIRCRAFT TRAILING VORTICES NEAR THE GROUND
M. ATIAS and D. WEIHS (Technion - Israel Institute of Technology, Haifa, Israel) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 783-786. Previously cited in issue 19, p. 2793, Accession no. A83-41953. refs

A84-49093#
PAN AIR APPLICATIONS TO MUTUAL INTERFERENCE EFFECTS
A. CENKO (Grumman Aerospace Corp., Bethpage, NY), E. N. TINOCO (Boeing Commercial Airplane Co., Seattle, WA), and J. TUSTANIWSKYJ (Burroughs Corp., San Diego, CA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 803-808. Previously cited in issue 06, p. 706, Accession no. A84-17953. refs

A84-49094*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
NONLINEAR AERODYNAMIC EFFECTS ON BODIES IN SUPERSONIC FLOW
J. L. PITTMAN (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) and M. J. SICLARI (Grumman Aerospace Corp., Bethpage, NY) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 809-815. Previously cited in issue 06, p. 715, Accession no. A84-19245. refs

A84-49095#
EVALUATION OF NCOREL, PAN AIR, AND W12SC3 FOR SUPERSONIC WING PRESSURES
M. SICLARI, A. CENKO, B. ROSEN, W. MASON (Grumman Aerospace Corp., Bethpage, NY), and M. VISICH Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 816-822. Previously cited in issue 06, p. 715, Accession no. A84-19242. refs

A84-49097#
EXPERIMENTAL INVESTIGATION OF DYNAMIC STALL FOR A PITCHING AIRFOIL
D. C. DALEY (USAF, Foreign Technology Div., Wright-Patterson AFB, OH) and E. J. JUMPER (USAF, Institute of Technology, Wright-Patterson AFB, OH) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 831, 832. USAF-supported research. refs

Experimental data were obtained as an aid to modeling dynamic stall for airfoils pitching about the midchord at a constant rate in a uniform flow. Attention was focused on separation in a series of wind tunnel tests which furnished both pressure distribution data and flow visualization with smoke injection. A NACA 0015 airfoil was used in connection with a device that provided 0-90 deg AOA at rates from 30-90 deg/sec. Data were taken at a rate of 4000 samples/sec in flows with velocities ranging from 12.3-47 fps and Re from 78,300-301,000. Nonduplicated data were retained from 28 runs. A trend was detected in the quarter-chord separation AOA as a function of the angular rate. M.S.K.

A84-49107#
TRANSONIC WING AND WING/BODY FLOW COMPUTATIONS ON NON-SURFACE-CONFORMING GRIDS
G. E. CHMIELEWSKI (McDonnell Douglas Research Laboratories, St. Louis, MO) IN: Developments in mechanics. Volume 12 - Midwestern Mechanics Conference, 18th, Iowa City, IA, May 16-18, 1983, Proceedings . Iowa City, IA, University of Iowa, 1983, p. 71-74. Research supported by the McDonnell Douglas Independent Research and Development Program. refs

A technique using nonconforming grids to compute the inviscid transonic flow field around a wing-body configuration is outlined. The physical and computational domains and the relationships linking them are characterized; the full potential equation in nonconservative form used as the flow model and the boundary conditions imposed on the wing-body surface, the centerline, and the external faces of the domain are defined; and the problems involved in the rotated finite-differences numerical solution scheme are indicated. T.K.

A84-49113#
APPLICATION OF A NEW NAVIER-STOKES SOLVER TO THREE-DIMENSIONAL JET FLOWS
W. W. BOWER, R. K. AGARWAL, and G. R. PETERS (McDonnell Douglas Research Laboratories, St. Louis, MO) IN: Developments in mechanics. Volume 12 - Midwestern Mechanics Conference, 18th, Iowa City, IA, May 16-18, 1983, Proceedings . Iowa City, IA, University of Iowa, 1983, p. 211-214. Research supported by the McDonnell Douglas Independent Research and Development Program. refs

The third-order-accurate upwind-difference numerical solution algorithm developed by Agarwal (1981) for the complete time-averaged Navier-Stokes equations of three-dimensional incompressible flow fields dominated by viscous effects is summarized, and its application to two sample problems is briefly described. The flow-field model is based on the Navier-Stokes equations and the k-epsilon model and comprises three Poisson equations for the velocity components, three transport equations for the vorticity components, and two transport equations for the turbulence parameters; coordinate-stretching transformations are used to simplify the application of the boundary conditions. The cases of a free jet bent by a normal stream or deflected by a normal plane (as during takeoff or hover of a VTOL aircraft) are considered. T.K.

A84-49389
A NEW AIRCRAFT DESIGN TOOL - COMPUTATIONAL FLUID DYNAMICS
J. E. GRAHAM (USAF, Wright-Aeronautical Laboratories, Wright-Patterson AFB, OH) Defense Systems Review and Military Communications, vol. 2, Sept. 1984, p. 49-52. refs

The development of Computational Fluid Dynamics (CFD) for solving aerodynamic problems without wind tunnel experiments is discussed. After a brief review of the history of aerodynamic theory, consideration is given to the use of computers with graphic capabilities for solving aerodynamic problems which normally require wind tunnel experiments. Because of the greater computational power of conventional computers, solutions to the important Navier-Stokes equations can be obtained for flows around a three dimensional object. Regions where flow variables are expected to have large gradients are covered by a dense portion of a computational mesh which can be graphically represented on a computer screen. At present, however, it is only possible to compute the flow around an advanced aircraft piece by piece. It is shown that the development of next generation computers will

permit the computation of all the important Navier-Stokes equations simultaneously. It is predicted that the increasing costs of ground tests will make the development of computer-aided aerodynamic analysis more attractive in the future. I.H.

A84-49503#
RE-EXAMINATION OF THE MAXIMUM NORMALIZED VORTEX-INDUCED SIDE FORCE
J. P. REDING and L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Spacecraft and Rockets (ISSN 0002-4650), vol. 21, Sept.-Oct. 1984, p. 433-440. Previously cited in issue 05, p. 586, Accession no. A83-16727. refs

A84-49546#
AERODYNAMIC CHARACTERISTICS FOR HEAVE DISPLACEMENT OF A SLENDER ROUND-NOSED BODY OF REVOLUTION IN A TUBE
H. NAKATANI and Y. MIYAI (Osaka Prefecture, University, Sakai, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, May 1984, p. 12-24. refs

A second-order expansion of the velocity potential for steady incompressible flow has been obtained for a slender body of revolution placed with a heave displacement in a long tube using the method of matched asymptotic expansions. The chordwise distribution of pressure coefficients due to the heave displacement is shown. Normal force coefficients and longitudinal and lateral added-mass or virtual-mass coefficients on the body are also calculated for various blockage ratios. These coefficients change linearly with the blockage ratio. The second-order longitudinal added-mass coefficients in the limiting case that the tube radius becomes infinite are compared with those given by Thwaites (1960) and Prasad and Subramaniam (1975) in free air and found to be in good agreement with the exact theory of Thwaites. Author

N84-33374 Stanford Univ., Calif.
AN EXPERIMENTAL INVESTIGATION OF AN UNDEREXPANDED RECTANGULAR JET EJECTOR Ph.D. Thesis
Y. C. HSIA 1984 125 p
Avail: Univ. Microfilms Order No. DA8412853

An experimental investigation was carried out on a rectangular ejector (constant area mixing duct) with an underexpanded rectangular jet as the primary flow. The purpose of this investigation is to study the mixing behavior of the ejector flow in general and to identify the effects of the screech tones on the mixing and performance of the ejector in particular. The quantities measured include frequency and amplitude of the screech tone, surface pressure on the ejector duct wall, and the mean flow velocity at the ejector exit in the two central planes of the primary jet. Schlieren flow visualization was made in the plane containing the short dimension of the primary nozzle. It has been found that the screech tone frequency of the ejector depends not only on the primary jet pressure ratio but also on the ejector duct width. The variations of the screech tone frequency with both the pressure ratio and the duct width show staging behavior. For a given duct width, each screech tone stage matches with one of the transverse modes of the duct. Dissert. Abstr.

N84-33375 Mississippi State Univ., Mississippi State.
A FULLY VECTORIZED NUMERICAL SOLUTION OF THE INCOMPRESSIBLE NAVIER-STOKES EQUATIONS Ph.D. Thesis
N. R. PATEL 1983 178 p
Avail: Univ. Microfilms Order No. DA8413955

A vectorizable algorithm is presented for the implicit finite difference solution of the incompressible Navier-Stokes equations in general curvilinear coordinates. The unsteady Reynolds averaged Navier-Stokes equations solved are in two-dimension and non-conservative primitive variable form. A two-layer algebraic eddy viscosity turbulence model is used to incorporate the effects of turbulence. Two momentum equations and a Poisson pressure equation, which is obtained by taking the divergence of the momentum equations and satisfying the continuity equation, are solved simultaneously at each time step. An elliptic grid generation approach is used to generate a boundary-conforming coordinate system about an airfoil. The governing equations are expressed in terms of the curvilinear coordinates and are solved on a uniform rectangular computational domain. A checkerboard SOR, which can effectively utilize the computer architectural concept of vector processing, is used for iterative solution of the governing equations. Dissert. Abstr.

N84-33376 Mississippi State Univ., Mississippi State.
TRANSONIC VISCOUS-INVISCID INTERACTION USING EULER AND INVERSE BOUNDARY-LAYER EQUATIONS Ph.D. Thesis
J. L. THOMAS 1983 116 p
Avail: Univ. Microfilms Order No. DA8413963

Transonic viscous-inviscid interaction is considered using Euler and inverse boundary-layer equations. The inverse boundary-layer equations are solved with a compressible, turbulent, mean-flow kinetic energy integral method. The integral method, originally developed for attached flows, is modified to account for separated flows by extensions to the velocity profile and turbulence models. Two velocity profile models are considered and each is reduced to a one-parameter family for separated flows by means of correlation with experimental data. A satisfactory description of turbulent velocity profiles can be obtained with either model. An approximate lag equation for the dissipation is developed. Prescribed displacement thickness (non-interacting) computations with the integral method are compared with experimental results for a low-speed separation diffuser and several normal shock-wave boundary-layer interactions. The Euler equations are used to represent the inviscid flow and are solved with a conservative, finite-volume, Runge-Kutta time-stepping scheme. Modifications are made to account for wall porosity boundary conditions. Dissert. Abstr.

N84-33377*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AERODYNAMIC DESIGN OF THE CONTOURED WIND-TUNNEL LINER FOR THE NASA SUPERCRITICAL, LAMINAR-FLOW-CONTROL, SWEPT-WING EXPERIMENT
P. A. NEWMAN, E. C. ANDERSON, and J. B. PETERSON, JR. Sep. 1984 46 p refs
(NASA-TP-2335; L-15521; NAS 1.60:2335) Avail: NTIS HC A03/MF A01 CSCL 01A

An overview is presented of the entire procedure developed for the aerodynamic design of the contoured wind tunnel liner for the NASA supercritical, laminar flow control (LFC), swept wing experiment. This numerical design procedure is based upon the simple idea of streamlining and incorporates several transonic and boundary layer analysis codes. The liner, presently installed in the Langley 8 Foot Transonic Pressure Tunnel, is about 54 ft long and extends from within the existing contraction cone, through the test section, and into the diffuser. LFC model testing has begun and preliminary results indicate that the liner is performing as intended. The liner design results presented in this paper, however, are examples of the calculated requirements and the hardware implementation of them. Author

N84-33378*# United Technologies Research Center, East Hartford, Conn.
REFINEMENT AND EVALUATION OF HELICOPTER REAL-TIME SELF-ADAPTIVE ACTIVE VIBRATION CONTROLLER ALGORITHMS Final Report
M. W. DAVIS NASA Aug. 1984 285 p refs
(Contract NAS2-11260)
(NASA-CR-3821; NAS 1.26:3821; R83-956149-16) Avail: NTIS HC A13/MF A01 CSCL 01A

A Real-Time Self-Adaptive (RTSA) active vibration controller was used as the framework in developing a computer program for a generic controller that can be used to alleviate helicopter vibration. Based upon on-line identification of system parameters, the generic controller minimizes vibration in the fuselage by closed-loop implementation of higher harmonic control in the main

rotor system. The new generic controller incorporates a set of improved algorithms that gives the capability to readily define many different configurations by selecting one of three different controller types (deterministic, cautious, and dual), one of two linear system models (local and global), and one or more of several methods of applying limits on control inputs (external and/or internal limits on higher harmonic pitch amplitude and rate). A helicopter rotor simulation analysis was used to evaluate the algorithms associated with the alternative controller types as applied to the four-bladed H-34 rotor mounted on the NASA Ames Rotor Test Apparatus (RTA) which represents the fuselage. After proper tuning all three controllers provide more effective vibration reduction and converge more quickly and smoothly with smaller control inputs than the initial RTSA controller (deterministic with external pitch-rate limiting). It is demonstrated that internal limiting of the control inputs a significantly improves the overall performance of the deterministic controller. B.W.

N84-33379*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN EXPERIMENTAL AND THEORETICAL INVESTIGATION OF DEPOSITION PATTERNS FROM AN AGRICULTURAL AIRPLANE
D. J. MORRIS, C. C. CROOM, C. P. VANDAM (Kansas Univ., Lawrence), and B. J. HOLMES Sep. 1984 157 p refs
(NASA-TP-2348; L-15718; NAS 1.60:2348) Avail: NTIS HC A08/MF A01 CSCL 01A

A flight test program has been conducted with a representative agricultural airplane to provide data for validating a computer program model which predicts aerially applied particle deposition. Test procedures and the data from this test are presented and discussed. The computer program features are summarized, and comparisons of predicted and measured particle deposition are presented. Applications of the computer program for spray pattern improvement are illustrated. Author

N84-33380*# National Aeronautics and Space Administration, Washington, D. C.
KASPRZYK AIRFOIL. THE FIRST WIND-TUNNEL TESTS
T. WUSATOWSKI Oct. 1984 8 p Transl. into ENGLISH from Tech. Lonicza i Astronautyczna (Poland), v. 30, no. 9, Sep. 1975 p 9-10 Original language document was announced as A76-11893 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-3541)
(NASA-TM-77757; NAS 1.15:77757) Avail: NTIS HC A02/MF A01 CSCL 01A

The Kasprzyk slotted flap glider airfoil (the Kasper wing) enabling glider flight at 32 km/h and 0.5 m/sec descent speed was wind tunnel tested in the U.S. The test layout is described and reasons offered for discrepancies between wind tunnel results and Polish in flight data: high induced drag caused by relative size of model wing span and tunnel, by vortex attenuators on the model and their proximity to the tunnel wall, nonsimilarity between flow over a smooth wing and flow over the Kasprzyk wing with bound vortices, obstruction of the tunnel test chamber cross section by the model wing, discrepant Reynolds numbers, and model airfoil aspect ratio much smaller than the prototype. The overall results offer partial confirmation of the Kasprzyk theory, but further in tunnel and in flight studies are recommended. (IAA)

N84-33381*# National Aeronautics and Space Administration, Washington, D. C.
EXPERIMENTAL DETERMINATION OF THE INERTIA CONSTANTS OF AN AIRPLANE OR OF A MISSILE
H. LOISEAU Mar. 1983 26 p refs Transl. into ENGLISH from La Rech. Aerospatiale (France), no. 120, 1967 p 53-62 Original language doc. was announced as A68-11437 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(NASA-TM-77767; NAS 1.15:77767) Avail: NTIS HC A03/MF A01 CSCL 01A

The possibility to measure the inertia constants of an airplane or of a missile by a unique experimental set up without having to materialize axes of rotation was investigated. It is sufficient to suspend the structure appropriately, to obtain the six natural modes determined by the suspension and to introduce these results as data into a computer. If the structure is very flexible it is necessary to take into account the first natural modes of deformation. Experiments on rigid and flexible models led to precise results and allow consideration of full scale measurements. The final goal is to provide, by a standard ground vibration test completed by the measured characteristics of the suspension modes, the set of data necessary for flutter calculations and for the determination of all the inertia constants. E.A.K.

N84-33382*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
HIGH REYNOLDS NUMBER TESTS OF THE CAST 10-2/DOA 2 AIRFOIL IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL, PHASE 2
D. A. DRESS, E. STANEWSKY (DFVLR), P. D. MCGUIRE, and E. J. RAY Aug. 1984 307 p refs
(NASA-TM-86273; NAS 1.15:86273) Avail: NTIS HC A14/MF A01 CSCL 01A

Wind tunnel tests of an advanced technology airfoil, the CAST 10-2/DOA 2, were conducted in the Langley 0.3-Meter Transonic Cryogenic Tunnel (0.3-m TCT). This was the third of a series of tests conducted in a cooperative airfoil research program between the National Aeronautics and Space Administration and the Deutsche Forschungsund Versuchsanstalt fur Luft- und Raumfahrt e. V. For these tests, temperature was varied from 270 K to 110 K at pressures from 1.5 to 5.75 atmospheres. Mach number was varied from 0.60 to 0.80, and the Reynolds number (based on airfoil chord) was varied from 2 to 20 million. The aerodynamic data for the 7.62 cm chord airfoil model used in these tests is presented without analysis. Descriptions of the 0.3-m TCT, the airfoil model, the test instrumentation, and the testing procedures are included. Author

N84-33383*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRENDS IN COMPUTATIONAL CAPABILITIES FOR FLUID DYNAMICS
V. L. PETERSON Sep. 1984 12 p refs
(NASA-TM-86012; A-9860; NAS 1.15:86012) Avail: NTIS HC A02/MF A01 CSCL 01A

Milestones in the development of computational aerodynamics are reviewed together with past, present, and future computer performance (speed and memory) trends. Factors influencing computer performance requirements for both steady and unsteady flow simulations are identified. Estimates of computer speed and memory that are required to calculate both inviscid and viscous, steady and unsteady flows about airfoils, wings, and simple wing body configurations are presented and compared to computer performance which is either currently available, or is expected to be available before the end of this decade. Finally, estimates of the amounts of computer time that are required to determine flutter boundaries of airfoils and wings at transonic Mach numbers are presented and discussed. Author

N84-33385*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DATA FROM TESTS OF A R4 AIRFOIL IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL
R. V. JENKINS, W. G. JOHNSON, JR., A. S. HILL, R. MUELLER (Deutsche Forshungs- und Versuchsanstalt fuer Luftund Raumfahrt), and G. REDEKER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt) Sep. 1984 356 p refs
(NASA-TM-85739; NAS 1.15:85739) Avail: NTIS HC A16/MF A01 CSCL 01A

Aerodynamic data for the DFVLR R4 airfoil are presented in both graphic and tabular form. The R4 was tested in the Langley 0.3-Meter Transonic Cryogenic Tunnel (TCT) at Mach number from 0.60 to 0.78 at angles of attack from -2.0 to 8.0 degrees. The

airfoil was tested at Reynolds numbers of 4, 6, 10, 15, 30, and 40 million based on the 152.32 mm chord. Author

N84-33387*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.
VORCAM: A COMPUTER PROGRAM FOR CALCULATING VORTEX LIFT EFFECT OF CAMBERED WINGS BY THE SUCTION ANALOGY
C. E. LAN and J. F. CHANG Nov. 1981 123 p refs
(Contract NSG-1629)
(NASA-CR-165800; NAS 1.26:165800; CRINC-FRL-426-2) Avail: NTIS HC A06/MF A01 CSCL 01A

A user's guide to an improved version of Woodward's chord plane aerodynamic panel computer code is presumed. The guide can be applied to cambered wings exhibiting edge separated flow, including those with leading edge vortex flow at subsonic and supersonic speeds. New orientations for the rotated suction force are employed based on the momentum principal. The supersonic suction analogy method is improved by using an effective angle of attack defined through a semiempirical method. E.A.K.

N84-33389# National Aeronautical Establishment, Ottawa (Ontario). High Speed Aerodynamics Lab.
TRANSONIC EQUIVALENCE RULE WITH LIFT Aeronautical Report
Y. Y. CHAN Mar. 1984 47 p
(AD-A143591; NAE-LR-614-PT-2; NRC-23412) Avail: NTIS HC A03/MF A01 CSCL 20D

The experimental study of the transonic equivalence rule with lift, has been extended to include a configuration of swept-back wing-body and the corresponding equivalent bodies for lift and zero-lift. For zero lift, the wing-body is shown to have higher wave drag than that of the equivalent body. At lifting condition, the analyses of the data, including those of the delta wing-bodies have verified the similitude of drag rise due to lift between the wing-bodies. The additional drag induced by the effective area due to lift on the equivalent body was found to agree reasonably with the wave drag generated by lift on the wing-body. The experiment thus verified the area rule with lift which must be considered in the optimal design of transonic configurations. GRA

N84-33390# Calspan Field Services, Inc., Arnold Air Force Station, Tenn.
UNSTEADY VISCOUS-INVISCID INTERACTION PROCEDURES FOR TRANSONIC AIRFOIL FLOWS Final Report, 1 Oct. 1982 - 30 Sep. 1983
T. L. DONEGAN Jul. 1984 55 p
(AD-A143764; AEDC-TR-84-7) Avail: NTIS HC A04/MF A01 CSCL 20D

This study is concerned with the development of a computational algorithm for viscous-inviscid interactions with application to two-dimensional transonic airfoil flows. The inner viscous flow is computed by the integral method of Whitfield, while the external flow is calculated by Jameson's Euler equation code. The two flows are matched by a linearized boundary condition at the airfoil surface. Of particular interest is the use of a time-dependent boundary-layer calculation method since it has been determined that a time-dependent method is desirable for extending the interaction method to three-dimensional flows. In general, it is found that the agreement between theoretical prediction and experimental data is satisfactory for engineering calculations. GRA

N84-33391# Applied Research Lab., State College, Pa.
SIDEWALL BOUNDARY LAYER CORRECTIONS IN SUBSONIC, 2-DIMENSIONAL AIRFOIL-HYDROFOIL TESTING Technical Memo
A. L. TREASTER, P. P. JACOBS, JR., and G. B. GURNEY 3 Mar. 1984 43 p
(Contract N00024-79-C-6043)
(AD-A144002; AD-E850686; ARL/PSU/TM-84-43) Avail: NTIS HC A03/MF A01 CSCL 20D

Historically, two-dimensional airfoil or hydrofoil section characteristics have been obtained by measuring individually the lift, drag and pitching moment by the most accurate technique available. The use of force balances to measure the three quantities simultaneously has met with only partial success. Although the lift and pitching moment data have usually been acceptable, the drag data have varied by as much as an order or magnitude from previous reference data. To investigate the parameters which influence two-dimensional force measurements, an experimental program was conducted in the subsonic wind tunnel of the Applied Research Laboratory at The Pennsylvania State University. From the results of this test program, the sidewall boundary layer was identified as the primary factor contributing to the erroneous drag measurements. A correction procedure which is based on the airfoil/hydrofoil geometry, the flow environment and the measured data was developed. Corrected data from the subject test program and from similar programs in other experimental facilities for both symmetrical and cambered sections are in good agreement with the reference data in all cases. Author (GRA)

N84-33393# Technische Hochschule, Darmstadt (West Germany). Inst. fuer Flugtechnik.
EXPERIMENTAL INVESTIGATIONS ON AIRFOILS WITH DIFFERENT GEOMETRIES IN THE DOMAIN OF HIGH ANGLES OF ATTACK Final Report [EXPERIMENTELLE UNTERSUCHUNGEN AN FLUEGELN VERSCHIEDENER GOEMETRIE IM HOHEN ANSTELLWINKELBEREICH]
J. KEIL 26 Mar. 1984 95 p refs In GERMAN
(Contract DFG-HA-515/57)
(REPT-A-5/84-PT-1) Avail: NTIS HC A05/MF A01

Wind tunnel tests were conducted on airfoil models in order to study the flow separation phenomena occurring for high angles of attack. Pressure distribution on wings of different geometries were measured. Results show that for three-dimensional airfoils layout and span lift play a role. Separation effects on airfoils with moderate extension are three-dimensional. The flow domains separated from the air foil must be treated three-dimensionally. The rolling-up of separated vortex layers increases with angle in intensity and induction effect and shows strong nonlinearities. Boundary layer material moves perpendicularly to the flow direction due to the pressure gradients at the airfoil; this has a stabilizing effect. The separation starts earlier with increasing pointed profiles. Author (ESA)

N84-34402# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Flight Test Department.
A TECHNIQUE TO DETERMINE LIFT AND DRAG POLARS IN FLIGHT
A. KNAUS *In* AGARD Flight Test Tech. 14 p Jul. 1984
Avail: NTIS HC A16/MF A01

Performance trials of the European combat aircraft Tornado concentrated on the systematic measurement of lift and drag polars. Such polars were successfully measured by means of well-adapted test instrumentation, a data reduction system, and a high calibration standard of the aircraft and engines. The use of a certain combination of steady state and dynamic test maneuvers resulted in a drastic reduction in the amount of flight time required to obtain sufficient data for the determination of the zero lift drag, induced drag characteristics, and drag increments due to aircraft configuration changes. Flight test results are presented which demonstrate the advantage of the test technique utilized and the high data quality achieved. R.S.F.

N84-34426# Joint Publications Research Service, Arlington, Va.
ROLE OF AERODYNAMICS IN TUPOLEV, ILYUSHIN AIRCRAFT DESIGNS
G. YUDIN *In its* USSR Rept.: Transp. (JPRS-UTR-84-027) p 14-18 24 Sep. 1984 Transl. into ENGLISH from Grazhdanskaya Aviats. (Moscow), no. 6, Jun. 1984 p 34-35
Avail: NTIS HC A04

The outlines of a new aircraft which originate in scientific search are examined. The design methods are based on the comprehensive solution of numerous designer problems, the majority of which are based on aerodynamics. The choice of an aerodynamic configuration of a new aircraft was based on theoretical and experimental studies to attain high aerodynamic efficiency and given lifting characteristics of the wing. These parameters will determine whether the aircraft is economical, easily controllable, and stable in various flying conditions, and will determine whether the aircraft designers' work will lead to the desired results. E.A.K.

N84-34428*# Compass Systems, Inc., San Diego, Calif.
WAKE PROFILE MEASUREMENTS OF FIXED AND OSCILLATING FLAPS
F. K. OWEN Apr. 1984 38 p refs
(Contract NAS2-11080)
(NASA-CR-166602; NAS 1.26:166602) Avail: NTIS HC A03/MF A01 CSCL 01A

Although the potential of laser velocimetry for the non-intrusive measurement of complex shear flows has long been recognized, there have been few applications in other small, closely controlled laboratory situations. Measurements in large scale, high speed wind tunnels are still a complex task. To support a study of periodic flows produced by an oscillating edge flap in the Ames eleven foot wind tunnel, this study was done. The potential for laser velocimeter measurements in large scale production facilities are evaluated. The results with hot wire flow field measurements are compared. S.B.

N84-34429*# *Compass Systems, Inc., San Diego, Calif.*
LASER VELOCIMETER MEASUREMENTS OF DYNAMIC STALL
F. K. OWEN Apr. 1984 25 p refs
(Contract NAS2-11080)
(NASA-CR-166603; NAS 1.26:166603) Avail: NTIS HC A02/MF A01 CSCL 01A

Laser velocimeter measurements were made during the study of a two-dimensional NACA 0012 airfoil undergoing conditions of dynamic stall. The measurements, which were obtained in the Ames 2 foot wind tunnel at reduced frequencies of 0.12 and 1.2, show significant flow field hysteresis around the static stall angle. Comparisons were also made with dual-plate interferograms and good agreement was found for the attached flow cases. For separated flow, characteristic vortex shedding caused poor agreement and significantly increased the measured Reynolds shear stresses. Author

N84-34430*# Aerometrics, Inc., Mountain View, Calif.
FLOW-FIELD MEASUREMENTS ON AN AIRFOIL WITH AN OSCILLATING TRAILING-EDGE USING HOLOGRAPHIC INTERFEROMETRY
W. D. BACHALO Jul. 1984 146 p refs
(Contract NAS2-11080)
(NASA-CR-166604; NAS 1.26:166604) Avail: NTIS HC A07/MF A01 CSCL 01A

Holographic interferometry data were acquired on an NACA 64A010 airfoil with an oscillating flap. The airfoil was installed in the Ames 11-Foot Transonic Wind Tunnel between splitter plates. Recordings were made at discrete phase angles of the oscillation. The interferometry results provided detailed flow visualization of the shock boundary-layer interaction and the separated flow. Quantitative results were extracted from the interferograms to produce pressure data. These results were compared to the surface pressures obtained with the surface pressure taps. Excellent agreement was found for low angles of incidence. At larger angles of incidence, the flow had greater three-dimensionality, and the results were not in good agreement in some regions of the flow field. Mach contours were traced for representative flow conditions. Wake profiles were also obtained using the assumption of constant pressure across the wake and the Crocco relationship. Author

N84-34431*# Integrated Systems, Inc., Palo Alto, Calif.
COMPARISON OF FREQUENCY-DOMAIN AND TIME-DOMAIN ROTORCRAFT VIBRATION CONTROL METHODS
N. K. GUPTA Apr. 1984 149 p refs
(Contract NAS2-11271)
(NASA-CR-166570; NAS 1.26:166570) Avail: NTIS HC A07/MF A01 CSCL 01A

Active control of rotor-induced vibration in rotorcraft has received significant attention recently. Two classes of techniques have been proposed. The more developed approach works with harmonic analysis of measured time histories and is called the frequency-domain approach. The more recent approach computes the control input directly using the measured time history data and is called the time-domain approach. The report summarizes the results of a theoretical investigation to compare the two approaches. Five specific areas were addressed: (1) techniques to derive models needed for control design (system identification methods), (2) robustness with respect to errors, (3) transient response, (4) susceptibility to noise, and (5) implementation difficulties. The system identification methods are more difficult for the time-domain models. The time-domain approach is more robust (e.g., has higher gain and phase margins) than the frequency-domain approach. It might thus be possible to avoid doing real-time system identification in the time-domain approach by storing models at a number of flight conditions. The most significant error source is the variation in open-loop vibrations caused by pilot inputs, maneuvers or gusts. The implementation requirements are similar except that the time-domain approach can be much simpler to implement if real-time system identification were not necessary. B.W.

N84-34432*# National Aeronautics and Space Administration, Washington, D. C.
A NEW METHOD OF EVALUATING THE SIDE WALL INTERFERENCE EFFECT ON AIRFOIL ANGLE OF ATTACK BY SUCTION FROM THE SIDE WALLS
H. SAWADA, S. SAKAKIBARA, M. SATO, H. KANDA, and T. KARASAWA Aug. 1984 39 p refs Transl. into ENGLISH of "Sokuhtkikarano Suikomi ni Yogu Tsubasa Gata Geikakueno Sokuh Ekikansho Kohkano Atarashi" rept. NAL-TR-680 National Aerospace Lab., Tokyo, Aug. 1981 p 1-18 Original language document was announced as N82-17123 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASW-3542)
(NASA-TM-77722; NAS 1.15:77722; NAL-TR-680) Avail: NTIS HC A03/MF A01 CSCL 01A

A quantitative evaluation method of the suction effect from a suction plate on side walls is explained. It is found from wind tunnel tests that the wall interference is basically described by the summation form of wall interferences in the case of two dimensional flow and the interference of side walls. Author

03

AIR TRANSPORTATION AND SAFETY

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

A84-47261
AGES EXPLORATORY DEVELOPMENT INVESTIGATION OF AIRCREW EMERGENCY ESCAPE RAM-AIR INFLATED FLEXIBLE WING
M. C. BUTLER (U.S. Naval Weapons Center, China Lake, CA) SAFE Journal, vol. 14, Fall 1984, p. 16-23.

The objective of the Aircrew Gliding Escape System (AGES) program is to investigate the feasibility of incorporating a ram-air inflated flexible wing parachute canopy into contemporary military aircrew ejection seat escape systems. This report describes the research, development, fabrication, and testing of the AGES ram-air inflated parachute wings. The primary focus of the investigation to date has been on high-airspeed tests to obtain data on the structural integrity of the parachute wing and reefing system design and performance. Tests were made on 13 configurations over a period of eight years, including 36 torso dummy drop tests and one Cylindrical Test Vehicle (CTV) test used to evaluate the compatibility of the AGES canopy with the sealed pack developed for the Maximum Performance Ejection Seat (MPES) Program. These tests provided data on the structural integrity of the wing, container design, deployment dynamics, reefing performance, and inflation dynamics. The final configuration was tested at speeds as high as 300 KIAS pack open without structural damage.
Author

A84-47349
HANDBOOK FOR PARACHUTE INSTRUCTORS [SPRAVOCHNIK INSTRUKTORA-PARASHIUTISTA]
V. A. SMIRNOV Moscow, Izdatel'stvo DOSAAF SSSR, 1983, 144 p. In Russian.

A handbook describing the basic design specifications and recommended operating procedures for parachutes is presented. Attention is given to various types of parachutes including emergency, training, and backup parachutes, and some important parachute devices incorporated into the AN-2 aircraft are described. Several methods for enhancing the safety of parachute jumps are considered, as well as some training techniques for amateur skydivers. I.H.

A84-48521
SPEED-SENSING SEATS - MARTIN-BAKER ADAPTS TO STAY AHEAD
B. WANSTALL Interavia (ISSN 0020-5168), vol. 39, Sept. 1984, p. 961, 962.

Several types of rocket-powered ejection seat systems are described including the Mk10; Mk12 (which is currently being qualified for the Harrier GR5); the Naval Aircrew Common Ejection Seat: a single type of advanced seat with variable delay settings being specified by the U.S. Navy for use in F/A-18s, the F-14D, the Grumman A-6F, and the MDC/BAe T-45; and a new emergency escape system being developed by the Douglas Aircraft Company under a U.S. Air Force crew escape technologies (CREST) development program. The primary features of the CREST program are outlined, and the current production status of Mk4, Mk8L, Mk10, and Mk10L ejection seat systems is examined. J.P.

A84-48536
AIRPORT NOISE MODELLING AND AIRCRAFT SCHEDULING SO AS TO MINIMIZE COMMUNITY ANNOYANCE
L. FRAIR (Virginia Polytechnic Institute and State University, Blacksburg, VA) Applied Mathematical Modelling (ISSN 0307-904X), vol. 8, Aug. 1984, p. 271-281. refs

A nonlinear mathematical model of the annoyance created by commercial aircraft to residents near airports is described. The model uses population distribution considerations and the annoyance caused by aircraft noise over a period of 24 hours. Several constraint relationships are included in the model, including aircraft type, time period, the demand for flight services, and the number of operations for each aircraft type. The solution technique for the model makes use of a successive linear approximation algorithm. An attractive feature of the solution algorithm is that it is capable of obtaining solutions to problems involving several thousand variables and over 500 linear constraints. By rescheduling flights on the basis of model predictions it is estimated that between 10 and 40 percent reductions in noise impacts are possible. I.H.

A84-49092*# Tennessee Univ., Tullahoma.
SIMULATED FLIGHT THROUGH JAWS WIND SHEAR
W. FROST (Tennessee, University; FWG Associates, Inc., Tullahoma, TN), K. L. ELMORE, J. MCCARTHY (National Center for Atmospheric Research, Boulder, CO), and H.-P. CHANG Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 797-802. Research supported by the National Center for Atmospheric Research, NSF, and NOAA; U.S. Department of Transportation. Previously cited issue 06, p. 716, Accession no. A84-17992. refs
(Contract DOT-FA01-82-Y-10513; NASA ORDER H-59314-B)

N84-33394* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FIRE BLOCKING SYSTEMS FOR AIRCRAFT SEAT CUSHIONS Patent
J. A. PARKER and D. A. KOURTIDES, inventors (to NASA) 7 Aug. 1984 9 p Filed 23 Dec. 1982 Supersedes N83-17525 (21 - 08, p 1132)
(NASA-CASE-ARC-11423-1; NAS 1.71:ARC-11423-1; US-PATENT-4,463,465; US-PATENT-APPL-SN-452466; US-PATENT-CLASS-5-459; US-PATENT-CLASS-297-DIG.5; US-PATENT-CLASS-428-71; US-PATENT-CLASS-428-76; US-PATENT-CLASS-428-246; US-PATENT-CLASS-428-280; US-PATENT-CLASS-428-287; US-PATENT-CLASS-428-304.4; US-PATENT-CLASS-428-319.1; US-PATENT-CLASS-428-423.5; US-PATENT-CLASS-428-921) Avail: US Patent and Trademark Office CSCL 01C

A configuration and method for reducing the flammability of bodies of organic materials that thermally decompose to give flammable gases comprises covering the body with a flexible matrix that catalytically cracks the flammable gases to less flammable species. Optionally, the matrix is covered with a gas impermeable outer layer. In a preferred embodiment, the invention takes the form of an aircraft seat in which the body is a poly(urethane) seat cushion, the matrix is an aramid fabric or felt and the outer layer is an aluminum film.
Official Gazette of the U.S. Patent and Trademark Office

N84-33395# Dayton Univ., Ohio. Div. of Aerospace Mechanics.
IMPROVING THE BIRDSTRIKE RESISTANCE AND DURABILITY OF AIRCRAFT WINDSHIELD SYSTEMS: PROGRAM TECHNICAL SUMMARY Final Report, 20 Feb. 1980 - 20 Feb. 1984
B. S. WEST Wright-Patterson AFB, Ohio AFWAL May 1984 26 p
(Contract F33615-80-C-3401)
(AD-A143712; UDR-TR-84-12; AFWAL-TR-84-3039) Avail: NTIS HC A03/MF A01 CSCL 01B

This final report defines the program objectives, presents an abstract for each technical report generated, and lists the major papers and presentations resulting from the technical effort. Major program accomplishments, both generic and specific, are also enumerated. Author (GRA)

N84-34433 Department of the Air Force, Washington, D.C.
SELF-DEPLOYING AFTERBODY APPARATUS FOR AN EJECTION SEAT Patent
E. R. SCHULTZ, inventor (to Air Force) 31 Jul. 1984 6 p
(AD-D011205; US-PATENT-4,462,562;
US-PATENT-APPL-SN-418117; US-PATENT-CLASS-244-122)
Avail: US Patent and Trademark Office CSCL 01C

A self-deploying afterbody apparatus for an ejection seat of an aircraft includes a cover plate, a plurality of arcuate-shaped stiffeners and a fabric skin of material. The cover plate is pivotally mounted at one end to the back side of the ejection seat and the stiffeners are pivotally mounted at their bases to the back side of the seat and share a common pivotal axis with the cover plate. The stiffeners are located between the cover plate and seat, and the fabric skin extends between the cover plate and seat and covers the stiffeners so as to form an expandible and collapsible bellows-like afterbody structure. In the collapsed position, the afterbody structure is folded up and locked against the back of the seat. When the seat ejects, a lanyard attached between the cover plate and aircraft floor pulls the afterbody structure into an expended, operative position. When the afterbody structure is fully extended, the continued ejection of the seat causes the lanyard to detach from the floor or cover plate. Author (GRA)

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A84-46604
A PHYSICALLY SMALL DUAL CIRCULAR MICROSTRIP ANTENNA
J. M. DEVRIES (U.S. Navy, Pacific Missile Test Center, Point Mugu, CA) IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 19-30.

The design and performance of a compact low-cost etched dual circular microstrip antenna suitable for mounting in the aerodynamically shaped radome of a target drone aircraft are reported. The antenna structure is a sandwich comprising (in descending order) a 400-ohm-impedance 8.0-GHz element, a 1.57-mm-thick layer of PTFE glass-reinforced 11.8 KV/mm dielectric, a 500-ohm 2.2-GHz element, a 3.18-mm-thick dielectric layer, and an Al plate; 50-ohm feeds are connected off-center to the larger upper disk and through the center field null of the larger disk to the appropriate off-center location on the smaller upper disk. The performance characteristics include well-behaved radiation patterns, linear polarization, and gain 6 dBi. Return losses of more than 10 dB are found with bandwidth 3.7 percent and isolation over 40 dB at 2.2 GHz and with bandwidth 5.7 percent and isolation over 18 dB at 8.0 GHz. T.K.

A84-46614
USE OF FORWARD ERROR CORRECTION IN A GROUND-TO-AIR-TO-GROUND TELEMETRY AND CONTROL LINKS
S. GARDNER and E. LEVY IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 121-134. refs

The techniques involved in using forward error correction with interleaving in air-to-ground/ground-to-air telemetry of control links are discussed. The design considered includes a 19.2 kbps data rate uplink for control data and a telemetry downlink at over two mbps. The uplink, a Gaussian memoryless channel, is equipped with a Viterbi decoder to randomize the effects of fading, jamming and noise bursts. Interleaving is applied in the telemetry downlink to reduce error rates in data bursts, and is accomplished by, e.g., a periodic convolutional interleaver which shuffles encoded signals continuously. Random convolutional interleaving is used in the presence of jamming and allows only one appearance of any particular write address in a buffer for each burst of encoded data. The data is written into the buffer in a pseudo-random mode. All apparatus can be mounted on a 20 sq in. printed circuit board. Details of the hardware needed for both ground and airborne segments are described. M.S.K.

A84-46624
NAVSTAR GPS HOST VEHICLE TELEMETRY SYSTEM
R. M. PUTNAM (Aerospace Corp., El Segundo, CA) and M. H. LOPEZ (USAF, Space Div., Los Angeles, CA) IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 265-273.

The development, integration and operational parameters of the GPS airborne host vehicle telemetry system being used to simulate GPS performance configurations as part of tests to define the production units are discussed. The vehicle allows real-time control of test operation, quick-look data analysis, real-time display and dual mission capability over a 50 mi range link. The system is mounted on a Convair 880 aircraft. Care was taken to avoid blockage during antenna mounting, while power conditioning was neglected since the telemetry system design allowed for worst-case vehicle power. Detailed technical parameters of the system, which has operated successfully throughout the tests, are provided. M.S.K.

A84-46640
APPLICATION OF GPS TO NATIONAL TEST RANGES
H. L. JONES and T. J. MACDONALD (Analytic Sciences Corp., Reading, MA) IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 487-493. refs

This paper summarizes an evaluation of the potential use of the NAVSTAR Global Positioning System (GPS) as a source of Time Space Position Information (TSPI) for weapon system test and evaluation. The study was conducted in support of a Tri-Service Steering Committee chartered by the Office of the Under Secretary of Defense Research and Engineering to investigate applications of GPS for the DOD test and training ranges. The performance capabilities and life-cycle costs of GPS- and non-GPS-based instrumentation equipment are compared for eight generically-defined test ranges. Based on these analyses, a prioritized ranking of applications is presented. Finally, desirable characteristics for a family of GPS equipment are described and technical issues requiring resolution through field tests are identified. Author

A84-46642
GPS/INS INTEGRATION FOR RANGE INSTRUMENTATION
J. L. ARNOLD and R. W. BLANK (Rockwell International Corp., Collins Government Avionics Div., Cedar Rapids, IA) IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 503-512.

The NAVSTAR satellite-based Global Positioning System (GPS) may revolutionize instrumentation methods for test and training range evaluations of equipment, doctrine, and operator performance. In highly dynamic environments, an integrated system comprising a GPS receiver and an Inertial Navigation System (INS) can overcome the effects of vehicle acceleration and vehicle structure-induced signal blocking. The GPS receiver uses INS velocity measurements to aid satellite reacquisition, in the wake of signal loss, as well as to navigate during signal outages due to antenna masking. The long term accuracy of GPS is also used to compensate for INS instrument error effects such as gyro drift. GPS receiver complexity for a given level of system performance is reduced by INS. O.C.

A84-46670
USING THE STD BUS FOR ENCODER/DECODER SYSTEMS ABOARD A HIGH-ALTITUDE BALLOON PLATFORM
J. WILLIS (New Mexico State University, Las Cruces, NM) IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 813-818. USAF-sponsored research.

The Stabilized High Altitude Research Platform is a balloon-launched system encompassing several onboard microprocessor-based subsystems which provide telemetry, command, and navigation data. The versatility of the platform's electronic subsystems, on which a broad variety of scientific experiments will depend, is secured by means of the STD bus (which is a standard interface throughout the computer industry) in virtue of its availability, ruggedness, versatility, and wide selection of compatible, off-the-shelf components. O.C.

A84-47693*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DIGITAL AVIONICS - THE BEST IS YET TO COME
C. R. SPITZER (NASA, Langley Research Center, Hampton, VA) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, July 1984, p. 486-492. refs

The history and background of digital avionics and the possibilities for the future are reviewed. There are payoffs in many areas from digital avionics; however, the ultimate benefits are increased mission effectiveness and lower costs. Two major U.S. Air Force avionics programs designed to increase mission effectiveness are reviewed. Major barriers to the expanded use of digital avionics in civil transports as a means to lower operating costs are examined. The paper also examines lightning effects, architectures, optical components, displays, and voice-interactive control, which are current research areas that promise to yield significant advances for digital avionics systems. Author

A84-48124
PRECISION DME - DISTANCE MEASUREMENT IN THE MLS [LE DME DE PRECISION - MESURE DE LA DISTANCE DANS LE SYSTEME D'ATTERRISSAGE MICRO-ONDES /MLS/]
J. HETYEI (Thomson-CSF, Paris, France) Navigation (Paris) (ISSN 0028-1530), vol. 32, Jan. 1984, p. 45-60. In French. refs

The capabilities and operation of the precision DME (DME/P) systems being developed for MLS are surveyed and compared with those of conventional enroute DME (DME/N). The system parameters are listed in tables; photographs of the installations are provided; and the problems posed by the requirement of the ICAO All-Weather-Operations Panel (1980) that the proposed DME/P system be compatible with existing DME/N facilities are examined. These problems are seen as solved by the dual-pulse signal format proposed by Hetyei (1981), which is briefly characterized. T.K.

A84-48125
PROBLEMS IN AIR NAVIGATION AT THE NORTH POLE - I. [PROBLEMES DE NAVIGATION AERIENNE AU POLE NORD - I.]
J. F. FOURNIER and J. HAMELIN Navigation (Paris) (ISSN 0028-1530), vol. 32, Jan. 1984, p. 72-91. In French.

Problems encountered in flying air routes near the North Pole are examined; the history of military, scientific, rescue, and commercial flights since 1939 is reviewed; and the conventional techniques developed to overcome the problems are surveyed and illustrated with maps, diagrams, drawings, and photographs. Subjects discussed include polar Mercator and stereographic map projections, the role of the magnetic compass in polar navigation, astronomical direction finders, positioning techniques, and polar-zone meteorology. The use of the sky compass to locate the sun position during twilight periods, the identification of night and day zones with a high-latitude twilight computer, and isobaric navigation are presented in appendices. T.K.

A84-48538
AUTOMATIC MICROPROCESSOR-BASED RECEIVERS FOR THE DECCA NAVIGATOR SYSTEM
J. D. LAST (North Wales, University College, Bangor, Caern, Wales) and D. K. LINSDALL (Racal Positioning Systems, Ltd., Leatherhead, Surrey, England) Radio and Electronic Engineer (ISSN 0033-7722), vol. 54, July-Aug. 1984, p. 281-289. Research supported by Decca Survey, Ltd. refs

The paper deals with the design principles of a type of microprocessor-based receiver for the Decca Navigator continuous-wave, hyperbolic radio-navigation system. Two experimental receivers are described, one for automatic vehicle location, the other hand-portable. Both are fully automatic in operation. Novel features of their hardware and software are outlined and the results of land-vehicle, marine, airborne and hand-held field trials are presented. The results demonstrate that, although the receivers are small, light, cheap to manufacture and low in power consumption, their accuracy, fix repeatability and skywave interference sensitivity compare favorably with those of traditional analog receivers. Author

A84-49193
MICROWAVE AIRBORNE TELEMETRY - UNUSUAL PROBLEMS, UNUSUAL HARDWARE
J. RIEGER (U.S. Naval Weapons Center, China Lake, CA) and K. BIRCH (Kitchen Productions, Inc., Ridgecrest, CA) Microwaves & RF (ISSN 0745-2993), vol. 23, Sept. 1984, p. 38-40, 42, 44.

It is pointed out that microwave airborne telemetry systems are employed to test new equipment and to train weapons-system operators. The telemetry systems, which prior to 1969 utilized the frequency range from 216 to 265 MHz, operate currently in the L-band (1435 to 1535 MHz) for aircraft and S-band (2200 to 2300 MHz) for missile and space-to-earth transmissions. The power output of a telemetry system for long-range operation can be as high as 20 W, but most systems are designed to produce from 2 to 5 W. On test ranges, the telemetry set as an 'add-on' system often replaces the warhead in a missile under test. Telemetry transmitters cost from $1500 to $10,000. Almost all telemetry systems use FM transmission. Attention is given to the use of multiple receiving sites for recording the data transmitted by the airaiborne unit, the transmitting antenna for telemetry, and the importance of frequency management. G.R.

A84-49194
EXPENDABLE JAMMERS PROVE INDISPENSABLE
A. G. SELF (Royal Signals and Radar Establishment, Malvern, Worcs., England) Microwaves & RF (ISSN 0745-2993), vol. 23, Sept. 1984, p. 143-145, 147-149. refs

In modern warfare, the importance of jamming as a means for interrupting enemy communications increases more and more. However, jamming must be carefully controlled to prevent interference with friendly communications. Unattended expendable jammers (UEJs) may provide the key to both effective and well-controlled communications jamming. The majority of VHF radios used in Western combat net radio (CNR) systems operate in the frequency range from 30 to 90 MHz and cover distances from 20 to 50 km for vehicle-mounted units. Small UEJs have advantages over large, stand-off jammers (SOJs). UEJs can be used to jam a variety of command, control and communications functions. The present article is primarily concerned with the typical Western manpack VHF radio. Attention is given to the basic jamming problem, propagation models, a depiction of jammer deployment, and a frequency-hopping radio. G.R.

A84-49285
DESIGN OF AN ADAPTIVE HIGH-FREQUENCY DATA LINK
J. AMES (SRI International, Menlo Park, CA), S. STEIN (SCPE, Inc., Newton Centre, MA), and G. W. IRVINE (Canadian Embassy, Washington, DC) IN: ICC '83 - Integrating communication for world progress; International Conference on Communications, Boston, MA, June 19-22, 1983, Conference Record. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1121-1125. FAA-sponsored research. refs

A design for a HF data link for automated over-the-ocean ATC is described. The design goals were to service 200 aircraft in flight over the North Atlantic, assuming 70 provide automatic position reports. The link includes several unattended ground stations and two control centers interconnected by satellite or cable with a full duplex 2400 pbs data rate. Ten bands covering 22 MHz are utilized to maximize network reliability given the variety of ionospheric, atmospheric and sea states, and distances faced. A polling protocol provides the bulk of the oceanic ATC data link requirements, with polling taking place in 10 sec epochs for individual aircraft, which could be switched among families of frequencies. Account is taken of interference, acquisition, and recovery mode problems and procedures. M.S.K.

A84-49320
AIR NAVIGATION [VOZDUSHNAIA NAVIGATSIIA]
L. M. VOROBEV Moscow, Izdatel'stvo Mashinostroenie, 1984, 256 p. In Russian. refs

Basic theory in the navigation of aircraft is presented. Particular emphasis is given to the accuracy of solutions to navigational problems, methods of solution and the application of computer systems to navigational complexes. Several mathematical models of navigational processes are presented as examples. I.H.

A84-49331
COURSE-INDICATING SYSTEMS AND THEIR OPERATION ABOARD AIRCRAFT (3RD REVISED AND ENLARGED EDITION) [KURSOVYE SISTEMY I IKH EKSPLUATATSIIA NA SAMOLETAKH /3RD REVISED AND ENLARGED EDITION/]
N. M. BOGDANCHENKO Moscow, Izdatel'stvo Transport, 1983, 224 p. In Russian. refs

The theory, design, and operation of state-of-the-art onboard course-indicating system are reviewed. In particular, attention is given to the principal navigation concepts and definitions, magnetic and compass bearings, magnetic and gyroscopic compasses, and general principles of the design of course-indicating systems. The discussion also covers the design, electrical circuit, operation, and maintenance of the course-indicating systems GMK-1, KS-8, and TSK-P2. V.L.

A84-49357#
GYROS IN BUSINESS AIRCRAFT
E. J. LERNER Aerospace America (ISSN 0740-722X), vol. 22, Oct. 1984, p. 66-69.

The benefits of laser navigation systems for business aircraft are discussed. Although laser inertial reference systems have been used in commercial airliners, their bulk and flight data processing requirements are considered to be too great for application to the smaller business aircraft market. A laser gyroscope is based on a set of three triangular ring lasers aligned perpendicularly to each other. Each ring laser has a resonant cavity whose path lengths define the exact frequency at which the beam is emitted. By measuring the shift in all three laser fringe patterns when the gyro is moving, the change of aircraft orientation can be computed in three dimensions. It is expected that fiber optics technology will be integrated in laser gyro designs, thereby reducing costs to make the systems standard equipment for business aircraft. Photographs are provided which illustrate the data display of standard factory model laser navigation system. I.H.

A84-49396
THE REQUIREMENT FOR OCEANIC NAVIGATION IN THE AIR
R. CROXFORD (Civil Aviation Authority, London, England) Journal of Navigation (ISSN 0020-3009), vol. 37, Sept. 1984, p. 325-332.

An operational requirement for an oceanic application of global civil satellite navigational systems, in case there should develop such a requirement, is to emerge almost certainly first in the North Atlantic airspace. The present investigation is, therefore, entirely concerned with the North Atlantic, although the potential application in other areas cannot be overlooked. Attention is given to details regarding operational requirements, a historical review, present day conditions, future developments, aspects of satellite monitoring, and problems of vertical separation. It is concluded that the only currently stated operational requirement for NAT navigational performance is the MNPS adopted by ICAO. This requirement can be satisfied by current navigation systems (INS and Omega/VLF), and culd also be met by the anticipated performance of global civil satellite navigation systems. G.R.

A84-49397
GLOBAL CIVIL SATELLITE NAVIGATION SYSTEMS - AN AIRLINE OPERATOR'S VIEW
P. MOORE and D. M. PAGE (British Caledonian Airways, Ltd., Crawley, West Sussex, England) Journal of Navigation (ISSN 0020-3009), vol. 37, Sept. 1984, p. 333-338.

In recent years, a number of proposals have been made for the use of satellites by aviation. So far, the proposed new systems have failed to gain the approval of the airline operators. The operators will have to be convinced that operating costs can be improved. Current navigation systems are discussed, and the potential benefits of a satellite system are evaluated. It is concluded that, in general, the existing navigation systems are adequate for present-day requirements. A refinement of present systems will be capable of meeting all requirements for at least twenty years, while in some instances present aircraft navigation capability is already ahead of the air traffic infrastructure. In view of the fact, however, that Navstar/GPS will soon be available for use, it would be logical for civil aviation to consider carefully whether some benefits could not be obtained from its use. Requirements for an acceptance of satellite navigation are examined. G.R.

A84-49399
CIVIL AVIATION APPLICATION OF NAVSTAR
L. E. DEGROOT, D. H. MONK, and M. Y. MCELREATH (Rockwell International Corp., Collins Government Avionics Div., Cedar Rapids, IA) Journal of Navigation (ISSN 0020-3009), vol. 37, Sept. 1984, p. 360-370.

A description is given of user equipment for the Navstar Global Positioning System (GPS), which was developed by an American aerospace company. Attention is given to currently available preproduction hardware which was developed to meet a multiplicity of user requirements for the military services of the U.S., future developments related to civil aviation applications, and the capabilities of the GPS system to meet today's civil aviation operational requirements. In order to illustrate the capabilities of GPS in today's ATC environment, an operational demonstration of the system was provided in May 1983. The Global Positioning System was used to navigate an aircraft from Cedar Rapids, Iowa, to Le Bourget Airport and the 1983 Paris Air Show even though only six usable GPS satellites were in orbit. G.R.

N84-33396*# Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
FAULT-TOLERANT SYSTEM CONSIDERATIONS FOR A REDUNDANT STRAPDOWN INERTIAL MEASUREMENT UNIT
P. MOTYKA, R. ORNEDO, and R. MANGOUBI Aug. 1984 116 p refs
(Contract NAS1-16887)
(NASA-CR-172426; NAS 1.26:172426; CSDL-R-1717) Avail: NTIS HC A06/MF A01 CSCL 01D

The development and evaluation of a fault-tolerant system for the Redundant Strapdown Inertial Measurement Unit (RSDIMU) being developed and evaluated by the NASA Langley Research

Center was continued. The RSDIMU consists of four two-degree-of-freedom gyros and accelerometers mounted on the faces of a semi-octahedron which can be separated into two halves for damage protection. Compensated and uncompensated fault-tolerant system failure decision algorithms were compared. An algorithm to compensate for sensor noise effects in the fault-tolerant system thresholds was evaluated via simulation. The effects of sensor location and magnitude of the vehicle structural modes on system performance were assessed. A threshold generation algorithm, which incorporates noise compensation and filtered parity equation residuals for structural mode compensation, was evaluated. The effects of the fault-tolerant system on navigational accuracy were also considered. A sensor error parametric study was performed in an attempt to improve the soft failure detection capability without obtaining false alarms. Also examined was an FDI system strategy based on the pairwise comparison of sensor measurements. This strategy has the specific advantage of, in many instances, successfully detecting and isolating up to two simultaneously occurring failures. Author

N84-33397# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
APPLICATION OF A PROBABILISTIC TRACKING FILTER: A FIRST EVALUATION WITH EMPHASIS ON AIR TRAFFIC CONTROL. PART 1: EVALUATION RESULTS
H. A. P. BLOM 7 Feb. 1984 49 p refs 2 Vol.
(NLR-TR-82088-U-PT-1) Avail: NTIS HC A03/MF A01

In order to gain insight into the problem of tracking an aircraft, using uncertain radar measurements, a fundamental study on the application of nonlinear filtering theory was undertaken. The theory on modeling and filtering of Markov processes, and Martingale theory were used. A complete probabilistic tracking algorithm for a surveillance radar was obtained. Evaluations partly based on the tracking results for a number of live traffic samples show that the algorithm gives accurate, consistent estimates. Author (ESA)

N84-33398# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
APPLICATION OF A PROBABILISTIC TRACKING FILTER: A FIRST EVALUATION WITH EMPHASIS ON AIR TRAFFIC CONTROL. PART 2: LIVE TRAFFIC SAMPLES
H. A. P. BLOM 7 Feb. 1984 177 p refs 2 Vol.
(NLR-TR-82088-U-PT-2) Avail: NTIS HC A09/MF A01

In order to gain insight into the problem of tracking an aircraft, using uncertain radar measurements, a fundamental study on the application of nonlinear filtering theory was undertaken. The theory on modeling and filtering of Markov processes, and Martingale theory were used. A complete probabilistic tracking algorithm for a surveillance radar was obtained. Evaluations partly based on the tracking results for a number of live traffic samples show that the algorithm gives accurate, consistent estimates. Author (ESA)

N84-33399# National Aerospace Lab., Amsterdam (Netherlands). Vliegtuigen Atfeling.
THE MICROWAVE LANDING SYSTEM (MLS)
T. H. M. HAGENBERG Nov. 1983 24 p refs In DUTCH; ENGLISH summary Presented at Ned. Electron. en Radiogenootschap Work Meeting, Delft, 13 Dec. 1983
(NLR-MP-83070-U; AD-B085966) Avail: NTIS HC A02/MF A01

The Microwave Landing System (MLS) is described. It is an approach and landing aid, standardized by the International Civil Aviation Organization to replace the existing Instrument Landing System. Possible MLS configurations, system operation, ground equipment, and the related avionics are described. Author (ESA)

N84-34406# Royal Aircraft Establishment, Farnborough (England).
REFERENCE SYSTEMS FOR THE EVALUATION OF DEAD-RECKONING NAVIGATION EQUIPMENT
R. F. STOKES and S. G. SMITH *In* AGARD Flight Test Tech. 17 p Jul. 1984
Avail: NTIS HC A16/MF A01

Aircraft dead reckoning navigation systems present particular problems in their assessment, and diagnosis in development where a continuous measurement of their error pattern is required. The need for long range, long duration flights with a continuous high accuracy reference led to the development of an integrated navigation system. The recorded data is processed post-flight in a Kalman filter which is used to estimate the inertial system errors. The final reference is formed by compensating the inertial outputs for these errors and has the properties of high accuracy, low noise, and continuous availability. Although simple in concept the implementation of such a scheme is complex. The major problem lies in constructing suitable mathematical models of the various equipments, and the technique of pre-processing is described. The second difficult area is that of obtaining the statistical information regarding the performance of the equipments in a form suitable for inclusion in the models. Although the reference is produced off-line, it is possible to implement the techniques on-line. R.S.F.

N84-34419# Boeing Commercial Airplane Co., Seattle, Wash.
AN EXTENDED REAL-TIME MICROWAVE AIRPLANE POSITION SYSTEM
P. L. PEREBOOM, J. H. LINCOLN, and R. N. SNOW *In* AGARD Flight Test Tech. 12 p Jul. 1984
Avail: NTIS HC A16/MF A01

A real time Microwave Airplane Position System (MAPS) is currently being used by the Boeing Company for noise certification testing. The system measures ranges and range rates from several ground transponders to an airplane, and computes the airplane position using a Kalman Filter algorithm. Airplane position relative to a fixed Earth coordinate system is available for recording and cockpit display five times per second. Comparisons of position data from MAPS with data from Boeing phototheodolite systems have shown that MAPS accuracy is better than two meters when the airplane is within the design envelope of the ground transponder array. Unfortunately, the minimum practical altitude of a sign envelope is 50 meters, so MAPS cannot be used for takeoff and landing tests. To bridge the gap from the ground to 50 meters altitude, an alternate source of altitude information is required. The problems of obtaining absolute altitude information from other sources have been well documented. This report examines the inclusion of these alternate sources of altitude data in the Kalman Filter used by MAPS. Filter initialization was modified to include the calculation of bias errors found in the other sources derived from the original filter's estimate of airplane location. The measurement matrix was expanded to include the alternate sources in a manner that places emphasis on the most reliable sources of data with respect to the airplane's location. B.W.

N84-34435# Federal Aviation Administration, Washington, D.C.
MODERNIZATION OF THE US NATIONAL AIRSPACE SYSTEM. FOUNDATION FOR THE FUTURE
May 1984 36 p
(AD-A144332) Avail: NTIS HC A03/MF A01 CSCL 17G

The United States, with a large and complex aviation system, has embarked on a major program to provide safer, better and more efficient Federal services to the aircraft operators who use the U.S. National Airspace System. The effort also will reduce costs of operations and raise the productivity of the Federal Government. This booklet describes in brief and understandable form the nature of the modernization and the major elements of system improvement. GRA

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A84-46579
MODELING COST AND EFFECTIVENESS FOR TACTICAL AIRCRAFT SURVIVABILITY
K. H. FLEMING and R. C. RUE (U.S. Air Force Academy, Colorado Springs, CO) IN: Simulation and modelling; Proceedings of the Eighth International Symposium, Orlando, FL, November 9-11, 1983 . Anaheim, CA and Calgary, Canada, Acta Press, 1984, p. 67-70.

Decision making in modern military planning is a complex undertaking. An attempt is presently made by means of a decision tree method to quantify the tradeoffs involved in the employment of NATO airpower during combat. The problem chosen involves all decisions required to achieve an effective sortie. The model is not proposed as a substitute for informed judgment, but as a systematic method of accounting for all variables encountered. Decision makers are free to enter the parameters as experience and actual cost data dictate. The model facilitates comparative studies between very complex cost/effectiveness calculations. O.C.

A84-46667
THE GRUMMAN ADVANCED TELEMETRY PREPROCESSOR
D. SANGL and J. SILBERTO (Grumman Data Systems Corp., Calverton, NY) IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 775-785.

An automated telemetry system (ATS) was designed in the late 1960's. This system supported the first F-14 flight on December 21, 1970. Since then it has been employed to support 3,700 flights of F-14 and other aircraft. The ATS represents one of the first computer-based real-time flight test systems. It provided answers which enabled the aerospace company using it to meet cost effectively its aircraft test objectives since 1970. An overview of the ATS is presented. Telemetered PCM data and converted analog data are conditioned in the preprocessor section for entry into the central computer. After further processing, the data is sent on to the display section. The present investigation is concerned with the analyses and design tradeoffs made when the first major section, including the preprocessor subsystem, of the ATS was to be replaced, taking into account also the acceptance test results of the Advanced Telemetry Preprocessor. G.R.

A84-46967#
AN APPROACH TO SELECTING GAS TURBINE ENGINE RATINGS FOR FIXED WING AIRPLANES
R. K. AGRAWAL (Pratt and Whitney Aircraft of Canada, Ltd., Longueuil, Quebec, Canada) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 5 p.
(ASME PAPER 84-GT-163)

This paper presents an approach to selecting the various ratings for Gas Turbine engines in the fixed wing airplane application. The approach followed is first to estimate the minimum airplane power demands to pass its certification requirements under worst operating conditions. These power demands are then checked against those available from the engine within its certification requirements. Meaningful trade off studies, involving both the airplane and engine designers, can thus be conducted fairly early on in the airplane/engine design cycle to arrive at engine ratings which will best suit both the vehicle and its power plant within their respective certification constraints. Author

A84-46968#
DESIGNING FOR DURABILITY IN FIGHTER ENGINES
B. L. KOFF (Pratt and Whitney Group, Engineering Div., West Palm Beach, FL) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p.
(ASME PAPER 84-GT-164)

The U.S. Air Force's Engine Structural Integrity Program (ENSIP) has fostered improvements in methods for durability evaluation during the development phase of new fighter aircraft engines, at moderate cost. ENSIP has also promoted damage tolerant design concepts which encompass crack growth-retarding material processing techniques. The durability of high usage and high cost hot section parts can be demonstrated on the basis of a deepened understanding of engine field usage. On that basis, the F100 engine's high pressure turbine blades and vanes are showing service lives consistent with accelerated mission tests. Attention is presently given to the most durability-critical elements of a representative fighter engine's compression, combustion, and turbine systems, as well as the variety of powder metallurgical techniques developed for high durability manufacturing. O.C.

A84-47076
A COMPARISON OF THE WEIGHT RATIOS OF THE AIRFRAME DESIGNS OF AIRCRAFT WITH A CANTILEVER WING AND WITH A CLOSED WING SYSTEM [SRAVNENIE VESOVOI OTDACHI KONSTRUKTIVNO-SILOVYKH SKHEM LETATEL'NYKH APPARATOV SO SVOBODNONESUSHCHIM KRYLOM I S ZAMKNUTOI SISTEMOI KRYL'EV]
V. N. SEMENOV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 65-71. In Russian. refs

A procedure is presented for the comparative analysis of the weight ratios of various aircraft designs at the stage of selecting the type of airframe structure. It is shown that high weight efficiency can be achieved with an airframe design including a biplane delta wing system with rigidly joined ends. V.L.

A84-47260
STABILITY, SEQUENCING AND RECOVERY (SSR)
P. AYOUB (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) SAFE Journal, vol. 14, Fall 1984, p. 10-14.

The Stability, Sequencing, and Recovery program of the U.S. Navy seeks to correct existing ejection seat deficiencies in aerodynamic stability, multiseat ejection sequencing, and parachute recovery. The program's areas of investigation range over yaw stability improvement by means of deployable fins, the use of an Automatic Inflation Modulation parachute, and the application of microprocessor control to the escape system sequencer and its tester. O.C.

A84-47580
REDESIGNING FUSELAGE COMPARTMENTS BY THE SPECIAL CONTOUR METHOD [PEREZADANIE OTSEKOV FIUZELIAZHEI METODOM SPETSIAL'NOGO KONTURA]
F. K. CHISTIAKOV, V. V. NAIKHANOV, and A. A. DUBANOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 106-108. In Russian.

A computer-aided design system based on the special contour method, that has been developed for designing fuselage-type surfaces, makes it possible to describe analytically the surfaces of a fuselage specified as a skeleton frame structure. A procedure is proposed here whereby any changes in the design can be made by using mathematical methods based on the special contour approach. The redesign procedure is illustrated by an example. V.L.

A84-48551
TORNADO - FOUR YEARS ON
P. JACKSON Air International (ISSN 0306-5634), vol. 27, Sept. 1984, p. 113-119, 121, 123, 124, 126.

The first four years of Tornado fighter operation by the RAF, both in home bases and in West Germany, are assessed. Nearly

all of the weapons intended for Tornado deployment have been used, and progressively lower terrain-following missions have been flown with the introduction of the appropriate avionics equipment. Attention is presently given to the operations of the Trinational Tornado Training Establishment, periodic Tornado production fluctuations, and the variety of bomb, missile, and automatic cannon munitions with which training has thus far been conducted. Antiradar missiles and airfield attack submunitions are under high priority development. A detailed account is given to the composition of both training and operational squadrons. O.C.

A84-48552
SOV AIR - THE NEW WAVE
Air International (ISSN 0306-5634), vol. 27, Sept. 1984, p. 131-140, 142.

A comprehensive assessment is made of the technological development status of Soviet military aircraft, with attention to the operational capability enhancements that design trends to date portend. The MiG-31 'Foxhound', Su-27 'Flanker', and MiG-29 'Fulcrum', which are to begin deployment later in this decade, represent the first generation of Soviet fighters possessing true radar lookdown/shootdown capabilities, combined with multiple target tracking and beyond-visual-range engagement facilities, that are predicated on advanced electronics. Attention is given to two aircraft representative of recent design practice, the MiG-23MF 'Flogger-B' air combat fighter and the Tu-142 'Bear-D' bomber of the Soviet Air Force and Naval Air Force. Other types to enter service in the 1980s are the An-400 'Condor' strategic transport and Tupolev 'Blackjack' supersonic strategic bomber. O.C.

A84-48553
THE SHAPE OF THINGS TO COME
R. BRAYBROOK Air International (ISSN 0306-5634), vol. 27, Sept. 1984, p. 143-147, 149.

An assessment is made of the configurational possibilities under consideration by the American and West European military aircraft manufacturers currently competing for the design and production of next-generation air superiority fighters. After noting the most innovative of exoatmospheric/hypersonic strategic aircraft proposals, attention is given to such NATO-oriented fighter proposals as those of the British Experimental Aircraft program, the U.S. Air Force's Advanced Tactical Aircraft program (ATF), the French Avion de Combat Experimental, and the five-nation Future European Fighter Aircraft. The ATF has benefited from data obtained through flight testing of the Highly Maneuverable Aircraft Technology RPV. O.C.

A84-49087*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STATUS REVIEW OF A SUPERSONICALLY BIASED FIGHTER WING DESIGN STUDY
R. M. WOOD, D. S. MILLER, D. E. HAHNE (NASA, Langley Research Center, Hampton, VA), L. G. NIEDLING, and J. R. KLEIN (McDonnell Aircraft Co., Engineering Technology Div., St. Louis, MO) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 767-775. Previously cited in issue 17, p. 2465, Accession no. A83-38684. refs

A84-49088*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
COMPUTER CONTROL FOR AUTOMATED FLIGHT TEST MANEUVERING
E. L. DUKE and F. P. JONES (NASA, Flight Research Center, Edwards, CA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 776-782.

The application of an experimental flight test maneuver autopilot test technique for collecting aerodynamic and structural flight research data on a highly maneuverable aircraft is described in this paper. This technique, which was developed to increase the quality and quantity of data obtained during flight test, was applied to the highly maneuverable aircraft technology (HiMAT) vehicle. A primary flight experiment was to verify the design techniques used to develop the HiMAT aerodynamics and structures. This required the performance of maneuvers for collection of large quantities of high-quality pressure distribution, loads, and wing and canard deflection data. Flight data obtained while executing these research maneuvers are presented to demonstrate the effectiveness of this new technique. Author

A84-49096*# Texas A&M Univ., College Station.
PERFORMANCE DEGRADATION OF A MODEL HELICOPTER ROTOR WITH A GENERIC ICE SHAPE
K. D. KORKAN, E. J. CROSS, JR., and T. L. MILLER (Texas A&M University, College Station, TX) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 823-830. refs
(Contract NAG3-242)

An experimental program using a commercially available remotely controlled model helicopter in the Texas A&M University (TAMU) subsonic wind tunnel has been conducted to investigate the performance degradation resulting from the simulated formation of ice on the leading edge of the main rotor blades in both hover and forward flight. The rotor blades utilized a NACA 0012 airfoil with a 2.5-in. constant chord. A generic ice shape derived from a predetermined natural ice condition was applied to the 53.375-in.-diameter main rotor, and thrust and torque coefficients were measured for the main rotor as functions of velocity, main rotor rpm, fuselage angle of incidence, collective pitch angle, and spanwise extent of icing. The model helicopter test exhibited significant performance degradation of the main rotor when generic ice was added. An increase of approximately 150 percent in torque coefficient to maintain a constant thrust coefficient was noted when generic ice had been applied to the 85 percent rotor radial location. Also, considerable additional degradation occurred when generic ice was applied to the 100 percent rotor radial location, as compared with the 85 percent simulated ice performance values, indicating the sensitivity of the rotor tip region. Author

A84-49187#
ANALYSIS OF A SEMI-LEVERED SUSPENSION LANDING GEAR WITH SOME PARAMETRIC STUDY
P. JAYARAMI REDDY, V. T. NAGARAJ (Hindustan Aeronautics, Ltd., Bangalore, India), and V. RAMAMURTI (Indian Institute of Technology, Madras, India) ASME, Transactions, Journal of Dynamic Systems, Measurement and Control (ISSN 0022-0434), vol. 106, Sept. 1984, p. 218-224. refs

A set of nonlinear differential equations describing the response of a semilevered suspension type of landing gear with a single stage oleo-pneumatic shock strut is derived. This includes the kinematics of the articulation of the gear, oil compressibility effect, wheel spin-up as a function of slip ratio, and the hydraulic, pneumatic, and friction forces of the shock strut. A parametric study on a gear of a helicopter has been conducted and the effect of variations in the main orifice diameter, coefficient of discharge of main orifice, initial air volume and pressure, polytropic exponent for air compression process, coefficients of friction at lower and upper bearings and the horizontal velocity of the aircraft during landing on the behavior of the landing gear has been studied. Author

A84-49356#
LIGHTNING PROTECTION FOR AIRCRAFT COMPOSITES
R. DEMEIS Aerospace America (ISSN 0740-722X), vol. 22, Oct. 1984, p. 62-65.

Several methods of structural protection against lightning for composite materials in aircraft are described. Attention is given to the problem of maintaining the Faraday cage effects without adding weight to detract from the natural advantages of composite materials. Strips of metal can be applied to the composite surfaces to form conductive paths for the electric currents in the lightning strike. In tests with a F-14 horizontal stabilizer, it was found that no unacceptable damage was incurred following a lightning strike. Metallized paint covering the composite components of the airframe is also identified as an effective means of lightning protection. Another technique is the weaving of an aluminum filament into graphite fabric, typically a 0.004-in. diameter wire spaced on a 0.125-in. grid. With this method lightning damage is limited to a

small area of the outer ply which is burned at the point of contact. The conductivity of graphite can also be increased by electroplating the graphite fibers in the outer layer with a small amount of nickel. It is estimated that this method can increase the conductivity of graphite by as much as a factor of 40. I.H.

A84-49371
GATES-PIAGGIO 180 - NO AERODYNAMIC COMPROMISES?
D. J. HOLT Aerospace Engineering (ISSN 0736-2536), vol. 4, Sept.-Oct. 1984, p. 26-29.

The design of the GP-180 7-9-passenger business-class aircraft is characterized and illustrated with drawings. The GP-180 has a small forward lifting surface, a nonswept main wing of span 45.4 ft and area 170 sq ft, length 46.5 ft, height 12.9 ft, empty weight 6200 lb, maximum take-off weight 9800 lb, fuel weight 2680 lb, maximum cruise speed 400 kt, maximum altitude 41,000 ft, and maximum range 2100 n.m. at 320 kts. Two 800-shp engines drive pusher propellers to provide climb rate 3650 fpm and take-off distance over a 50-ft obstacle 2413 ft. A high T-tail is used to minimize propwash across its lifting surface, and the aircraft construction uses both aluminum structural components and graphite-epoxy composite components. T.K.

A84-49387
B-1B PROGRAM CONTINUES TWO AND ONE-HALF MONTHS AHEAD OF SCHEDULE
M. MATHEWS (Rockwell International Corp., Los Angeles, CA) Defense Systems Review and Military Communications, vol. 2, Sept. 1984, p. 22-24.

The current status of the development project for the B-1B strategic bomber is reviewed. Emphasis is given to the high degree of cooperation between subcontractors in the design of aircraft components, and to flexibility in the engineering of design changes as a result of uncertainties surrounding the financial support for the program in Congress. Attention is also given to some of the important design features of the aircraft, including EMP hardening for the electronics systems; a damage tolerant structure incorporating new composite materials; improved turbofan F101-GE 102 powerplants; and an offensive/defensive avionics system for greater mission versatility. I.H.

A84-49579#
DEVELOPMENT OF A BIRD IMPACT RESISTANT T-38 INSTRUCTOR'S WINDSHIELD
G. J. STENGER (Dayton, University, Dayton, OH) IN: Society for Experimental Stress Analysis, Spring Conference, Cleveland, OH, May 15-19, 1983, Proceedings . Brookfield Center, CT, Society for Experimental Stress Analysis, 1984, p. 31-36.
(Contract F33615-80-C-3401)

The objective of the T-38 instructor's windshield development program was to define the existing birdstrike capability and then to structurally modify the existing structure so as to maximize the impact resistance while providing for an acceptable failure mode and a minimum of spalled structure. The modifications were developed through an iterative approach, combining numerical analysis and development testing, each building on the results of the other. Experimental results are presented of tests that consisted of 19 four-pound artificial bird impact tests. The key design features of the resulting bird-resistant transparency system are enumerated, including energy absorbing rear support rods, high strength shroud, reinforcing straps between shroud and lower frame, reinforcing strips on lower frame, circumferentially bolted transparency, reinforcing caps on side of frame, transparency retainer, and top fore and aft transparency reinforcements. B.J.

N84-33400*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
HELICOPTER ANTI-TORQUE SYSTEM USING STRAKES Patent Application
H. L. KELLEY (Army Air Mobility Research and Development Lab., Hampton, Va.), J. C. WILSON (Army Air Mobility Research and Development Lab., Hampton, Va.), and A. E. PHELPS, inventors (to NASA) (Army Air Mobility Research and Development Lab., Hampton, Va.) 11 Sep. 1984 12 p Sponsored by NASA
(NASA-CASE-LAR-13233-1; NAS 1.71:LAR-13233-1; US-PATENT-APPL-SN-649329) Avail: NTIS HC A02/MF A01 CSCL 01C

A helicopter is disclosed with a system for controlling main-rotor torque which reduces the power and size requirements of conventional anti-torque means. The torque countering forces are generated by disrupting the main rotor downwash flowing around the fuselage. The downwash flow is separated from the fuselage surface by a strake positioned at a specified location on the fuselage. This location is determined by the particular helicopter wash pattern and fuselage configuration, generally being located between 20 deg before top dead center (TDC) and 80 deg from TDC on the fuselage side to which the main rotor blade approaches during rotation. The strake extends along the fuselage from the cabin section to the aft end and can be continuous or separated for aerodynamic surfaces such as a horizontal stabilizer. NASA

N84-33401*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
HOVER TEST OF A FULL-SCALE HINGELESS ROTOR
W. WARMBRODT and R. L. PETERSON Aug. 1984 26 p refs
(NASA-TM-85990; A-9827; NAS 1.15:85990) Avail: NTIS HC A03/MF A01 CSCL 01C

The performance and aeroelastic stability in hover of a 9.8-m diameter, hingeless helicopter rotor system was evaluated. Rotor performance and inplane damping data were obtained for rotor operation between 350 and 425 rpm for thrust coefficients (CT/sigma) between 0.0 and 0.12. At constant rotor thrust, a minimum in rotor inplane damping was measured at 400 rpm. Good agreement is shown between experimental performance data and predicted performance. The influence of different aerodynamic inflow models on predicting damping levels is also shown. The best correlation with experimental stability data was obtained when a dynamic inflow model was used instead of static or quasistatic inflow models. Comparison with other full scale, hingeless rotor data in hover is presented. The hingeless rotor data and data from a full scale, bearingless main rotor test performed on the same general purpose test apparatus were compared. Although the bearingless rotor was more highly damped at design tip speed and 1-g thrust operation, greater sensitivity to operating conditions is shown. At low thrust levels the bearingless main rotor is less damped than the hingeless rotor. E.A.K.

N84-33402*# Lockheed-California Co., Burbank.
INTEGRATED TECHNOLOGY WING DESIGN STUDY Final Report, Nov. 1979 - Dec. 1980
A. P. HAYS, W. E. BECK, W. H. MORITA, B. J. PENROSE, R. E. SKARSHAUG, and B. S. WAINFAN Washington NASA Aug. 1984 460 p
(Contract NAS1-16273)
(NASA-CR-3586; NAS 1.26:3586; LR-30000) Avail: NTIS HC A20/MF A01 CSCL 01C

The technology development costs and associated benefits in applying advanced technology associated with the design of a new wing for a new or derivative trijet with a capacity for 350 passengers and maximum range of 8519 km, entering service in 1990 were studied. The areas of technology are: (1) airfoil technology; (2) planform parameters; (3) high lift; (4) pitch active control system; (5) all electric systems; (6) E to 3rd power propulsion; (7) airframe/propulsion integration; (8) graphite/epoxy composites; (9) advanced aluminum alloys; (10) titanium alloys; and (11) silicon carbide/aluminum composites. These technologies were applied to the reference aircraft configuration. Payoffs were

determined for block fuel reductions and net value of technology. These technologies are ranked for the ratio of net value of technology (NVT) to technology development costs. E.A.K.

N84-33403*# Douglas Aircraft Co., Inc., Long Beach, Calif.
RESULTS OF DESIGN STUDIES AND WIND TUNNEL TESTS OF AN ADVANCED HIGH LIFT SYSTEM FOR AN ENERGY EFFICIENT TRANSPORT
W. R. OLIVER Dec. 1980 373 p refs
(Contract NAS1-14744)
(NASA-CR-159389; NAS 1.26:159389) Avail: NTIS HC A16/MF A01 CSCL 01C

The development of an advanced technology high lift system for an energy efficient transport incorporating a high aspect ratio supercritical wing is described. This development is based on the results of trade studies to select the high lift system, analysis techniques utilized to design the high lift system, and results of a wind tunnel test program. The program included the first experimental low speed, high Reynolds number wind tunnel test for this class of aircraft. The experimental results include the effects on low speed aerodynamic characteristics of various leading and trailing edge devices, nacelles and pylons, aileron, spoilers, and Mach and Reynolds numbers. Results are discussed and compared with the experimental data and the various aerodynamic characteristics are estimated. E.A.K.

N84-33404# Naval Ship Research and Development Center, Bethesda, Md. Dept. of Aviation and Surface Defects.
AERODYNAMIC FEASIBILITY FOR AIRBORNE RETRIEVAL OF A REMOTELY PILOTED VEHICLE Final Report
E. F. MCCABE, JR. and D. W. LACEY Nov. 1976 46 p
(Contract W33-59)
(AD-A143695; DTNSRDC-76/0043) Avail: NTIS HC A03/MF A01 CSCL 01B

A combined wind tunnel/computer analysis was undertaken to evaluate the aerodynamic feasibility for airborne recovery of a fixed-wing remotely piloted vehicle (RPV). A mpa of aerodynamic loads interacting on the aircraft and RPV was obtained in the wind tunnel. The flow field was then represented mathematically and used to evaluate the aerodynamic feasibility of airborne retrieval. It was concluded that retrieval forward of the aircraft is potentially dangerous, unless a separation of more than two meters is maintained; retrieval aft of the aircraft is aerodynamically safe without restriction. In addition, it was determined that the primary effect of the aircraft flow field on the RPV was in the pitch plane. Author (GRA)

N84-33406# Southwest Research Inst., San Antonio, Tex.
DEVELOPMENT OF ACCELERATED FUEL-ENGINE QUALIFICATION PROCEDURES Final Technical Report, Oct. 1981 - Sep. 1983
J. A. RUSSELL, J. P. CUELLAR, JR., R. A. ALVAREZ, R. L. RENTZ, and T. J. TIMBARIO Sep. 1983 142 p
(Contract DAAK70-81-C-0209)
(AD-A143845; SWRI-6797/4) Avail: NTIS HC A07/MF A01 CSCL 15E

Activities and findings are described for a 24-month program aimed at the development of procedures for accelerating the qualification of new fuels on Army equipment, emphasizing those derived from oil shale and coal. Principal activities were the development of bench and component test methodology for specific testing of properties peculiar to non-petroleum derived liquid hydrocarbon fuels not now covered under present federal or military fuels specifications. Laboratory test method development entailed modification of the a Jet Fuel Thermal Oxidation Tester (JFTOT) to evaluate not only thermal stability but elastomer compatibility by incorporating a heated reservoir to examine fuel effects on elastomer swell and hardness change as well as elastomer leachate on thermal stability. Lubricity evaluations entailed the application of the Ball-on-Cylinder-Machine (BOCM). Diesel injector pumps were subjected to 300-hour endurance testing using a recirculatory fuel loop and maintaining the lubricity of the fuel at very poor levels by clay filtration. Author (GRA)

N84-33407# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FLIGHT OPERATION MANUAL FOR THE MI-8 HELICOPTER
G. BUGAYEV 11 Jul. 1984 15 p Transl. into ENGLISH from Rukovodstvo po Letnoy Eksplautatsii Vertoleta Mi-8 (USSR) 1971 6 p
(AD-A143860; FTD-ID(RS)T-0320-84) Avail: NTIS HC A02/MF A01 CSCL 01B

This flight manual lists aerodynamic characteristics and instructions for the successful operation of the MI-8 helicopter. Weather data, safety considerations, durability and handling qualities are described. B.W.

N84-34397# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
DETERMINATION OF EXTERNAL STORE DRAG
K. LUTZ and R. MATECKI *In* AGARD Flight Test Tech. 9 p Jul. 1984 refs
Avail: NTIS HC A16/MF A01

The evaluation of external stores concerns single store configurations and double store configurations. The necessary considered further work for completing external store statistical basic data is listed. The external store drag is evaluated in a classical manner for all configurations and configuration components beginning with the clean aircraft as first reference configuration and than evaluating step by step additional components (e.g., gun-pod, pylons, tanks e.a.). The main effort is directed on underwing stores, as the ALPHA-Jet has only one under-fuselage station for a gun-pod. M.A.C.

N84-34399# Air Force Flight Test Center, Edwards AFB, Calif.
HIGH ANGLE OF ATTACK TEST AND EVALUATION TECHNIQUES FOR THE 1980S
G. L. JONES *In* AGARD Flight Test Tech. 13 p Jul. 1984 refs
Avail: NTIS HC A16/MF A01

The principles that guide the development of stall/post stall/spin flight test demonstration specification MIL-S-83691 and at how recent flight test experiences at the AFFTC have modified and expanded upon those ideas over the past decade are examined. Sixteen high angle-of-attack (AOA) flight test programs on four different series of fighter/attack aircraft are completed. The basic objectives of each one of those programs emphasized the determination of departure characteristics and the development of methods for departure prevention and spin avoidance. M.A.C.

N84-34400# National Aerospace Lab., Amsterdam (Netherlands).
DETERMINATION OF PERFORMANCE AND STABILITY CHARACTERISTICS FROM DYNAMIC MANOEUVRES WITH A TRANSPORT AIRCRAFT USING PARAMETER IDENTIFICATION TECHNIQUES
J. H. BREEMAN, L. J. J. ERKELENS, and A. M. H. NIEUWPOORT *In* AGARD Flight Test Tech. 18 p Jul. 1984 refs
Avail: NTIS HC A16/MF A01

A flight test program is executed with the Fokker F28 transport aircraft to investigate whether it is possible to determine performance and stability characteristics from dynamic maneuvers using parameter identification techniques, with sufficient accuracy for certification purposes. A research moving base flight simulator, programmed with the F28 aerodynamic model derived from conventional flight tests and wind-tunnel data, is used to select an optimal set of maneuvers from which the desired characteristics could be determined with a satisfactory degree of accuracy. Flight test data is analyzed, using the Two-Step method. This method starts by reconstructing the aircraft flight path as the first step. The second step is the calculation of all aerodynamic coefficients using straightforward regression analysis techniques. The advantage of this method over the more often used maximum likelihood estimation methods is that a large number of alternative non-linear aerodynamic models can be investigated in a short time using an interactive program. The flight test results are

compared with results derived from conventional test programs. From this comparison it is clear that the data is sufficiently accurate. M.A.C.

N84-34404# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Flight Test Department.
AIRCRAFT TESTS IN THE CLEARANCE PROGRAM FOR THE USE OF A COMBAT AIRCRAFT FROM A RUNWAY AFTER DAMAGE REPAIR
W. SEIDEL *In* AGARD Flight Test Tech. 16 p Jul. 1984
Avail: NTIS HC A16/MF A01

The requirements of the repair quality of a damaged runway depend highly on the design capabilities and the strength of an aircraft and its undercarriage. This makes accurate knowledge of the behavior of the aircraft on non flat surfaces necessary and it is standard practice to develop a computer model of the aircraft and its undercarriage for analytical coverage of all operational cases. This analytical model requires comprehensive verification in tests; the tests are additionally necessary to optimize pilot techniques for the use of the aircraft under such conditions with minimum risk. Tests are described which were performed with a combat aircraft on a runway where mat repair was simulated. A description is given of the test setup, and the reasons for the selection of test configurations and test cases are discussed. Test instrumentation, data acquisition, and data processing are briefly described along with the test techniques which were used to meet predetermined test conditions. Examples of test results are presented and compared with predictions. A discussion of unpredicted results highlights the need for accurate test performance. Desirable improvements in measuring techniques and pilot supporting test equipment are considered. R.S.F.

N84-34405# Aeroplane and Armament Experimental Establishment, Boscombe Down (England).
THE HANDLING AND PERFORMANCE TRIALS NEEDED TO CLEAR AN AIRCRAFT TO ACT AS A RECEIVER DURING AIR-TO-AIR REFUELLING
J. BRADLEY *In* AGARD Flight Test Tech. 16 p Jul. 1984
Avail: NTIS HC A16/MF A01

A brief description is given of the air to air refueling equipment and techniques presently used in the RAF. The handling and performance tests needed to clear a new receiver type aircraft are described, together with some of the results obtained when large transport aircraft are used in the receiver role. R.S.F.

N84-34410# Aeroplane and Armament Experimental Establishment, Boscombe Down (England).
FLIGHT TEST TECHNIQUES EMPLOYED IN THE NIMROD MR MK 2 WEAPON SYSTEM PERFORMANCE TRIALS
L. M. DUTTON *In* AGARD Flight Test Tech. 13 p Jul. 1984
Avail: NTIS HC A16/MF A01

The potential accuracy of the Nimrod's ASW systems which was matched by the precision of trial data collection, in the air and on and below the sea surface is shown. To gain such precision, the aircraft were instrumented and the majority of the trials were conducted at the Atlantic Undersea Test and Evaluation Center (AUTEC) Range. The trial analysis technique which has to match the variety of combinations of the data which are needed to make a statement on overall system performance is outlined. It is shown how forward trial planning is drawing on experience gained so far. E.A.K.

N84-34413# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Unternehmensbereich Flugzeuge.
FLIGHT TEST TECHNIQUES USED FOR PROOF OF STRUCTURAL INTEGRITY OF TORNADO WHEN CARRYING EXTERNAL STORES
M. PEHL, F. J. RUDOLPH, E. BERTOLINA, and A. IPPOLITO *In* AGARD Flight Test Tech. 25 p Jul. 1984 refs Prepared in cooperation with Aeritalia S.p.A., Torino, Italy
Avail: NTIS HC A16/MF A01

The multirole characteristic of the MRCA (TORNADO) aircraft results in an almost universal capability to carry an array of existing stores in every conceivable combination, within different operational flight envelopes. In order to verify the structural integrity of the aircraft when carrying stores, a comprehensive flight loads survey program was set up to validate the store aerodynamics used for the design of pylon attachments to the main structure, the pylons, and the store structure. A description of the overall stores flight test program including the instrumentation and calibration procedures, the flight test techniques and a presentation of the to date available data are given. Finally an explanation of the most significant problems occurred during this task are pointed out. R.J.F.

N84-34415# Avions Marcel Dassault-Breguet Aviation, Istres (France). Dept. Moyens de Mesure et Essais.
FLIGHT TESTING AND REAL TIME DATA PROCESSING FOR DEVELOPMENT AND INTEGRATION OF WEAPON SYSTEMS
J. COSTARD *In* AGARD Flight Test Tech. 12 p Jul. 1984
Avail: NTIS HC A16/MF A01

Flight tests conducted on thirteen different families of aircraft by a total of 1259 personnel at the Istres, Bretigny, and Cazaux test centers are discussed. The advantages of using real time telemetry and data processing are examined. Signal reception and processing facilities used at each center for flight tests of the airframe, the effects of external loads, certification, weapons systems development, EMC-EMI compatibility, and reconnaissance capabilities are described. Transl. by A.R.H.

N84-34436 Department of the Navy, Washington, D. C.
PIVOTAL MONO WING CRUISE MISSILE WITH WING DEPLOYMENT AND FASTENER MECHANISM Patent
F. D. GROUTAGE, S. N. CONJERTI, and L. S. SHAW, inventors (to Navy) 12 Jun. 1984 9 p
(AD-D011192; US-PATENT-4,453-426; US-PATENT-APPL-SN-372870-82; US-PATENT-CLASS-74-2)
Avail: US Patent and Trademark Office CSCL 16D

A moveable wing aircraft including a quick release, attachment mechanism for carrying the aircraft on a bomb rack or other carrier and a mechanism for deploying the moveable wing from its captive carry position to its extended free flight position are disclosed. The aircraft includes an elongate fuselage, a portion of the top surface of which is substantially flat in order to accommodate the moveable wing. The moveable wing is positionable between a captive carry position in which it is aligned with the longitudinal axis of the fuselage and an extended free flight position. The single, moveable wing is pivoted around a central point from its captive carry position to its extended free flight position such that it is substantially perpendicular to the aircraft fuselage. The quick release mechanism extends through apertures in the wing in its captive carry position and is spring biased to retract through the wing and into the aircraft fuselage when released from the bomb rack or other carrier. The deployment mechanism includes a spring loaded cable and pulley arrangement. GRA

N84-34437# Aeronautical Research Labs., Melbourne (Australia).
IMPROVING THE FATIGUE LIFE OF THE MIRAGE IIIO WING MAIN SPAR
J. Y. MANN, A. S. MACHIN, and W. F. LUPSON 1984 110 p refs
(ARL-STRUC-REPT-398; AR-003-004) Avail: NTIS HC A06/MF A01

An increased life-of-type requirement for Mirage IIIO aircraft operated by the Royal Australian Air Force (RAAF) was associated with a specific need to develop a refurbishment technique for extending the lives of fatigue-cracked wing main spars. This led to a comprehensive series of flight-by-flight fatigue tests on specimens of a geometry and thickness (32 mm) closely representing the inboard lower rear flange section of the spar. Of the various options investigated, the most promising was the use of interference-fit steel bushes in bolt holes-either alone or in combination with a modified anchor-nut sub-assembly which eliminated the need for some rivets in the spar flange. Specimens with oversize reamed holes utilizing oversized sleeved bolts

performed poorly, while cold-expansion of the critical bolt hole using the Boeing split-sleeve process was unsatisfactory because of small hole-to-spar edge distances and the proximity of small rivet holes. This investigation has shown that acceptable extensions in fatigue life for wing main spars of the Mirage IIIO are possibly by the use of combinations of standard bolts and 0.3% interference-fit steel bushes (of 1.5 mm wall thickness) in the critical bolt holes, with the provisos that pre-existing fatigue cracks are completely removed and that (after reworking) bolt hole/rivet hole separation distances are adequate. B.W.

N84-34438*# National Aeronautics and Space Administration, Washington, D. C.
GROB G-112: FLIGHT TESTING FULFILLS EXPECTATIONS
Sep. 1984 15 p Transl. into ENGLISH from Aerokurier (West Germany), v. 28, Jun. 1984 p 673-676 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-3541)
(NASA-TM-77745; NAS 1.15:77745) Avail: NTIS HC A02/MF A01 CSCL 01C

The G-112 aircraft built for exhibition exhibited at the ILA '84. The G-2500 engine designed especially for this purpose is economical, requires little maintenance and generates a power of 66 kW (90 Hp). The aircraft achieves a cruising speed of 185 km/h, using a drastically reduced amount of fuel, (only 17 liters aviation fuel or premium gasoline). This small two-seater requires only a very short takeoff and taxi run of about 250 meters.
Author

N84-34439*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
GROUND VIBRATION TEST OF F-16 AIRPLANE WITH INITIAL DECOUPLER PYLON
F. W. CAZIER, JR. and M. W. KEHOE (NASA. Ames Research Center) Oct. 1984 47 p refs
(NASA-TM-86259; L-15782; NAS 1.15:86259) Avail: NTIS HC A03/MF A01 CSCL 01C

A ground vibration test was conducted on an F-16 airplane loaded on each wing with a 370-gal tank mounted on a standard pylon, a GBU-8 store mounted on a decoupler pylon, and an AIM-9J missile mounted on a wing-tip launcher. The decoupler pylon is a passive wing/store flutter-suppression device. The test was conducted prior to initial flight tests to determine the modal frequencies, mode shapes, and structural damping coefficients. The data presented include frequency response plots, force effect plots, and limited mode shape data. Author

N84-34440# Naval Postgraduate School, Monterey, Calif.
AN ANALYSIS OF THREE APPROACHES TO THE HELICOPTER PRELIMINARY DESIGN PROBLEM M.S. Thesis
A. C. HANSEN Mar. 1984 117 p
(AD-A144315) Avail: NTIS HC A06/MF A01 CSCL 01A

Three methodologies from which to approach the problem of preliminary helicopter design are explored in this paper. The first is a sensitivity analysis of the basic helicopter performance equations. The purpose here is to ascertain where reasonable simplifications can be made that do not seriously degrade the accuracy of the results. The second is a graphical parametric design method, known as Carpet Plots. In this method a graphical solution is developed to meet the design criteria of the helicopter. In the third, an overview of Boeing Vertol's Helicopter Sizing and Performance Computer Program is given. The computer routines which enable a person to access HESCOMP on the Naval Postgraduate School main frame IBM system are also provided.
Author (GRA)

N84-34441# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
APPLICATION OF COMPUTATIONAL FLUID DYNAMICS IN AIRCRAFT DESIGN
19 Jul. 1984 14 p Transl. into ENGLISH from Guoji Hanghong (China), no. 3(253), Mar. 1984 p 6-8
(AD-A144323; FTD-ID(RS)T-0741-84) Avail: NTIS HC A02/MF A01 CSCL 20D

Three methods within computational fluid dynamics are discussed: the surface element method, the finite difference method, and the Navier-Stokes method. The advantages of computational fluid dynamics over wind tunnel tests are presented. The utilization of the three fluid dynamics methods in the design of fighter aircraft is described. R.S.F.

N84-34442# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
ACTIVE SUPPRESSION OF AEROELASTIC INSTABILITIES ON A FORWARD SWEPT WING USING A LINEAR OPTIMAL REGULATOR M.S. Thesis
G. J. PASQUINI 1 Jun. 1984 102 p
(AD-A144561; AFIT/GAE/AA/84J-01) Avail: NTIS HC A06/MF A01 CSCL 01C

Recent advances in composite materials and active control principles have lead to renewed interest in the Forward Swept Wing (FSW) as a feasible aircraft design alternative. Sweeping a wing forward results in low static divergence speeds and additional aeroelastic instabilities which must be adequately controlled for an aircraft employing this wing design to have an acceptable flight envelope. This thesis seeks to demonstrate the utility of applying active feedback control principles to suppress aeroelastic instabilities associated with a FSW design. Analytical studies investigate the potential of applying optimal control theory techniques to synthesis of active flutter suppression control laws. For an example application, a FSW/fuselage model previously analyzed by Thomas Noll of AFFDL was used. Through use of Pade approximants to represent unsteady aerodynamic forces, the equations of motion are written in standard state space form. Linear optimal regulator theory is then applied to determine particular sets of gains which minimize a quadratic cost function in terms of the states and controls. Control laws are developed at a design flight condition which increases the onset of the lowest instability speed 20% above the wing bending/torsion instability speed. The optimal control law is then applied at off-design flight conditions to assess the robustness of the optimal regulator. Program listings are included. GRA

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A84-46635
AUTOMATIC GAIN RANGING AMPLIFIER
R. E. TALMADGE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and E. LIRON (Aydin Corp., Vector Div., Newton, PA) IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 451-457.

An Automatic Gain Ranging Amplifier (AGRA) for integrating aircraft flight test data is described. AGRA has seven gain options from -12 dB to 60 dB and is capable fo increasing the signal to noise ratios sensing devices. Some typical applications for the device could include accurate temperatrue control, and wide-range vibration measurements of humidity, pressure and shocks. A schematic diagram of the system is provided. I.H.

A84-48720
THE ROLE OF HUMAN FACTORS IN VTOL AIRCRAFT DISPLAY TECHNOLOGY
S. N. ROSCOE, J. S. TATRO, and E. J. TRUJILLO (New Mexico State University, Las Cruces, NM) Displays (ISSN 0141-9382), vol. 5, July 1984, p. 149-153. refs

Several of the effects of critical display and control variables in the design of horizontal displays for vertical and translational flight are determined experimentally. Some of the variables tested were: tracking mode; flight path prediction time; flight path prediction order; and magnification factor. Other factors included control gain; control order; vertical gain reduction logic; and initial position error. Along-course, cross course and altitude tracking errors were recorded and analyzed using Yates' algorithm. Among the factors found to be most important are magnification of instantaneous error, control gain, tracking mode, control order, prediction time, and several interactions of these variables. It is found that the Horizontal and Vertically Integrated flight control and navigation information display takes the most important of these factors into account and therefore represents a successful display system for all weather VTOL aircraft. I.H.

A84-49091*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AIRBORNE INFRARED LOW-ALTITUDE WIND SHEAR DETECTION TEST
P. M. KUHN (NASA, Ames Research Center, Northrop Services, Inc., Moffett Field, CA) and R. L. KURKOWSKI (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 792-796. Previously cited in issue 06, p. 722, Accession no. A84-18043. refs
(Contract NAS2-10592)

A84-49388
HOLOGRAPHIC HEAD-UP DISPLAY GIVES MILITARY TRANSPORT PILOTS SEE-THROUGH ACCURACY
W. D. KYLE (Flight Dynamics, Inc., Hillsboro, OR) Defense Systems Review and Military Communications, vol. 2, Sept. 1984, p. 29-32.

A holographic head-up display system for presenting electronic symbology and sensor imagery is described. Considerations is given to a general discussion of the display characteristics of HUD, including a combiner which does not obscure the pilots view while displaying information. The combiner permits the simultaneous transmission of light and reflection of images at efficiency levels higher than those of nonholographic combines. The system also has a two-dimensional flight path vector which presents the immediate velocity of the aircraft. The vision goggle system is also discussed. Among the military transport applications of HUDs are: night-time terrain avoidance, low altitude operations, threat warning announcements, refueling operations, and formation flying. I.H.

N84-33408# Army Aviation Systems Command, St. Louis, Mo. Avionics Research and Development Activity.
A DUAL DIGITAL TO VIDEO CONVERTER AND COLOR VIDEO INSETTER FOR AVIONICS SYMBOLOGY AND MESSAGES
E. A. KARCHER and V. J. ORGANIC Jul. 1984 15 p
(AD-A143772; USAAVSCOM-TR-84-E-3) Avail: NTIS HC A02/MF A01 CSCL 09E

The design, interface, and operation of a general purpose raster scan display, digital-to-video converter and color video insetter is described which is capable of airborne or vehicular operation. GRA

N84-33409# National Aerospace Lab., Amsterdam (Netherlands). Vliegtuigen Hoofdafdeling.
THE APPLICATION OF FIBER OPTICS IN AIRCRAFT INSTRUMENTATION: TECHNOLOGY ASSESSMENT
J. C. T. VANDERVEEN 29 Apr. 1983 42 p refs In DUTCH; ENGLISH summary
(NLR-TR-83048-U; AD-B085967) Avail: NTIS HC A03/MF A01

The utilization of fiber optics in an aircraft environment is treated. Fiber optics appears very well suited for the applications to data transmission medium in aircraft. The advantages are substantial: galvanic isolation, electromagnetic compatibility, savings in volume and weight, and superior transmission qualities. Author (ESA)

N84-34409# Naval Air Test Center, Patuxent River, Md. Systems Engineering Test Directorate.
SIMULATION APPLIED TO THE AVIONICS SYSTEM TESTING IN THE F/A-18
A. C. CRUCE *In* AGARD Flight Test Tech. 9 p Jul. 1984
Avail: NTIS HC A16/MF A01

The use of simulation in support of flight test which can be used to leverage the flight test available in many programs to adequately cover the complex test requirements of modern systems is discussed. The simulation facility is designed around the multiplex data bus structure found in modern aircrafts. This architecture makes the simulation problem easier but is not a necessary condition for the application of these techniques to support flight test. However, for nonmultiplex bus systems the simulation is by nature more single purpose and the difficulty in changing the simulation facility from one aircraft type to another is greatly increased. The facility is used to support F/A-18 and AV-8B avionics system testing. The facility is being expanded to support flight system and flight control computer testing for the F/A-18, AV-8B, F-4S, F-14, and X-29 aircraft. It is asserted that the use of simulation to supplement flight test offers the opportunity to test highly complex and highly integrated weapons systems within the level of test assets expected to be available in future programs. E.A.K.

N84-34411# Air Force Flight Test Center, Edwards AFB, Calif.
F-16 AND A-10 DIFFRACTION OPTICS HEAD UP DISPLAY (HUD) FLIGHT TEST EVALUATION
H. G. F. WURFEL *In* AGARD Flight Test Tech. 19 p Jul. 1984
Avail: NTIS HC A16/MF A01

The introduction of wide field of view (WFOV) diffraction optics head-up displays (HUDs) which provide potentially more capability than has been previously available is discussed. A direct head up, pilot to real world interface via video raster and stroke written symbology permits low level maneuvering flight at night and provides at least a survivable capability. Integration of the WFOV HUD with the F-16 and A-10 aircraft provides a useful ability to make single seat night attack a realistic and effective alternative. The major planning activities and test results of the F-16 and A-10 head-up displays (HUD) evaluations were examined. Relevant test procedures and test techniques applicable to HUD testing in general and night video raster testing in particular are reviewed. The unique test requirements and safety aspects of night attack system testing are addressed. E.A.K.

N84-34420# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
GENERAL INTEGRATED MULTIPURPOSE INFLIGHT CALIBRATION SYSTEM (GIMICS)
R. GANDERT and R. KARMANN *In* AGARD Flight Test Tech. 17 p Jul. 1984
Avail: NTIS HC A16/MF A01

In 1985 the new Advanced Technology Testing Aircraft System (ATTAS) will be operable at the DFVLR in Braunschweig. Owing to the wide application spectrum of ATTAS and the varied range of users, a flight test instrumentation system having a very high degree of flexibility and testability was required. It was therefore decided that a versatile built in test and calibration system called

GIMICS should form an integral part of the ATTAS flight test instrumentation system. GIMICS is an intelligent, computer controlled system having dedicated access to the ATTAS subsystems. The system architecture and application flexibility of GIMICS will be presented. Author

N84-34421*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE DEVELOPMENT OF AN AIRBORNE INSTRUMENTATION COMPUTER SYSTEM FOR FLIGHT TEST
G. A. BEVER *In* AGARD Flight Test Tech. 13 p Jul. 1984 refs Previously announced as N84-20521 Prepared in cooperation with NASA. Dryden Flight Research Facility
Avail: NTIS HC A16/MF A01 CSCL 01D

Instrumentation interfacing frequently requires the linking of intelligent systems together, as well as requiring the link itself to be intelligent. The airborne instrumentation computer system (AICS) was developed to address this requirement. Its small size, approximately 254 by 133 by 140 mm (10 by 51/4 by 51/2 in), standard bus, and modular board configuration give it the ability to solve instrumentation interfacing and computation problems without forcing a redesign of the entire unit. This system has been used on the F-15 aircraft digital electronic engine control (DEEC) and its follow on engine model derivative (EMD) project and in an OV-1C Mohawk aircraft stall speed warning system. The AICS is presently undergoing configuration for use on an F-104 pace aircraft and on the advanced fighter technology integration (AFTI) F-111 aircraft. Author

N84-34443* National Aeronautics and Space Administration. Pasadena Office, Calif.
SYSTEM FOR INDICATING FUEL-EFFICIENT AIRCRAFT ALTITUDE Patent
B. L. GARY, inventor (to NASA) (JPL, California Inst. of Tech., Pasadena) 2 Oct. 1984 8 p Filed 26 Aug. 1982 Supersedes N83-17536 (08 - 21, p 1135) Continuation-in-part of US-Patent-Appl-SN-224231, filed 12 Jan. 1981, US-Patent-4,346,595
(NASA-CASE-NPO-15351-2; US-PATENT-4,474,062; US-PATENT-APPL-SN-412039; US-PATENT-CLASS-73-178-R; US-PATENT-APPL-SN-224231; US-PATENT-4,346,595) Avail: US Patent and Trademark Office CSCL 01D

A method and apparatus are provided for indicating the altitude at which an aircraft should fly so the W/d ratio (weight of the aircraft divided by the density of air) more closely approaches the optimum W/d for the aircraft. A passive microwave radiometer on the aircraft is directed at different angles with respect to the horizon to determine the air temperature, and therefore the density of the air, at different altitudes. The weight of the aircraft is known. The altitude of the aircraft is changed to fly the aircraft at an altitude at which is W/d ratio more closely approaches the optimum W/d ratio for that aircraft.
Official Gazette of the U.S. Patent and Trademark Office

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.

A84-46883#
SHEAR LAYER MIXING FOR LOW EMISSION GAS TURBINE PRIMARY ZONES
N. A. AL-DABBAGH, G. E. ANDREWS, and R. MANORHARAN (Leeds University, Leeds, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 10 p. Sponsorship: Science and Engineering Research Council of England. refs
(Contract SERC-GR/A/76894; SERC-GR/B/92812)
(ASME PAPER 84-GT-13)

Shear layer turbulent fuel and air mixing has been utilized in a simulated gas turbine primary zone combustor. Two methods of fuel injection and two values of the number of air injection holes have been investigated at a constant pressure loss of 4 percent at a reference Mach number of 0.047. The method of fuel injection and the number of air injection holes was found to influence the flame stability, and NO(x) emissions. A large number of holes produced much higher NO(x) emissions which was not compensated for by the ability to operate at weaker equivalence ratios due to the greater flame stability. An optimum primary zone operating condition, for very low NO(x) and high combustion efficiencies involving a flame temperature of approximately 1600 K, was identified, and there was a wide flame stability margin on this condition. Author

A84-46897#
TURBOTEST - A COMPUTER PROGRAM FOR RIG TEST ANALYSIS OF ARBITRARY GAS TURBINE ENGINES
J. R. PALMER (Cranfield Institute of Technology, Cranfield, Beds., England) and Y.-G. GU (Nanhua Powerplant Research Institute, Hunan, People's Republic of China) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-33)

The TURBOTEST computer model for both gas tubbine engine rig test analysis and the simulation of engine steady state performance can accommodate a large variety of gas turbine engine designs as well as any type of hydrocarbon fuel. Gas chemical dissociation and air humidity effects are encompassed by the model, which can also complete analyses in cases where incomplete test data has been used as input. The performance deterioration of engine components can be detected by comparing the results of a test analysis and of a parallel simulation, using stored component characteristics for the 'as new' condition. Attention is given to experience gained with turbojet and turbofan engines indicating close and repeatable agreement with design values. O.C.

A84-46903#
FILM COOLING ON A GAS TURBINE BLADE NEAR THE END WALL
R. J. GOLDSTEIN and H. P. CHEN (Minnesota, University, Minneapolis, MN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. USAF-supported research. Previously announced in STAR as N84-22569. refs
(ASME PAPER 84-GT-42)

Local film cooling effectiveness on a gas turbine blade with a row of discrete cooling jets was measured using a mass transfer technique. Emphasis is placed on phenomena near the end wall of the blade. This region contains a horseshoe vortex system modified by a passage vortex. On the concave (pressure) surface

the film cooling performance is not greatly altered by the presence of the end wall. On the convex surface of the blade the film cooling is essentially absent in a triangular region extending from near the region of peak curvature on the blade to its trailing edge. This unprotected region closely corresponds to location of the passage vortex as indicated by flow visualization. The passage vortex sweeps away the injected coolant flow from the surface. Upstream of the unprotected area the injected flow is skewed toward the middle span of the blade. End wall influence extends about one-half cord length up from the end wall in the present experiments. Author

A84-46908#
THE DEVELOPMENT OF THE HIGH ENERGY SURFACE DISCHARGE SPARK IGNITER
G. N. BURLAND, K. A. GOREHAM, and R. J. TAUNT (Smith Industries Aerospace and Defence Systems, Inc., London, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p.
(ASME PAPER 84-GT-51)

The High Energy Igniter is discussed from the point of view of its mechanism of operation and of factors which determine its operational life. Features of the engine environment and operation are considered in their effect on igniter life. The problems associated with continuous ignition and the overriding importance of the quality of the surface discharge material are discussed. The development of a new surface discharge ceramic is described. Author

A84-46929#
FUEL EFFECTS ON GAS TURBINE COMBUSTION - IGNITION, STABILITY, AND COMBUSTION EFFICIENCY
A. H. LEFEBVRE (Purdue University, West Lafayette, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 14 p. USAF-supported research. refs
(ASME PAPER 84-GT-87)

An analytical study is made of the substantial body of experimental data acquired during recent Wright-Patterson Aero Propulsion Laboratory sponsored programs on the effects of fuel properties on the performance and reliability of several gas turbine combustors, including J79-17A, J79-17C (Smokeless), F101, TF41, TF39, J85, TF33, and F100. Quantitative relationships are derived between certain key aspects of combustion, notably combustion efficency, lean blowout limits and lean light-off limits, and the relevant fuel properties, combustor design features, and combustor operating conditions. It is concluded that combustion efficiency, lean blowout limits, and lean lightoff limits are only slightly dependent on fuel chemistry, but are strongly influenced by the physical fuel properties that govern atomization quality and spray evaporation rates. Author

A84-46930#
SOME PRACTICAL ASPECTS OF STAGED PREMIXED, LOW EMISSIONS COMBUSTION
A. SOTHERAN, D. E. PEARCE, and D. L. OVERTON (Rolls-Royce, Ltd., Bristol, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-88)

An experimental program to research, develop, and demonstrate an axially staged, premixed low emissions combustor is described, with particular emphasis on the many mechanical and thermal problems which were encountered and which seem characteristic of the type. Of these, the risks of autoignition and flashback in the premixing duct were perhaps, the most severe. Their elimination imposed severe constraints on premixing duct geometry and indeed, dictated the layout of the whole combustor. Nevertheless, it proved possible to retain conventional technology to a large extent including the basic combustor structure and mounting arrangements and normal fuel injector accessibility. Large emissions reduction capability was demonstrated to be possible though not within conventional combustor dimensions. Author

A84-46939#
STRESS MAPPING OF A LOW PRESSURE COMPRESSOR FOR AN ADVANCED TURBOJET ENGINE
H. R. BANKHEAD (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) and C. E. MEECE (Pratt and Whitney Aircraft, West Palm Beach, FL) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-99)

Vibratory stress characteristics of the low pressure compressor in the Pratt & Whitney Aircraft PW1120 turbojet engine recently have been evaluated during full-scale engine testing at the United States Air Force's Arnold Engineering Development Center. A description is presented of the approach used to evaluate the vibratory characteristics of the new three stage low pressure compressor. Results are presented showing the effects of simulated altitude conditions, inlet pressure distortion, and off-schedule variable vane operation. Strain gage data is compared to case-mounted light probe data, and the levels of system damping and mistuning are discussed. Predicted vibratory response is compared to test results showing the new compressor to be free of destructive vibration. Author

A84-46941#
NO(X) ABATEMENT VIA WATER INJECTION IN AIRCRAFT-DERIVATIVE TURBINE ENGINES
D. W. BAHR and T. F. LYON (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p.
(ASME PAPER 84-GT-103)

The results of analytical and experimental investigations to develop efficient and reliable water injection methods for reducing the nitrogen oxides, or NO(x), levels of the LM2500 and LM5000 engines are presented. These aircraft-derivative turbine engines are equipped with compact annular combustors. In these investigations, various methods of injecting water into the combustor primary zone were evaluated in combustor and engine tests to identify methods with minimal water flow requirements for a given degree of NO(x) abatement. Primary emphasis was focused on the development of methods of injecting liquid water into the engines when operating with distillate fuels. Methods of injecting both liquid water and steam when operating with natural gas were also investigated. The impacts of water injection on combustor and engine performance and operability were additionally assessed. Satisfactory accommodation of water/fuel weight ratios above unity and associated NO(x) level reductions as high as 90 percent were demonstrated. Author

A84-46942#
A DESIGN APPROACH FOR A PRACTICAL TURBOJET ENGINE COMBUSTOR DIFFUSER SYSTEM
T. L. DUBELL, P. L. RUSSELL, and R. S. REILLY (Pratt and Whitney Aircraft, West Palm Beach, FL) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p.
(ASME PAPER 84-GT-104)

The combustion system in a gas turbine engine is the source of the energy released to produce propulsive power. Maintaining stable combustion and achieving good performance requires controlled introduction of air and good mixing in the combustor. The compressor discharge velocity must be reduced by diffusing the air before it reaches the combustor. There are fundamental and practical limits on how much diffusion can be done, and parasitic loss of pressure is introduced. This paper describes an approach to achieving an improved, cost effective diffuser design. The diffuser that results provides excellent performance, is simple, and is dynamically stable. Author

A84-46943#
THE EFFECT OF FUEL COMPOSITION ON HOT SECTION PERFORMANCE OF A GAS TURBINE ENGINE
S. RUTTER (Avco Corp., Avco Lycoming Stratford Div., Stratford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Navy-supported research. refs
(ASME PAPER 84-GT-105)

The combustor system of an AVCO Lycoming T53-L-13B turboshaft engine was tested to identify fuel properties detrimental to engine performance or hot section durability, and to measure their effect. Test fuels were characteristic of current and near-term alternate fuels for military aircraft. Relations were developed for altitude ignition, particulate emissions, combustion efficiency, and combustor liner life. Fuel hydrogen content was found to be an important consideration for particulates and combustor liner life, while fuel viscosity, density and mass transfer number were important to idle efficiency and altitude ignition. Author

A84-46944#
FULL LOAD OPERATION OF A GAS TURBINE COMBUSTOR WITH ACOUSTICALLY CONTROLLED DILUTION-AIR MIXING
P. J. VERMEULEN, J. ODGERS, and V. RAMESH (Calgary, University, Calgary, Alberta, Canada) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Sponsorship: Natural Sciences and Engineering Research Council of Canada. refs
(Contract NSERC-A-7801)
(ASME PAPER 84-GT-106)

A small combustor of conventional design that uses acoustically controlled dilution-air mixing processes has been successfully tested, up to full load operating conditions, in order to demonstrate the ability to trim the temperature profile. The exit plane temperature distribution can be beneficially controlled without detriment to other combustor performance factors. The results obtained indicate that acoustic modulation of dilution-air flows can selectively and progressively control exit plane temperature distributions. O.C.

A84-46955#
DEVELOPMENT OF THE F110-GE-100 ENGINE
M. S. COALSON (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p.
(ASME PAPER 84-GT-132)

The F110 engine is a derivative of the B-1 bomber's F101 low bypass turbofan, and is intended to replace the F100 engine of the F-14, F-15 and F-16 fighters. The core of the F110, consisting of the compressor, combustor, and high pressure turbine, is identical to that of the F101 engine. Flight testing of the engine in F-16, F-16XL, and F-14 airframes indicates substantially improved durability, reliability, operability, and life cycle cost over the F100 and TF30 engines being supplanted. Attention is given to thermodynamic performance and engine control. O.C.

A84-46958#
THE EFFECT OF OXYGEN CONCENTRATION ON IGNITION OF FUEL SPRAY IN LOW PRESSURE AIR FLOW
Y. H. ZHAO, N. K. CHEN, and J. S. CHIN (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p.
(ASME PAPER 84-GT-147)

Experimental research to improve ignition by oxygen addition in a combustion chamber of an aircraft engine is performed. Local oxygen injection improves low ignition performance caused by the low evaporation percentage of fuel spray. A semi-analytical equation has predicted maximum ignition velocity by oxygen addition and the equation correlates well with experimental data. The formation of a stagnant region with suitable oxygen concentration is an important factor in the design of the ignitor with oxygen addition. The layout of the test rig is shown and ignition loops without oxygen and with uniform oxygen addition are illustrated. S.H.

A84-46970#
AGT101 ADVANCED GAS TURBINE TECHNOLOGY UPDATE
J. R. KIDWELL, D. M. KREINER, R. A. RACKLEY (Garrett Turbine Engine Co., Phoenix, AZ), and J. L. MASON (Garrett Corp., Los Angeles, CA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 11 p.
(ASME PAPER 84-GT-166)

The AGT101 is a 100-hp, regenerated, single shaft gas turbine engine that operates at a maximum turbine inlet temperature of 1371 C. All of its high temperature components, including the turbine rotor, are ceramic. Individual and collective ceramic component screening tests have been successfully accomplished at temperatures of up to 1149 C. This research program is aimed at furnishing U.S. automotive manufacturers with high risk technology development data required for the production of automobile gas turbine powerplants that will yield reduced fuel consumption and environmental pollutants. O.C.

A84-46987#
IMPINGEMENT STARTING AND POWER BOOSTING OF SMALL GAS TURBINES
C. RODGERS (Solar Turbines, Inc., Turbomach Div., San Diego, CA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-188)

The test data presented for supersonic, side-admission impingement nozzles mounted on the stationary shrouds of small gas turbine compressors or turbines, where single stage radial outflow compressors and radial inflow turbines, respectively, are used, indicate that expansion efficiencies of the order of no more than 40 percent are obtainable. These poor results are due to rotor velocity coefficients close to zero, with high rotor incidence, and it is noted that overall expansion coefficients are even lower if expressed in terms of the overall nozzle inlet to rotor outlet pressure (as a result of the rotor reaction). Compressor shroud impingement nozzles typically reduced the standard electric system start time to rated speed from 20 to 9 sec. O.C.

A84-46989#
INFLUENCE OF A CLOSELY-COUPLED THROTTLE ON THE STALLING BEHAVIOR OF A RADIAL COMPRESSOR STAGE
J. W. RAILLY (Birmingham, University, Birmingham, England) and H. EKEROL American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. Research supported by the Department of Industry and Trade. refs
(ASME PAPER 84-GT-190)

The stability of a compressor stage consisting of a radial impeller, followed by a vaned radial diffuser with a small radial gap between them is treated for the specific condition in which a radial array of adjustable vanes at the diffuser exit serves to either throttle the flow or offer no resistance. In the latter case, throttling occurs by means of restrictions at the inlet that is situated upstream. The theory demonstrates that instability can occur in the former case only when the stage pressure characteristic slope becomes so positive that the throttle pressure characteristic is tangential to it. These theoretical results were experimentally confirmed by tests on a low speed radial compressor stage. When the vanes were used for throttling, no rotating stall appeared, while with throttling remote from the stage, a vigorous rotating stall mode developed. O.C.

A84-46990#
INTEGRATED FLIGHT/PROPULSION CONTROL SYSTEM CONSIDERATIONS FOR FUTURE AIRCRAFT APPLICATION
R. W. VIZZINI (U.S. Naval Air Propulsion Center, Trenton, NJ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 5 p. refs
(ASME PAPER 84-GT-192)

Flight and propulsion controls can effectively be integrated to provide operational benefits to the weapon system which cannot be achieved with either system acting independently. The key factor is the synergistic effect of digital computers and associated high-speed data links, engine condition monitoring, diagnostics, and shared power systems (hydraulic and electrical), thus providing potential improvements in reliability, life cycle cost, weight, and maintenance actions. This technical paper will address the integration concepts required for the airframe and the propulsion control configurations (for consideration in the design stages) to achieve the optimum weapon system configuration by assessing fiber optic and hardwired systems for future applications. Author

A84-46993*# Massachusetts Inst. of Tech., Cambridge.
OPTIMIZATION AND MECHANISMS OF MISTUNING IN CASCADES
E. F. CRAWLEY and K. C. HALL (MIT, Cambridge, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. Research supported by the Fannie and John Hertz Foundation. refs
(Contract NSG-3079)
(ASME PAPER 84-GT-196)

In the present inverse design procedure for the optimum mistuning of a high bypass ratio shroudless fan that is modeled as a cascade of blades (each with a single torsional degree-of-freedom), linearized supersonic aerodynamic theory is used to compute the unsteady aerodynamic forces in the 'influence coefficient' form at a typical blade section. The mistuning pattern is then numerically optimized in order to achieve a specified increase in the aeroelastic stability margin with a minimum amount of mistuning. If the blades are self-damped, an optimized mistuning pattern can be found that achieves a given stability margin for a much lower level of mistuning than required for the alternate mistuning pattern, which requires only two blade frequencies and is relatively insensitive to implementation errors. O.C.

A84-46999#
A NEW GENERATION T56 TURBOPROP ENGINE
W. L. MCINTIRE (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Research supported by the General Motors Corp. and U.S. Air Force.
(ASME PAPER 84-GT-210)

The T56-A-427, the U.S. Navy Series IV derivative of the 5000 shp-class T56 turboprop engine, is the result of 10 years of technology development aimed at improving output power and fuel consumption through the incorporation of demonstrated components, while retaining the long term durability and cost effectiveness of previous members of this engine family. An sfc reduction of 13 percent, together with an output power increase of 28 percent, has been demonstrated in this engine development program's most recent phase. Engine applications include the Navy P-3, C-2 and E-2 turboprop aircraft. O.C.

A84-47003#
THE APPLICATION OF AIR DYNAMOMETERS FOR TESTING TURBO-SHAFT GAS TURBINE ENGINES
W. B. FOOR (U.S. Naval Air Engineering Center, Lakehurst, NJ) and W. JANSEN (Northern Research Engineering Corp., Woburn, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. Navy-supported research.
(ASME PAPER 84-GT-216)

Air dynamometers employing a double-sided radial flow compressor with cantilevered blades and movable shrouds are being successfully used by the U.S. Navy in its turboshaft engine testing program. Attention is presently given to this test apparatus concept, as well as to the mechanical design features of the existing air dynamometer. Dynamometer power absorption performance at various power and speed settings are noted for the case of the T58/T700 engine. Tested outputs have ranged from 300 to 1870 hp, at up to 21,275 rpm. The apparatus' maximum capabilities are projected to range over 400-3500 hp at 22,000 rpm. O.C.

A84-47010#
THE PW1120 - A HIGH PERFORMANCE LOW RISK F100 DERIVATIVE
M. A. ZIPKIN (Pratt and Whitney Group, Government Products Div., West Palm Beach, FL) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p.
(ASME PAPER 84-GT-230)

The performance goals and operational characteristics of the PW1120 engine, which is a turbojet derivative of the F100 turbofan, have been met at both sea level and altitude simulated flight conditions. Attention is presently given to the degree of commonality between the PW1120 and F100, and its consequences for reliability, maintainability, safety, and improved logistics support. Components unique to the PW1120 include a new, low aspect ratio, wide chord blade design low pressure compressor, a single stage low pressure turbine, and a simplified, single stream augmentor and nozzle. This 20,000-lb thrust class engine is under consideration as a powerplant for reeingined F-4s, as well as the next-generation Israeli fighter, Lavi. O.C.

A84-47012#
AXIAL COMPRESSOR PERFORMANCE RESTORATION BY BLADE PROFILE CONTROL
W. B. ROBERTS (Flow Application Research, Fremont, CA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 12 p. refs
(ASME PAPER 84-GT-232)

The imperfections found in newly fabricated axial compressor blade shapes become further distorted in the course of operation through the effects of erosion, yielding an aerodynamic efficiency penalty that results in increased fuel consumption. A simple, numerical blade element panel method is presently combined with an integral boundary layer technique in order to undertake an aerodynamic analysis of the effect of imperfections in blade shape for compressor blading. Results indicate what blade shapes would result in increased profile losses, as well as what kind of reshaping allows restoration of nominal performance. These findings are verified through tests on JT8D engines. O.C.

A84-47017#
RELATIVE FLOW STRUCTURE AT EXIT FROM AN AXIAL COMPRESSOR ROTOR IN ROTATING STALL
R. CHENG (Nanjing Gas Turbine Institute, Nanjing, People's Republic of China), J. W. RAILLY (Birmingham, University, Birmingham, England), and H. EKEROL American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. Research supported by the Science and Engineering Research Council and University of Birmingham. refs
(ASME PAPER 84-GT-240)

The phase-lock-averaging (PLA) technique is used in association with a traverse gear mounted on an axial compressor rotor to explore the flow field at exit from the rotor during rotating stall. The technique requires the use of a trigger hot-wire anemometer also mounted on the rotor to ensure the proper location of the stall cell in relation to the measurement probe. The probe consists of a three-wire nonorthogonal array which may be traversed radially and peripherally over a complete blade passage. By a systematic adjustment of the probe orientation angle, the presence of reverse flow is detected. A mathematical procedure for the determination of the magnitude and direction of the flow vector is presented. On the basis of a large collection of phase-locked data it is demonstrated that the leading and trailing edges of the cell travel at a nonuniform rate and in such a way as to vary cyclically in peripheral extent with a period related to the blade passing frequency. The peripheral distribution of the flow vector at successive instants of relative time is also produced from the data collection and the evolution of the stall cell structure is presented. Author

A84-47022#
A STUDY OF THE PREDICTION OF TIP AND SEAL CLEARANCES AND THEIR EFFECTS IN GAS TURBINE TRANSIENTS
P. PILIDIS (Caledonian Airmotive, Ltd., Prestwick, Scotland) and N. R. L. MACCALLUM (Glasgow, University, Glasgow, Scotland) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-245)

Clearances of compressor and turbine blade tips and seals alter during and following speed transients. These changes affect the performance of the components and hence of the engine. This paper describes models for the prediction of blade tip clearance changes and seal clearance changes. These models have been applied to the H.P. compressor and H.P. Turbine and to two seals controlling air flows in a two-spool Bypass Engine. The predicted acceleration rates appear to be more influenced by the changes in the seal clearances than by the tip clearance changes. The increases in computing time in the engine transient program which result from inclusion of the model are acceptable. Author

A84-47024#
THE EFFECTS OF REYNOLDS NUMBER OF THE EFFICIENCY OF CENTRIFUGAL COMPRESSOR STAGES
M. V. CASEY (Sulzer-Escher Wyss, Ltd., Zurich, Switzerland) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-247)

An analysis of the friction losses in a centrifugal compressor stage is used to suggest a new form of correction equation for the effect of Reynolds number on efficiency. This equation relates the effect of Reynolds number to the surface roughness, the impeller outlet width ratio and the work input coefficient. Systematic tests on a wide range of compressor stages are used to calibrate the single empirical coefficient in the equation. Despite its simplicity this equation provides more accurate predictions of the Reynolds number effects than existing empirical methods. Author

A84-47028#
CORROSION AND CORROSION CONTROL IN GAS TURBINES. I - THE COMPRESSOR SECTION
H. J. KOLKMAN and A. J. A. MOM (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-255)

Corrosion processes due to electrochemical mechanisms in the compressor of gas turbines and possible counter measures are investigated. Emphasis is given to wet corrosion caused by hygroscopic particles in the intake air containing sea salt with air pollutants such as sulphur dioxide and nitrogen dioxides. Quantity and composition of salt deposits in the compressors of jet engines for aircraft are illustrated, to identify the dominant anion. Various methods to overcome these corrosion processes are discussed with special attention given to selection of corrosion resistant base materials, rinsing and washing of salt deposits, and protective coatings. These coatings can be either diffusion coating or electroplated coating composed of NiCd. Also analyzed are electrophoretically applied coatings. A schematic overview of the corrosion process is included. S.H.

A84-47029#
CORROSION AND CORROSION CONTROL IN GAS TURBINES. II - THE TURBINE SECTION
A. J. A. MOM and H. J. KOLKMAN (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-256)

Corrosion processes in gas turbines due to oxidation and hot corrosion during service and some possible counter measures are investigated. Conditions which govern corrosion behavior including temperature, pressure, and presence of sulphur compounds (SO2 or SO3) are discussed. Methods to overcome the corrosion attack are presented, emphasizing the use of fuel additives such as magnesium oxide forming magnesium-vanadates with a high melting point, or chromium base. The chemical composition of gas turbine material is a major factor controlling the extent of the corrosion process, with cobalt alloys showing better hot corrosion resistance than nickel alloys. For corrosion control the application of coatings (diffusion, metallic overlay, and ceramic) is studied extensively, mentioning advantages and disadvantages with respect to industrial and aircraft engines. Schematic views of the relative corrosion of Ni- and Co-alloys, and the formation of a protective oxide scale on a Ni-base superalloy are included. Further service experience is recommended. S.H.

A84-47030#
CT7-5A/7/7E TURBOPROP ENGINE FOR COMMUTER AIRLINE SERVICE
J. D. STEWART (General Electric Co., Aircraft Engine Business Group, Lynn, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p.
(ASME PAPER 84-GT-257)

The 1700-shp CT7 turboprop family of engines has been derived from the current T700/CT7 turboshaft engine family in order to meet the requirements of the growing computer airliner market. Attention is given to the purposes and features of component redesign in the cases of the compressor, the high and low pressure turbines, and the inlet system, together with the design of the propeller gearbox and a control system that oversees fuel handling, fuel flow computation, compressor bleed, variable geometry control, engine power selection, overspeed limiting, and the propeller speed bottoming governor. A Gulfstream twin-engine turboprop aircraft has been used as a flight test vehicle. O.C.

A84-47033#
AIRCRAFT ENGINE CONTROL MODE ANALYSIS
H. BROWN and J. A. ELGIN (General Electric Co., Cincinnati, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p.
(ASME PAPER 84-GT-262)

This paper describes the control mode analysis procedure that is used to establish closed-loop control requirements for advanced aircraft propulsion systems. The procedure utilizes anticipated variations in engine component performance, engine deterioration, and control tolerances in a statistical analysis to establish corresponding variations in engine output performance and safety parameters. Potential closed-loop control configurations are evaluated by this process, compared, and the best configurations selected for implementation into control law and schedule designs. A byproduct of the analysis is the establishment of engine design and performance margins. The paper will describe typical engine variational models used in this process, the General Electric COMET program designed to automate the analysis, and typical mode study results based on a current augmented turbofan engine. Author

A84-47035#
DEVELOPMENT OF A STATE-OF-THE-ART JET AIRCRAFT START UNIT FOR U.S. NAVY USE - A PROGRAM OVERVIEW
E. W. MIHALEK (U.S. Naval Air Engineering Center, Lakehurst, NJ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p.
(ASME PAPER 84-GT-264)

The development of a State-of-the-Art Jet Aircraft Start Unit was recently initiated by the U.S. Navy to meet current and projected operational aircraft requirements. An air supply system has been selected and is currently in the prototype testing phase. The unit employs a TITAL series small gas turbine engine as the pneumatic power source. The entire system is packaged in an enclosure that provides protection, serviceability, attenuation of hot exhaust gases, and commonality for shipboard and landbased use. Author

A84-47041#
DEVELOPMENT AND EVALUATION OF INTEGRATED FLIGHT/PROPULSION CONTROL ALGORITHMS FOR A TACTICAL FIGHTER
C. M. CARLIN, L. L. MUNGER (Boeing Military Airplane Co., Seattle, WA), and D. GANGSAAS (Boeing Commercial Airplane Co., Seattle, WA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 11 p. refs
(ASME PAPER 84-GT-282)

Linear quadratic synthesis is the basis of a feedforward controller combined with full state feedback that provides nearly decoupled response to both normal and longitudinal acceleration commands, as well as steady state tracking of vertical flight path and airspeed, for the Air Force Technology Integrator/F-111 aircraft. Enhanced maneuverability, and pilot workload reduction are achieved through coordinated commands to leading and trailing edge flaps, stabilons, and engine throttles. Preliminary evaluation of the design was performed on a nonlinear, six-degree-of-freedom, real time-piloted simulation using a simplified propulsion system model, and good performance was obtained for the fixed gain design over a wide range of flight conditions in the preliminary evaluation. O.C.

A84-47042#
THEORETICAL AND EXPERIMENTAL DETERMINATION OF THE TRANSFER FUNCTION OF A COMPRESSOR
J. PAULON (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-283; ONERA, TP NO. 1984-29)

On the basis of test results obtained on a subsonic compressor with near one-dimensional flow, and transients that are induced by a timewise-variable area, it is observed that inlet and outlet pressures during transients are functions of both the inlet axial velocity and inlet static pressure. The relation between these parameters depends on the inlet duct geometry. It is demonstrated that the prediction of compressor response to transients requires the resolution of both the momentum and mass conservation equations, under the present, simplified one-dimensional form that takes body forces into account. O.C.

A84-47066
AN EXPERIMENTAL STUDY OF THE CONDITIONS LEADING TO THE GENERATION OF A VORTEX AT THE AIR INTAKE OF A GAS-TURBINE ENGINE AND VORTEX-INDUCED PERTURBATIONS [EKSPERIMENTAL'NOE ISSLEDOVANIE USLOVII VOZNIKNOVENIIA VIKHRIA U VKHODA V VOZDUKHOZABORNIK GAZOTURBINNOGO DVIGATELIA I SOZDAVAEMYKH IM VOZMUSHCHENIIAKH]
V. I. RASSHCHUPKIN TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 119-123. In Russian. refs

Wind-tunnel studies have been conducted on a model to investigate the factors responsible for the formation of a vortex at the air intake of a gas-turbine engine operating in a fixed position near the ground. The factors investigated include the thickness of the boundary layer on the ground, nonsymmetric flow conditions in the suction flow, and the effect of the surrounding objects. Measurements of velocity and velocity fluctuation fields in the inlet section of the air intake model in the presence of a vortex flow are presented. V.L.

A84-47551
A LOBE MIXER FOR BYPASS ENGINES [LEPESTKOVYI SMESITEL' TRDD]
A. B. AGEEV and B. I. MAMAEV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 3-7. In Russian.

A lobe mixer design is proposed for bypass engines with high bypass ratios. The geometry and principal characteristics of the mixer are discussed, as are the results of full-scale tests. The extent of mixing and pressure losses are determined on the basis of test results, and it is shown that the mixer improves the fuel economy of the engine by 2.5 percent at cruising speeds. V.L.

A84-47552
A STUDY OF THE EFFICIENCY OF ALGORITHMS FOR THE GAS-AIR PATH DIAGNOSTICS OF GAS TURBINE ENGINES ON THE BASIS OF THERMOGASDYNAMIC PARAMETERS [ISSLEDOVANIE EFFEKTIVNOSTI ALGORITMOV DIAGNOSTIKI GAZOVOZDUSHNOGO TRAKTA GTD PO TERMOGAZODINAMICHESKIM PARAMETRAM]
A. M. AKHMEDZIANOV and K. F. GALIULLIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 7-13. In Russian. refs

The effect of detection errors on the efficiency of the algorithms used for the gas path diagnostics of gas turbine engines is investigated. It is shown that the algorithms using diagnostic matrices based on adequate engine models are generally highly efficient. However, as the noise due to errors in determinations of state attributes and model inadequacy increases, these algorithms become significantly less effective than the algorithms based on the least squares method. The algorithms based on the nonlinear programming concept are shown to be less efficient than the above mentioned algorithms. V.L.

A84-47557
EXERGIC ANALYSIS OF THE TURBOJET ENGINE CYCLE [EKSERGETICHESKII ANALIZ TSIKLA TRD]
K. A. MALINOVSKII Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 32-37. In Russian. refs

The turbojet engine cycle is analyzed using the exergy method, and the advantages of this approach over the energy method are examined. A determination is made of the balance of exergy fluxes in the turbojet engine which shows in which components of the engine and in what amounts the useful part of the fuel-derived energy is consumed. It is noted that the exergy method is particularly useful in analyzing combined power plants containing heat exchange devices. V.L.

A84-47558
ENERGY LOSSES IN MULTIROW JET COOLING OF THE LEADING EDGE OF TURBINE BLADES [POTERI ENERGII PRI MNOGORIADNOM STRUINOM OKHLAZHDENII VKHODNOI KROMKI TURBINNOI LOPATKI]
V. V. RUMIANTSEV and I. P. MAKOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 37-40. In Russian. refs

Experiments have been carried out to evaluate total pressure losses in cooling schemes where several rows of air jets impinge on the inside surface of the leading edge of turbine blades. The drag coefficient and the flow coefficient are determined as a function of the Reynolds number and H/d ratio for systems with one, two, and three rows of cooling jets. Results are presented in graphical form. V.L.

A84-47559
AN EXPERIMENTAL DETERMINATION OF THE OPTIMUM OUTLET-INLET ROTOR BLADE HEIGHT RATIO FOR RADIAL INWARD-FLOW MICROTURBINES [EKSPERIMENTAL'NOE OPREDELENIE OPTIMAL'NOGO OTNOSHENIIA VYSOT LOPATOK RABOCHEGO KOLESA NA VYKHODE I VKHODE RADIAL'NYKH TSENTROSTREMITEL'NYKH MIKROTURBIN]
N. T. TIKHONOV, A. N. TIKHONOV, and V. N. MATVEEV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 40-44. In Russian.

Optimum outlet-inlet rotor blade height ratios are determined experimentally for rotors with h2/h1 ratios of 1.54, 1.90, 2.44, 2.91, 3.43, 3.77, and 4.50. Expressions are obtained which relate the blade height ratio to the partial admission, the expansion ratio, and the velocity ratio. For turbines with variable partial admission, it is recommended that the blade height ratio be selected for the maximum value of partial admission. V.L.

A84-47560
CERTAIN CHARACTERISTICS OF THE OPERATION OF BYPASS ENGINES WITH THE AFTERBURNER ON [NEKOTORYE OSOBENNOSTI RABOTY TRDDF NA FORSAZHNYKH REZHIMAKH]
B. D. FISHBEIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 45-49. In Russian. refs

A study has been made of the effect of power takeoff due to the operation of the augmentation pump on the performance of the components of bypass engines and changes in the parameters of the turbocompressor. It is shown that during operation with maximum augmentation thrust, an additional power takeoff for the pump drive is of the order of 1.0-1.4 percent during takeoff and 2.0-2.4 percent during landing, when flying at Mach 2.8. The effect of various turbocompressor control schemes on the engine parameters is examined. V.L.

A84-47564
SYNTHESIS OF AN OPTIMAL ON-BOARD ELECTRIC POWER DISTRIBUTION SYSTEM FOR AIRCRAFT USING COMPUTER-AIDED DESIGN [SINTEZ OPTIMAL'NOI SAMOLETNOI SISTEMY RASPREDELENIIA ELEKTROENERGII PRI AVTOMATIZIROVANNOM PROEKTIROVANII]
V. S. TERESHCHUK Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 64-68. In Russian.

A method is developed for optimizing the synthesis of on-board open-loop electric power circuits of radial configuration. Procedures for determining the required number of distribution devices, their arrangement on board an aircraft, and the distribution of the feeders of energy-receiving devices are discussed. The optimization procedures are based on the dynamic programming approach. V.L.

A84-47570
THE EFFECT OF THE INJECTION OF WATER INTO THE COOLING AIR ON THE FUEL ECONOMY OF GAS TURBINE ENGINES DURING OPERATION WITH THE AFTERBURNER ON [VLIIANIE VPRYSKA VODY V VOZDUKH, OKHLAZHDAIUSHCHII TURBINU, NA EKONOMICHNOST' GTD PRI RABOTE NA FORSAZHNYKH REZHIMAKH]
G. M. GORELOV, V. P. DANILCHENKO, and V. E. REZNIK Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 81-83. In Russian. refs

Formulas are presented for calculating fuel savings resulting from the injection of water into the air that cools turbine blades and nozzle guide vanes. It is shown that the fuel economy achieved depends to a large degree on the maximum gas temperature at the turbine inlet. It is calculated that the fuel saved during one hour of operation with the afterburner on can be sufficient for a 1.5-2-hr flight at an altitude of 11 km and Mach 0.8. V.L.

A84-47572
A STUDY OF A FLOW CONTROL DEVICE IN THE FORM OF A CIRCULAR GROOVE IN THE CASING OF A COMPRESSOR [ISSLEDOVANIE USTROISTVA UPRAVLENIIA POTOKOM V VIDE KOL'TSEVOI VYTOCHKI V KORPUSE KOMPRESSORA]
V. N. ERSHOV, A. P. EFIMENKO, and V. IU. NEZYM Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 85, 86. In Russian.

Experimental results are presented for axial-flow compressors in which an annular groove in the housing above the rotor is used as an anti-stall device. It is shown that the design proposed here makes it possible to considerably widen the range of stall-free operation. The results obtained are applicable to the startup of gas turbine engines. V.L.

A84-47576
MATHEMATICAL MODELING OF THE OPERATION OF GAS TURBINE ENGINES UNDER TRANSIENT CONDITIONS [K MATEMATICHESKOMU MODELIROVANIIU RABOTY GTD NA NESTATSIONARNYKH REZHIMAKH]
IU. A. SKVORTSOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 96-98. In Russian.

Transient gas flow in gas turbine engines can be calculated by directly substituting local approximation functions into the integral form of gas dynamics equations. A comparison is made here between methods using piecewise constant and piecewise linear approximations of flow parameters with respect to the spatial coordinate. Also, a modified version of the piecewise linear approximation method is examined which simplifies flow computation without a substantial decrease in accuracy. V.L.

A84-47628
THE EFFECT OF SERVICE CONDITIONS ON THE TECHNICAL-ECONOMICAL CHARACTERISTICS OF AIRCRAFT ENGINES [VLIIANIE USLOVII EKSPLUATATSII NA TEKHNIKO-EKONOMICHESKIE KHARAKTERISTIKI AVIADVIGATELIA]
K. P. ALEKSEEV Moscow, Izdatel'stvo Transport, 1983, 96 p. In Russian. refs

A method is developed for estimating the effect of the principal service factors (e.g., flight conditions, nonstop flight duration, the condition of the runway, and environmental factors) on the reliability, service life, performance, and cost effectiveness of aircraft engines. In accordance with the approach proposed here, the effect of service conditions on the technical and economical performance of aircraft engines is estimated quantitatively using a mathematical model that describes the statistical reliability of the engine. Accelerated testing techniques involving overstrained operation are reviewed. V.L.

A84-49352#
PROPFANS - FUEL SAVING BUT EAR SPLITTING
R. DEMEIS *Aerospace America* (ISSN 0740-722X), vol. 22, Oct. 1984, p. 37, 40, 88.

Some recent developments in the design of propfan engines for commercial aircraft are reviewed. Consideration is given to the problem of reducing cabin noise without incurring weight or performance penalties for the aircraft as a whole. NASA flight tests with a Jetstar and P-3C aircraft equipped with 2-ft. diameter propfans have shown that synchrophasing prop speed and position between engines can reduce cabin noise levels significantly. By adding more wall insulation it is predicted that noise reductions of as much as 25 dB will be possible in the future. I.H.

A84-49353#
SUPERSONIC V/STOL READY FOR TECHNOLOGY PUSH
W. J. LEWIS (Rolls-Royce, Ltd., Bristol, England) and D. PALFREYMAN (Rolls-Royce, Inc., Atlanta, GA) Aerospace America (ISSN 0740-722X), vol. 22, Oct. 1984, p. 46-51.

Recent developments in the design of V/STOL engine configurations for supersonic aircraft are reviewed. Attention is given to the early history of V/STOL designs, and to efforts to overcome the inherent weight penalties V/STOL engines impose on aircraft due to the need for thrust vectoring, thrust reversing, and reaction control systems. Among the designs described are: the F402 vectored thrust engine; a tilt nacelle configuration; hybrid fan vectored-thrust (HFVT); and several types of remote augmented lift systems (RALS). A series of diagrams is provided which describes the operation of the HFVT tandem fan RALS and ejector lift V/STOL design concepts in detail. I.H.

A84-49354#
UNDUCTED FAN FOR TOMORROW'S SUBSONIC PROPULSION
R. C. HAWKINS (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) Aerospace America (ISSN 0740-722X), vol. 22, Oct. 1984, p. 52-55.

Some of the performance criteria used in the design of a counter-rotating unducted fan (UDF) for subsonic commercial aircraft are discussed. Attention is given the results of preliminary wind tunnel tests of a model counter rotating UDF which show that the fan design can produce high loading (65 hp/sq ft) efficiently and quietly. Fuel savings accrued by the fans are expected to be near 30 percent in comparison with ducted turbofans. The UDF can be applied to twin engine aircraft carrying from 120 to 150 passengers. Some of the possible military applications of UDF include tanker aircraft propulsion, long range supply and patrol planes, carrier capable aircraft, and drones. A schematic diagram describing the operation of a UDF engine is provided. I.H.

A84-49355#
NO BED OF ROSES FOR THE MILITARY ENGINE DESIGNER
E. C. SIMPSON Aerospace America (ISSN 0740-722X), vol. 22, Oct. 1984, p. 56-59.

Several issues in the debate over aircraft engine procurement policy are identified from the point of view of the aircraft engine designer. Considerations is given to the demands imposed upon the engine designer under current DOD procurement policy concerning accurate estimates of cost, production schedules and system reliability. It is argued that congressional impatience and inconsistency in spending priorities often make it difficult for aerospace companies to produce highly durable, maintenance free, and inexpensive products. As a specific example, attention is given to the problems inherent in reducing the weight of aircraft engines without giving up important performance characteristics, maintenance, and cost advantages. It is recommended that recent congressional insistence be eased concerning guarantees from aerospace manufacturers as to the quality and costs of their products. I.H.

A84-49369
ELECTRICAL POWER GENERATION IMPROVED
D. J. HOLT Aerospace Engineering (ISSN 0736-2536), vol. 4, Sept.-Oct. 1984, p. 4-9.

Variable-speed constant-frequency generator systems to provide 400-Hz electric power in aircraft are discussed. It is found that dc-link systems using transistors to rectify the 1000-2000-Hz generator output to a nominal 300 Vdc and static inverters are more reliable than cycloconverter systems based on silicon-controlled rectifiers; the mean times between failure of 40-kW systems operating at 93 C are given as 81,347 and 3470 hours, respectively. Modular versions of the dc-link system are in use in military aircraft such as the F-16, AV-8B, and F-20, and similar generating systems for commercial aircraft are under development. Block diagrams and photographs of typical systems are provided. T.K.

A84-49548#
INFLUENCE OF UNSTEADY AERODYNAMICS ON AIRCRAFT PARAMETER IDENTIFICATION
H. OKUBO (Osaka Prefecture, University, Sakai, Japan) and H. TSUNASHIMA (Kobe Steel, Ltd., Kobe, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, May 1984, p. 41-52. refs

The influence of unsteady lift force on the identification of the aircraft stability and control derivatives from flight data is investigated. The dynamics of the unsteady lift force are *incorporated with the short-period equations of the motion of aircraft* by using the finite-order Padeapproximants. The result of the parameter identification from simulated flight data leads to the following conclusions on the effect of unsteady lift dynamics: first, it causes evident deviations in the estimated value of the stability derivatives from the quasi-steady value. (The tail-downwash delay also has strong influence on the identified parameter values, particularly on damping-in-pitch). Second, it can cause a large error in the estimated value of the control derivatives when they are identified simultaneously with the stability derivatives. Finally, it exponentially decreases with an increase of the period of control input used to excite the aircraft motion. Author

N84-33410* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIR MODULATION APPARATUS Patent
D. T. LENAHAN (GE, Cincinnati), R. J. CORSMEIER (GE, Cincinnati), and A. P. STERMAN, inventors (to NASA) (GE, Cincinnati) 22 Nov. 1983 8 p Filed 25 Feb. 1981 Supersedes N83-30957 (21 - 19, p 3136) Sponsored by NASA
(NASA-CASE-LEW-13524-1; NAS 1.71:LEW-13524-1; US-PATENT-4,416,111; US-PATENT-APPL-SN-238257; US-PATENT-CLASS-60-39.29; US-PATENT-CLASS-60-39.83; US-PATENT-CLASS-415-115) Avail: US Patent and Trademark Office CSCL 20E

An air modulation apparatus, such as for use in modulating cooling air to the turbine section of a gas turbine engine is described. The apparatus includes valve means disposed around an annular conduit, such as a nozzle, in the engine cooling air circuit. The valve means, when in a closed position, blocks a portion of the conduit, and thus reduces the amount and increases the velocity of cooling air flowing through the nozzle. The apparatus also includes actuation means, which can operate in response to predetermined engine conditions, for enabling opening and closing of the valve means.
Official Gazette of the U.S. Patent and Trademark Office

N84-33411*# National Aeronautics and Space Administration, Washington, D. C.
COMPARISON OF COMBUSTION EFFICIENCIES FOR RAMJET ENGINES
J. W. BERGMANN Sep. 1984 10 p refs Transl. into ENGLISH from Z. fuer Flugwiss. and Weltrauforsch. (West Germany), v. 8, no. 2, Mar. - Apr. 1984 p 129-133 Original language document was announced as A84-34723 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-3541)
(NASA-TM-77749; NAS 1.15:77749) Avail: NTIS HC A02/MF A01 CSCL 21E

Four different combustion efficiencies commonly used for assessing ramjet engines are compared. The mixture ratios cover a range from stoichiometric to an equivalence ratio of 0.2, and the polyethylene/air propellant system is used. The ratio of effective to ideal temperature rise is taken as reference efficiency. As might be expected, major differences can be observed near stoichiometric and down to equilvalence ratios of 0.5. These are quantitatively demonstrated. (IAA)

N84-33412*# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
AN EXPERIMENTAL INVESTIGATION OF GAS JETS IN CONFINED SWIRLING AIR FLOW Final Report
H. MONGIA, S. A. AHMED, and H. C. MONGIA Washington NASA Sep. 1984 159 p refs
(Contract NAG3-260)
(NASA-CR-3832; L-2178; NAS 1.26:3832) Avail: NTIS HC A08/MF A01 CSCL 21E

The fluid dynamics of jets in confined swirling flows which is of importance to designers of turbine combustors and solid fuel ramjets used to power missiles fired from cannons were examined. The fluid dynamics of gas jets of different densities in confined swirling flows were investigated. Mean velocity and turbulence measurements are made with a one color, one component laser velocimeter operating in the forward scatter mode. It is shown that jets in confined flow with large area ratio are highly dissipative which results in both air and helium/air jet centerline velocity decays. For air jets, the jet like behavior in the tube center disappears at about 20 diameters downstream of the jet exit. This phenomenon is independent of the initial jet velocity. The turbulence field at this point also decays to that of the background swirling flow. A jet like behavior in the tube center is noticed even at 40 diameters for the helium/air jets. The subsequent flow and turbulence field depend highly on the initial jet velocity. The jets are fully turbulent, and the cause of this difference in behavior is attributed to the combined action swirl and density difference. This observation can have significant impact on the design of turbine combustors and solid fuel ramjets subject to spin. E.A.K.

N84-33414*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RESPONSE OF A SMALL-TURBOSHAFT-ENGINE COMPRESSION SYSTEM TO INLET TEMPERATURE DISTORTION
T. J. BIESIADNY, G. A. KLANN, and J. K. LITTLE Sep. 1983 28 p refs
(NASA-TM-83765; E-2198; NAS 1.15:83765; USAAVSCOM-TR-84-C-13) Avail: NTIS HC A03/MF A01 CSCL 21E

An experimental investigation was conducted into the response of a small-turboshaft-engine compression system to steady-state and transient inlet temperature distortions. Transient temperature ramps ranged from less than 100 deg K/sec to above 610 deg K/sec and generated instantaneous temperatures to 420 K above ambient. Steady-state temperature distortion levels were limited by the engine hardware temperature limit. Simple analysis of the steady-state distortion data indicated that a particle separator at the engine inlet permitted higher levels of temperature distortion before onset of compressor surge than would be expected without the separator. Author

N84-33415*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PROPULSION CONTROL EXPERIENCE USED IN THE HIGHLY INTEGRATED DIGITAL ELECTRONIC CONTROL (HIDEC) PROGRAM Final Report
L. P. MYERS and F. W. BURCHAM, JR. Oct. 1984 18 p refs Presented at the SAE Aerospace Congr. and Exposition, Long Beach, Calif., 15-18 Oct. 1984
(NASA-TM-85914; H-1267; NAS 1.15:85914) Avail: NTIS HC A02/MF A01 CSCL 21E

The highly integrated digital electronic control (HIDEC) program will integrate the propulsion and flight control systems on an F-15 airplane at NASA Ames Research Center's Dryden Flight Research Facility. Ames-Dryden has conducted several propulsion control programs that have contributed to the HIDEC program. The digital electronic engine control (DEEC) flight evaluation investigated the performance and operability of the F100 engine equipped with a full-authority digital electronic control system. Investigations of nozzle instability, fault detection and accommodation, and augmentor transient capability provided important information for the HIDEC program. The F100 engine model derivative (EMD) was also flown in the F-15 airplane, and airplane performance was significantly improved. A throttle response problem was found and solved with a software fix to the control logic. For the HIDEC program, the F100 EMD engines equipped with DEEC controls will be integrated with the digital flight control system. The control modes to be implemented are an integrated flightpath management mode and an integrated adaptive engine control system mode. The engine control experience that will be used in the HIDEC program is discussed. Author

N84-33416*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
NOZZLE PERFORMANCE CALIBRATION AND TURBOMACHINERY OPERATIONAL ANALYSIS OF TURBO-POWERED SIMULATORS (TPS) FOR THE NASA-LANGLEY EET PROPULSION AIRFRAME INTEGRATION INVESTIGATION Final Report
R. K. ROWE Aug. 1982 125 p
(Contract NAS1-15345)
(NASA-CR-165949; NAS 1.26:165949; R82AEB436) Avail: NTIS HC A06/MF A01 CSCL 21E

The Boeing flight simulator chamber facility energy efficient transport (EET) propulsion/airframe integration investigation was tested. Two turbopowered simulators (TPS) were calibrated with four different nacelle configurations. Two nacelle configurations were calibrated on each TPS, each calibration simulating the full nozzle pressure ratio range encountered in a one atmosphere

total pressure wind tunnel operating over a Mach number range from 0.70 to 0.90 Mach. The results of the calibration test are in the form of velocity and discharge coefficient which is used in determining the simulator thrust while the TPS is operating in the wind tunnel. E.A.K.

N84-33468# Motoren- und Turbinen-Union Muenchen G.m.b.H. (West Germany).
MEASURES FOR MATERIALS CONSERVATION IN AERO-ENGINE CONSTRUCTION
H. HUFF, R. GRAETER, and R. FROEHLING *In* AGARD Mater. Substitution and Recycling 9 p Apr. 1984
Avail: NTIS HC A13/MF A01

Based on the minimization of critical raw materials input the production of as little scrap (machining wastes, parts out of service) as possible, concepts for reducing the use of materials and the associated dependence upon raw materials imports are explained. With reference to aeroengine components, the following possibilities are shown as examples: Very different materials can be combined by means of modern joining techniques. Components built up in this way contain expensive materials only where they are indispensable. The blank contour can be approximated to the final contour of the component (thus reducing machining losses) by contour forging, flow turning and powder metallurgy. Run parts can be reusable. It is shown that a considerable economy of materials is obtainable and has partly been achieved already. Attention is drawn to problems which may follow from the application; e.g., material deposition or joining of dissimilar materials results in a tendency to render the recycling of such engine components more difficult. R.J.F.

N84-33470# General Electric Co., Cincinnati, Ohio. Engineering Materials Technology Labs.
GAS TURBINE ENGINE DESIGN CONSIDERATIONS AS RELATED TO ALLOYS OF HIGH CRITICAL ELEMENT CONTENT
R. A. SPRAGUE *In* AGARD Mater. Substitution and Recycling 6 p Apr. 1984
Avail: NTIS HC A13/MF A01

The trade offs that a designer must make in the selection of materials for specific component applications are reviewed. Emphasis is placed on discussion of what options are available in reducing the strategic material content of the engine system while still achieving performance and cost objectives. The primary payoff is selection of wrought/cast alloys containing strategic elements is performance, not cost. For example, in commercial engines, the temperatures that parts are exposed to have increased steadily in an effort to improve specific fuel consumption. In military engines, higher operating temperatures are usually governed by efforts to improve thrust to weight ratio. R.J.F.

N84-34444*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IDENTIFICATION OF QUASI-STEADY COMPRESSOR CHARACTERISTICS FROM TRANSIENT DATA Final Report
K. B. NUNES and S. M. ROCK Sep. 1984 290 p
(Contract NAS3-23537)
(NASA-CR-174685; NAS 1.26:174685) Avail: NTIS HC A13/MF A01 CSCL 20E

The principal goal was to demonstrate that nonlinear compressor map parameters, which govern an in-stall response, can be identified from test data using parameter identification techniques. The tasks included developing and then applying an identification procedure to data generated by NASA LeRC on a hybrid computer. Two levels of model detail were employed. First was a lumped compressor rig model; second was a simplified turbofan model. The main outputs are the tools and procedures generated to accomplish the identification. Author

08

AIRCRAFT STABILITY AND CONTROL

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

A84-48517
FLY-BY-WIRE BRITISH STYLE
D. BOYLE Interavia (ISSN 0020-5168), vol. 39, Sept. 1984, p. 899, 900.

The Experimental Aircraft Program (EAP) aircraft will be designed to fly with a fully digital flight-crucial automatic flight control system for all the aerodynamic control surfaces. The aircraft, which will have no reversion to manually signalled mechanical or electrical control, will use fly-by-wire techniques in its flight control system. To safely reduce the degree of redundancy, a duo-complex system will replace a duo-triplex actuation system. Other developments for the EAP aircraft include: a minimum-displacement center-mounted control stick, hardware similar to that of the Italo-Brazilian AMX aircraft, and a digital system which is to provide sophisticated control capability. It is noted that the success of the FBW Jaguar project has been an encouragement in the development of the EAP. J.P.

A84-49186#
NONLINEAR CONTROL OF MISMATCHED UNCERTAIN LINEAR SYSTEMS AND APPLICATION TO CONTROL OF AIRCRAFT
S. N. SINGH (Vigyan Research Associates, Inc., Hampton, VA; Santa Catarina, Universidade Federal, Florianopolis, Brazil) and A. A. R. COELHO (Para, Universidade Federal, Belem, Brazil) ASME, Transactions, Journal of Dynamic Systems, Measurement and Control (ISSN 0022-0434), vol. 106, Sept. 1984, p. 203-210. refs

This paper describes an approach to control of nonzero set points of uncertain linear systems based on the theory of ultimate boundedness. A nonlinear control is derived which guarantees that every system response is ultimately bounded within a certain neighborhood of the desired nonzero set point. Analytical expressions for the bounds on variations in parameters for ultimate boundedness are obtained. These results are applied to control of a VTOL aircraft whose time-varying parameters are uncertain. Unlike previous works, arbitrary and fast variations in aircraft parameters are allowed. It is shown that the nonlinear controller is effective for larger variation in parameters than the reduced linear controller. Digital simulation results show that the aircraft can be precisely maneuvered in spite of uncertain parameter variations. Author

N84-33417*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
SUBSONIC/TRANSONIC STALL FLUTTER INVESTIGATION OF A ROTATING RIG Final Report
R. R. JUTRAS, R. B. FOST, R. M. CHI, and B. F. BEACHER Feb. 1981 319 p refs
(Contract NAS3-20605)
(NASA-CR-174625; NAS 1.26:174625; R81AEG282) Avail: NTIS HC A14/MF A01 CSCL 01C

Stall flutter is investigated by obtaining detailed quantitative steady and aerodynamic and aeromechanical measurements in a typical fan rotor. The experimental investigation is made with a 31.3 percent scale model of the Quiet Engine Program Fan C rotor system. Both subsonic/transonic (torsional mode) flutter and supersonic (flexural) flutter are investigated. Extensive steady and unsteady data on the blade deformations and aerodynamic properties surrounding the rotor are acquired while operating in both the steady and flutter modes. Analysis of this data shows that while there may be more than one traveling wave present during flutter, they are all forward traveling waves. M.A.C.

N84-33419# Princeton Univ., N. J. Dept. of Mechanical and Aerospace Engineering.
IN-FLIGHT INVESTIGATION OF LONGITUDINAL FLYING QUALITIES CRITERIA Final Report, 19 Sep. 1980 - 31 Mar. 1982
D. B. I. GLADE and M. E. MURPHY Warminster, Pa. Naval Air Development Center Feb. 1983 101 p
(Contract N62269-80-C-0720)
(AD-A143614; MAE-1594; NADC-80157-60) Avail: NTIS HC A06/MF A01 CSCL 01D

Flight tests were conducted to aid in the development of new longitudinal flying qualities criteria and to investigate some of the implications of equivalent system analysis, in which an aircraft's high-order dynamics are modelled by a low-order system. These tests were flown by U.S. Navy test pilots in Princeton's Variable-Response Research Aircraft (VRA), a fly-by-wire, in-flight simulator. Both analog and digital (microprocessor-based) systems were used for closed-loop control. Tests of 22 dynamic configurations evaluated by 5 pilots are reported, with emphasis on tasks representative of approach and landing on an aircraft carrier. A standard carrier landing mirror provided pilot cues, and all flights were evaluated from the long approach through touchdown. Conclusions regarding flying qualities are based on a limited number of flights. Ratings of conventional configurations generally indicated a compatibility with present flying qualities boundaries based upon the control anticipation parameter (CAP), but the latter do not adequately predict pilot ratings for short period natural frequencies of 2 rad/sec and less. CAP tended to confirm landing task ratings, but it did not confirm ratings based solely on pitch response. GRA

N84-33420# Department of the Air Force, Washington, D.C.
DIRECT LIFT COMMAND BLENDING Patent Application
J. D. MCALLISTER, inventor (to Air Force) 29 May 1984 22 p
(AD-D011178; US-PATENT-APPL-SN-614904) Avail: NTIS HC A02/MF A01 CSCL 01D

The rapid and precise control of an aircraft flight path is obtained by a continuous blending of direct lift and conventional longitudinal control system commands by a unit that consists of a combination of a linear gradient and breakout element, a blending integrator, a nonlinear element, a Direct Lift Limit element, an interconnect gain element, and three summing junctions. Direct Lift is blended with conventional control as the pilot manual command is conditioned by the linear gradient and breakout element to provide the command signal to the first summing junctions. The difference between this command and the output of the blending integrator is applied to the recentering nonlinear element. The direct lift command is obtained by passing the output of the recentering nonlinear element through the direct lift limit element. The second summing junction is used to reform the total system command which is applied to the third summing junction. The conventional longitudinal command is the output of the third summing junction; this output being the difference between the total system command and the direct lift command as modified by the interconnect gain.
Author (GRA)

N84-34398# British Aerospace Aircraft Group, Preston (England).
THE FLIGHT TEST OF AN AUTOMATIC SPIN PREVENTION SYSTEM
P. S. BUTCHER and K. MCKAY *In* AGARD Flight Test Tech. 11 p Jul. 1984
Avail: NTIS HC A16/MF A01

The flight testing of the Spin Prevention and Incidence Limiting System (SPILS) now fitted to the Tornado aircraft is investigated. The trial is carried out in parallel with the conventional stalling and spinning trial and the special aircraft equipment and test procedures are common to both trial and is considered in some detail. The SPILS flight testing is described with and without stores, and describes the reasons for the control law modifications required to fine tune the performance of the system. M.A.C.

N84-34401# Grumman Data Systems Corp., Calverton, N.Y.
APPLICATION OF ADVANCED PARAMETER IDENTIFICATION METHODS FOR FLIGHT FLUTTER DATA ANALYSIS WITH COMPARISONS TO CURRENT TECHNIQUES
H. J. PERANGELO and P. R. WAISANEN (Grumman Aerospace Corp., Calverton, N.Y.) *In* AGARD Flight Test Tech. 29 p Jul. 1984 refs
Avail: NTIS HC A16/MF A01

The implementation and evaluation of advanced parameter identification software for use in flutter test data processing operations is investigated. The maximum likelihood parameter identification algorithm is used in conjunction with a detailed physical aeroelastic aircraft model to perform optimal flutter test data analysis. Extended Kalman filtering is considered for eventual use as a second advanced parameter identification method. A mathematical description of the advanced parameter identification approach and least-squares flutter analysis procedures are presented. A comparison between this current analysis capability and prototype code for the maximum likelihood parameter identification algorithm on response data excited randomly (via atmospheric turbulence) and by swept shaker inputs indicates a significant improvement in analysis results with the advanced method. M.A.C.

N84-34403# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
FLIGHT TESTING A DIGITAL FLIGHT CONTROL SYSTEM: ISSUES AND RESULTS
B. W. VANVLIET *In* AGARD Flight Test Tech. 10 p Jul. 1984 refs
Avail: NTIS HC A16/MF A01

The AFTI/F-16 advanced development program modified a F-16A to be a testbed for evaluating new flight control related technologies. Some of the technologies developed on this program are: a triplex digital fly-by-wire flight control system which operates asynchronously, an analog independent backup unit (IBU), eight separate digital task-tailored control laws, and six decoupled controller options. Included among these task-tailored modes are normal operation modes, air-to-air combat modes, and air-to-surface combat modes. Two of these modes, the normal mode and the IBU, were flight tested on the AFTI/F-16 itself, and the flight test results were different from any of the simulators' predicted results. Several flight test issues are discussed in terms of how they were resolved and their effect especially on the aircraft handling qualities. Specific topics considered are: the IBU, the effect of the asynchronous computer operation and system redundancy management on the flight control laws and flight testing, and some handling qualities problems with combination coupled/decoupled control laws. R.S.F.

N84-34407# Aeritalia S.p.A., Caselle Torinese (Italy). Combat Aircraft Group.
AUTOPILOT PERFORMANCE EVALUATION TORNADO EXPERIENCE AND FUTURE APPLICATIONS
R. CARABELLI and R. PELISSERO *In* AGARD Flight Test Tech. 17 p Jul. 1984 refs
Avail: NTIS HC A16/MF A01

The Tornado autopilot system performance was evaluated. Problems affecting equipments, control laws, system integration were studied. A digital processor to analyze data from fast data transmission lines and an avionic integration rig with real time closed loop simulation capability were employed. New facilities tailored to cover as much as possible of weapon system testing needs are developed to cope with requirements from oncoming projects which rely upon more advanced technologies. Trends for next trials conduct are discussed and engineering activities and ground facilities needs like simulation and system rig, required to support flight testing of prototype avionic systems are outlined.
E.A.K.

N84-34445*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
IDENTIFICATION AND VERIFICATION OF FREQUENCY-DOMAIN MODELS FOR XV-15 TILT-ROTOR AIRCRAFT DYNAMICS
M. B. TISCHLER, J. G. M. LEUNG, and D. C. DUGAN Aug. 1984 20 p refs Prepared in cooperation with Army Research and Technology Lab., Moffett Field, Calif.
(NASA-TM-86009; A-9851; NAS 1.15:86009; TM-84-A-6) Avail: NTIS HC A02/MF A01 CSCL 01C

Frequency-domain methods are used to extract the open-loop dynamics of the XV-15 tilt-rotor aircraft from flight test data for the cruise condition (V = 170 knots). The frequency responses are numerically fitted with transfer-function forms to identify equivalent model characteristics. The associated handling quality parameters meet or exceed Level 2, Category A, requirements for fixed-wing military aircraft. Step response matching is used to verify the time-domain fidelity of the transfer-function models for the cruise and hover flight conditions. The transient responses of the model and aircraft are in close agreement in all cases, except for the normal acceleration response to elevator deflection in cruise. This discrepancy is probably due to the unmodeled rotor rpm dynamics. The utility of the frequency-domain approach for dynamics identification and analysis is clearly demonstrated.
Author

N84-34446# Dynamic Controls, Inc., Dayton, Ohio.
A DIGITAL LINEAR POSITION SENSOR FOR FLIGHT CONTROL ACTUATION Final Report, Jun. 1982 - Sep. 1983
G. D. JENNEY and H. W. SCHREADLEY Wright-Patterson AFB, Ohio AFWAL May 1984 64 p
(Contract F33615-82-C-3605)
(AD-A144283; AFWAL-TR-84-3043) Avail: NTIS HC A04/MF A01 CSCL 01C

This report describes the digital position sensor using incremental encoding of a rod by using alternate washers of ferreous and nonferreous material. Sensors are mounted radially around the rod. The technique was successful. The report describes the theory, demonstration hardware and the test results.
Author (GRA)

N84-34447# Naval Postgraduate School, Monterey, Calif.
COMPUTER PROGRAM TO SIMULATE THE LATERAL-DIRECTIONAL RESPONSE OF A HIGH PERFORMANCE AIRCRAFT DIGITAL ELECTRONIC FLIGHT CONTROL SYSTEM M.S. Thesis
S. F. GRAVES Mar. 1984 77 p
(AD-A144480) Avail: NTIS HC A05/MF A01 CSCL 01C

The IBM Company's Continuous System Modeling Program was used to simulate the lateral and directional flight control systems of the F/A-18 aircraft. The model is designed for use in studies of high angle-of-attack maneuvering flight and is restricted to the Auto Flaps Up mode of operation. The model accepts simulated pilot stick and rudder inputs, air data information, and rate gyro, angle-of-attack, and acceleration feedback signals. Outputs are differential stabilator, differential leading-edge and trailing edge flap, aileron, and rudder deflections. Typical input values are used to validate the model, generating output controls surface deflections which correspond to those expected for the F/A-18 aircraft.
Author (GRA)

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.

A84-46639
APPLYING GPS TO TRAINING SYSTEMS
D. D. THORNBURG and M. C. WASIELEWSKI (General Dynamics Corp., Electronics Div., San Diego, CA) IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 481-486.

The use of a Global Positioning System (GPS) to provide more realistic simulations of air combat, land-armor engagements, and war at sea for training military personnel is discussed. It is shown that because of its highly accurate position, velocity, and time information, GPS will significantly enhance the capability of range instrumentation systems to support field training exercises. GPS provides a precise real-time navigation solution that improves weapons simulation accuracy and simplifies participant pairing at all altitudes. GPS is a worldwide, common grid system and covers large areas with a minimum of instrumentation hardware. I.H.

A84-46641
GPS TRANSLATOR APPLICATION CONSIDERATIONS FOR TEST RANGES
J. B. MCCONNELL (USAF, Western Space and Missile Center, Vandenberg AFB, CA) and R. B. PICKETT (Federal Electric Corp., Systems Performance Analysis Dept., Vandenberg AFB, CA) IN: ITC/USA/ '83; Proceedings of the International Telemetering Conference, San Diego, CA, October 24-27, 1983 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 495-502.

Tracking system implementations based on the retransmission of Global Positioning System (GPS) satellite signals from a test vehicle with signal tracking and trajectory estimation performed by ground-based range equipment are addressed. Two types of vehicle-borne frequency translators are described, techniques for correcting translator local oscillator error are proposed and potential techniques for receiving, recording and relaying translator signals using IRIG standard telemetry equipment are suggested. Author

A84-46764#
DEVELOPMENTS IN RESEARCH STIMULATED BY CRYOGENIC WIND TUNNEL CONSTRUCTION PLANNING AND PROJECTS
J. CHRISTOPHE, M. BAZIN, P. BROUSSAUD, G. FRANCOIS, P. PACI, and M. DUBOIS (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 2, 1984, p. 25-44. refs

Recent developments in cryogenic wind tunnel research are briefly summarized. Particular emphasis is given to work currently being performed by ONERA in the effort to design transonic wind tunnels with high Reynolds numbers. Some technical considerations in the design of the European Transonic Wind Tunnel are discussed, including wind tunnel insulation, the use of alternative gases such as liquid nitrogen, and the properties of materials to be used in the construction of wind tunnel models. Consideration is also given to the design and construction of precooling and wind tunnel introduction devices. I.H.

A84-46846
R-F ANECHOIC CHAMBER TEST FACILITIES
B. F. LAWRENCE (Keene Corp., Ray Proof Div., Norwalk, CT) EMC Technology (ISSN 0278-4270), vol. 2, Apr.-June 1983, p. 32-36, 38.

A general description of the physical characteristics of three types of R-F anechoic chamber industrial test facilities is presented. Attention is given to rectangular anechoic chambers for microwave frequencies, tapering anechoic chambers, and anechoic EMC test

chambers for determining the sensitivity of electronic devices to different electromagnetic interference (EMI) sources. An equation is derived which expresses the optimal relation between rectangular chamber parameters and energy reflectivity for use in rectangular chamber design. Consideration is also given to the optimal design parameters for tapering and EMC anechoic R-F test chambers. Some performance criteria for Radar Absorbing Materials (RAM) and R-F shielding techniques for chamber walls are also discussed. I.H.

A84-46936#
AN ADVANCED FACILITY FOR THE ANALYSIS OF GAS TURBINE EXHAUSTS
R. E. PEARCE and R. D. WOOD (Ruston Gas Turbines, Ltd., New Products Div., Lincoln, Lancs., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-95)

New developments led to requirements regarding the analysis of exhaust gas from gas turbines which could not be satisfied with existing analytical systems. The problems arising in the case of a British manufacturer of gas turbines are discussed, taking into account the limitations of the data provided by the existing analytical equipment, a study of other available systems, the establishment of the parameters to be measured, and a design concept for the analytical facility needed. It was found that an analytical determination of oxides of nitrogen (NOx), oxygen (O2), relative humidity (R.H.), carbon monoxide (CO), carbon dioxide (CO2), and total hydrocarbons (THC) was needed. Important systems functions were related to sample acquisition, sample transportation, sample analysis, and data recording. The use of solenoid valves and electronic solid state controls was specified. Attention is given to design details, system operation, system development, and the computer system. G.R.

A84-46950#
THE MIT BLOWDOWN TURBINE FACILITY
A. H. EPSTEIN, G. R. GUENETTE (MIT, Cambridge, MA), and R. J. G. NORTON (Rolls-Royce, Inc., Atlanta, GA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. Research supported by Rolls-Royce, Inc., and U.S. Navy. refs
(ASME PAPER 84-GT-116)

A short duration (0.4 sec) test facility, capable of testing 0.5-meter diameter, film-cooled, high work aircraft turbine stages at rigorously simulated engine conditions has been designed, constructed, and tested. The simulation capability of the facility extends up to 40 atm inlet pressure at 2500 K (4000 F) turbine inlet temperatures. The facilty is intended primarily for the exploration of unsteady, three-dimensional fluid mechanics and heat transfer in modern turbine stages. Author

A84-47006#
THE USE OF TANDEM EJECTOR PUMPS IN AN INTERMITTENT BLOWDOWN TUNNEL
N. C. BAINES (Imperial College of Science and Technology, London, England), P. I. KING (U.S. Air Force Academy, Colorado Springs, CO), M. L. G. OLDFIELD (Oxford University, Oxford, England), and L. C. DANIELS (Atomic Energy Research Establishment, Engineering Sciences Div., Harwell, Oxon, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Research supported by the Science and Engineering Research Council and Rolls-Royce, Ltd. refs
(ASME PAPER 84-GT-226)

A one-dimensional ejector theory is developed for intermittent blowdown tunnel's tandem ejector pumping system, which will achieve subatmospheric exit pressures and substantially extend operating range. In this one-dimensional treatment, the driving mass flow must be known in order to obtain the driven stream's constant Mach number. Several ejector geometries have been tested in various configurations in a one-tenth scale model, prior to the development of the prototype ejectors. It is demonstrated that, through the suitable grouping of terms, it becomes possible to correlate both the model and the prototype ejector performance values. O.C.

A84-49084#
THE ROLE OF COMPUTATIONAL FLUID DYNAMICS IN AEROPROPULSION GROUND TESTING
J. M. BARTON (Sverdrup Technology, Inc., Arnold Air Force Station, TN; Sverdrup Technology, Inc., Middleburg Heights, OH) Journal of Aircraft (ISSN 0021-8669), vol. 21, Oct. 1984, p. 745-750. Previously cited in issue 05, p. 599, Accession no. A83-16557. refs

A84-49370
WIND TUNNEL MODELS - A DESIGNER'S TOOL
D. J. HOLT Aerospace Engineering (ISSN 0736-2536), vol. 4, Sept.-Oct. 1984, p. 12-15.

Current techniques in the design and construction of aircraft wind-tunnel models are discussed. Factors affecting the model design include wind-tunnel safety guidelines, tunnel velocity and temperature, tunnel and model instrumentation requirements, and the types of data required by the aerodynamicist. CAD/CAM procedures can be used to produce numeric contours from the full scale aircraft design and to control the machining of the external shape, as well as to produce detailed stress analyses and determine the tolerances for the components. The final stages of model construction include hand assembly, application of surface finishes with the required roughness, and installation and calibration of the large numbers of transducers and instruments required. Photographs and drawings are provided. T.K.

N84-33370# Joint Publications Research Service, Arlington, Va.
AEROPROYEKT INSTITUTE'S WORK IN AVIATION FACILITY DESIGN
V. IVANOV *In its* USSR Rept.: Transportation (JPRS-UTR-84-026) p 11-14 18 Sep. 1984 Transl. into ENGLISH from Vozdushnyy Transport (Moscow), 31 Jul. 1984 p 3
Avail: NTIS HC A05/MF A01

Soviet airport facilities are discussed. Automatic systems to improve human productivity and reduce aircraft downtime are mentioned. The application of scientific and technical advances to ground support for contemporary aircraft is emphasized. R.S.F.

N84-33421 Department of the Navy, Washington, D. C.
AIRCRAFT LOADING ADAPTER FOR USE WITH ORDNANCE LIFT VEHICLE Patent
V. E. RENFRO, R. L. GUDGEON, J. P. CLELLAND, and C. C. COLE, inventors (to Navy) 8 May 1984 5 p Supersedes AD-D009563
(AD-D011147; US-PATENT-4,447,186;
US-PATENT-APPL-SN-363349; US-PATENT-CLASS-414-589)
Avail: US Patent and Trademark Office CSCL 13F

An adapter for use with lift forks or the like of a lift truck to allow very accurate positioning of ordnance and the like for attachment to aircraft is discussed. The adapter comprises a base which is supported or secured to the lift forks and includes an ordnance load carrying cradle carried on a trolley mechanism that allows degrees of freedom in the fore/aft and lateral directions. Author (GRA)

N84-33422*# General Dynamics/Convair, San Diego, Calif.
DESIGN STUDY OF TEST MODELS OF MANEUVERING AIRCRAFT CONFIGURATIONS FOR THE NATIONAL TRANSONIC FACILITY (NTF)
S. A. GRIFFIN, A. P. MADSEN, and A. A. MCCLAIN Washington NASA Aug. 1984 283 p refs Prepared in cooperation with General Dynamics/Convair, Fort Worth, Tex.
(Contract NAS1-16848)
(NASA-CR-3827; NAS 1.26:3827) Avail: NTIS HC A13/MF A01 CSCL 14B

The feasibility of designing advanced technology, highly maneuverable, fighter aircraft models to achieve full scale Reynolds number in the National Transonic Facility (NTF) is examined. Each of the selected configurations are tested for aeroelastic effects through the use of force and pressure data. A review of materials and material processes is also included. M.A.C.

N84-33423# Committee on Science and Technology (U. S. House).
AIRPORT SAFETY TECHNOLOGY: WASHINGTON NATIONAL AIRPORT
Washington GPO 1984 144 p refs Hearing before the Subcomm. on Transportation, Aviation and Mater. of the Comm. on Sci. and Technol., 98th Congr., 2d Sess., no. 76, 21 Mar. 1984
(GPO-34-406) Avail: Subcommittee on Transportation, Aviation and Materials

A Congressional Report containing testimony concerning safety conditions at National Airport in Washington, D.C. is presented. National airport safety can be improved by realigning the northern approach and by upgrading the minimum safe attitude warning system. The Federal Aviation Administration (FAA) has adopted the recommendation that the aircraft must maintain a 720 foot altitude till they are beyond Rosslyn. The FAA also recommends a shift of the Localizer Directional Aid (LDA) approach course and to create a second LDA with an inbound course coinciding with the inbound course of the runway 18 approach. Airport safety procedures are discussed in detail, as well as airport certification, physical condition, and runway safety measures. The effectiveness of the certification program is discussed. S.B.

N84-33424# Naval Coastal Systems Center, Panama City, Fla.
COMPENDIUM OF US INCOMPRESSIBLE FLOW FACILITIES
A. F. LEHMAN (Lehman (A. F.) Associates, Inc., Centerpoint, N.Y.) and D. C. SUMMEY May 1984 378 p
(AD-A143650) Avail: NTIS HC A17/MF A01 CSCL 14B

This compendium describes the physical characteristics and performance capability of each facility. Included are subsonic wind tunnels, water tunnels, towing tanks, rotating arms, maneuvering and seakeeping basins, channels, and flumes, anechoic flow facilities, and buoyancy propelled facilities. The information contained in this document will be valuable during the design and testing of applicable hydrodynamic and aerodynamic vehicles.
GRA

N84-34448* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
MODEL MOUNT SYSTEM FOR TESTING FLUTTER Patent
M. G. FARMER, inventor (to NASA) 9 Oct. 1984 9 p Filed 31 Mar. 1983 Supersedes N83-25727 (15 - 20, p 2351)
(NASA-CASE-LAR-12950-1; US-PATENT-4,475,385;
US-PATENT-APPL-SN-481106; US-PATENT-CLASS-73-147)
Avail: US Patent and Trademark Office CSCL 14B

A wind tunnel model mount system is disclosed for effectively and accurately determining the effects of attack and airstream velocity on a model airfoil or aircraft. The model mount system includes a rigid model attached to a splitter plate which is supported away from the wind tunnel wall several of flexible rods. Conventional instrumentation is employed to effect model rotation through a turntable and to record model flutter data as a function of the angle of attack versus dynamic pressure.
Official Gazette of the U.S. Patent and Trademark Office

N84-34449 Department of the Air Force, Washington, D.C.
AIRPLANE TAKE-OFF SYSTEM Patent
T. D. EARL, inventor (to Air Force) 31 Jul. 1984 8 p
(AD-D011204; US-PATENT-4,462,560;
US-PATENT-APPL-SN-341459; US-PATENT-CLASS-244-63)
Avail: US Patent and Trademark Office CSCL 01B

This invention provides a system for launching aircraft into free flight regime regardless of runway conditions, wherein a sled of the self-powered air cushion vehicle type is configured in plan form so as to accept in temporarily locked relation thereupon and in combination there with an airplane in such manner that a successful take-off run in mutually aerodynamically compatible regime may be accomplished in spite of surface problems with the runway. Upon attainment of airborne speed, under control of the pilot the aircraft lifts off the sled into full free flight; and thus is airborne albeit the runway is at the time unusable by conventional wheelgeared aircraft; for example, as the result of a previous bombing attack on the runway by enemy aircraft. The sled incorporates self-propelling and directional guidance means for retrieval/reuse purposes, as well as a take-off abort control system. Author (GRA)

N84-34450# Resource International, Inc., Columbus, Ohio.
MECHANISTIC METHODOLOGY FOR AIRPORT PAVEMENT DESIGN WITH ENGINEERING FABRICS. VOLUME 1: THEORETICAL AND EXPERIMENTAL BASE Final Report
K. MAJIDZADEH, G. ILVES, H. SKLYUT, and V. R. KUMAR Aug. 1984 173 p refs
(Contract DTFA01-81-C-10043)
(DOT/FAA/PM-84-9.1) Avail: NTIS HC A08/MF A01

A survey of available mechanistic models for reflection cracking as well as geotextile systems is reviewed. A first generation design program (EFRON), was developed based upon a two-dimensional finite element program to determine the stress patterns in the overlay. A three-dimensional computer program (RISC) is used to estimate existing pavement life. The fatigue cracking resistance of the fabric reinforced overlay system is evaluated by conducting laboratory beam fatigue testing on asphaltic overlays over concrete base. Three types of fabrics, as well as a control with no fabric, were used in the tests. Both thermal and loading fatigue cracking are simulated by applying external vertical and/or horizontal forces to produce joint movements equal to that of the full-scale pavements under field conditions. The results of the laboratory fatigue testing demonstrated the effectiveness of the engineering fabrics in retarding the formation of reflective cracking. Furthermore, the comparison of these results with EFRON program analysis indicated the full capability of EFRON to model the laboratory performance and hence its potential to predict the performance of overlays of actual runway. Author

N84-34451*# National Aeronautics and Space Administration, Washington, D. C.
CRYOGENIC WIND TUNNEL TECHNOLOGY. A WAY TO MEASUREMENT AT HIGHER REYNOLDS NUMBERS
J. W. BECK May 1984 34 p refs Transl. into ENGLISH from "Kryo-Windkanal-Technologie: Ein Weg zur Messung bei Hoeheren Reynolds-Zahlen" Munich, 1982 p 53-81, 83-87 Original language doc. was announced as A83-46484 Transl. by Scientific Translation Services, Santa Barbara, Calif. Original doc. prep. by Deutsche Forschungs- und Versuchanstalt fuer Luft-und Raumfahrt, Oberpfaffenhofen, West Germany
(Contract NASW-3542)
(NASA-TM-77481; NAS 1.15:77481) Avail: NTIS HC A03/MF A01 CSCL 14B

The goals, design, problems, and value of cryogenic transonic wind tunnels being developed in Europe are discussed. The disadvantages inherent in low-Reynolds-number (Re) wind tunnel simulations of aircraft flight at high Re are reviewed, and the cryogenic tunnel is shown to be the most practical method to achieve high Re. The design proposed for the European Transonic Wind tunnel (ETW) is presented: parameters include cross section. DISPLAY 83A46484/2 = 4 sq m, operating pressure = 5 bar, temperature = 110-120 K, maximum Re = 40 x 10 to the 6th,

liquid N2 consumption = 40,000 metric tons/year, and power = 39,5 MW. The smaller Cologne subsonic tunnel being adapted to cryogenic use for preliminary studies is described. Problems of configuration, materials, and liquid N2 evaporation and handling and the research underway to solve them are outlined. The benefits to be gained by the construction of these costly installations are seen more in applied aerodynamics than in basic research in fluid physics. The need for parallel development of both high Re tunnels and computers capable of performing high-Re numerical analysis is stressed. R.J.F.

N84-34452# ICON, Inc., San Diego, Calif.
FLEET PROJECT TEAM PARTICIPATION IN MAJOR AVIATION TRAINING DEVICE DEVELOPMENT, ACQUISITION AND SUPPORT Final Report
J. P. CHARLES Jun. 1984 107 p
(Contract N61339-82-M-1131)
(AD-A144182; NAVTRAEQUIPC-82-M-1131-1) Avail: NTIS HC A06/MF A01 CSCL 05A

A survey and analysis of the Fleet Project Team support requirements was conducted. A survey of typical team functions was completed. An analysis of the procedures involved in major aviation training device acquisition and support was conducted. Feasible solutions to Fleet Project Team problems in supporting trainer life cycle design, development, operation and modification/update were developed and recommendations made. Author (GRA)

N84-34453# Army Construction Engineering Research Lab., Champaign, Ill.
EVALUATION OF THE PAVEMENT CONDITION INDEX FOR USE ON POROUS FRICTION SURFACES Final Report
S. D. KOHN and M. Y. SHAHIN Jul. 1984 23 p
(AD-A144521; CERL-TR-M-351) Avail: NTIS HC A02/MF A01 CSCL 13B

This report documents the results of a field study conducted to evaluate the use of the Pavement Condition Index (PCI) on porous friction surfaces (PFS). Pavements at seven landing field installations using PFS were studied. Results showed that the major problems on this type of surface were: (1) deterioration of underlying asphalt concrete material due to stripping of the asphalt binder; (2) delamination due to loss of bond between the PFS and underlying layer; and (3) raveling/weathering due primarily to jet blast. Based on the findings of this study, several modifications were recommended for incorporation into current procedures for evaluating and managing PFS pavements: (1) Modify severity-level definitions for longitudinal/transverse cracks and for raveling/weathering; (2) Rate low severity dense-graded patches as medium-severity; (3) Use a surface treatment of asphaltic material if permeability loss is more than half the original; (4) Develop a nondestructive test to locate areas of delamination; (5) Modify the PCI of older PFS pavements carefully to document when failures occur; and (6) Collect all available PCI and construction date information for PFS pavement and use it to develop a PCI Time Chart. GRA

N84-34454# Federal Aviation Administration, Washington, D.C. Office of Airport Planning and Porgramming.
INTRODUCTION TO THE AIRPORT IMPROVEMENT PROGRAM
Nov. 1983 17 p
(AD-A144556) Avail: NTIS HC A02/MF A01 CSCL 05A

To promote the development of a system to meet the Nation's needs, the Federal Government embarked on a grants in aid program to units of state and local government shortly after the end of World War II. This early program, the Federal aid airport program (FAAP), was authorized by the Federal airport act of 1946 and drew its funding from the general fund of the treasury. In 1970, a more comprehensive program was established with the passage of the airport and airway development act of 1970. This act provided grants for airport planning under the planning grant program (PGP) and for airport development under the airport development aid program (ADAP). These programs were funded from a newly established airport and airway trust fund, into which were deposited revenues from several aviation user taxes on such items as airlines fares, air freight, and aviation fuel. The authority to issue grants under these two programs expired on September 30, 1981. During this 11 year period, 8,809 grants totalling $4.5 billion were approved for airport planning and development. The current grant program, known as the airport improvement program (AIP), was established by the airport and airway improvement act of 1982; it continues to provide funding for airport planning and development, but under a single program. Funding through the Airport and Airway Trust Fund is also continued, along with many other features in the previous legislation. The 1982 Act also authorizes funds for noise compatibility planning and to carry out noise compatibility programs as set forth in the Aviation Safety and Noise Abatement Act of 1979 (P.L. 96-193). GRA

N84-34455# Air Force Human Resources Lab., Brooks AFB, Tex.
COMPARISON OF COLOR VERSUS BLACK-AND-WHITE VISUAL DISPLAYS AS INDICATED BY BOMBING AND LANDING PERFORMANCE IN THE 2B35 TA-4J FLIGHT SIMULATOR Final Report, Jun. 1980 - Mar. 1983
R. S. KELLOGG, R. R. WOODRUFF, and R. S. KENNEDY Jul. 1984 17 p
(Contract AF PROJ. 1123)
(AD-A144674; AFHRL-TR-84-22) Avail: NTIS HC A02/MF A01 CSCL 05I

Twenty-two highly qualified and experienced Navy instructor pilots were tested with respect to: (1) bombing, and (2) landing performance in the General Electric 2B35 TA-4J full-color wide-screen flight simulator. Half the pilots flew with color first and then black-and-white, the other half flew in reverse order. In Phase I of the study, repeated bombing runs were made and circular bombing errors obtained. In Phase 2, repeated carrier-type landings were made and critical landing parameters were measured. Under the conditions of the study, no statistically significant differences were shown between performance with color or with black-and-white. Author (GRA)

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A84-47561
HYDRODYNAMIC MODELING OF TRANSIENT PROCESSES IN THE FEED SYSTEM OF AIRCRAFT ENGINES DURING PUMP ACCELERATION TO NORMAL SPEED [GIDRODINAMICHESKOE MODELIROVANIE PEREKHODNYKH PROTSESSOV V SISTEME PITANIIA DVIGATELEI LETATEL'NYKH APPARATOV PRI RASKRUTKE NASOSA]
V. V. CHERVAKOV, N. S. ERSHOV, and B. V. OVSIANNIKOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 49-54. In Russian.

The operation of the pump of an aircraft engine during startup is studied, and a mathematical model describing the feed system of the engine is developed. Sets of criteria and boundary conditions are obtained for the hydrodynamic modeling of transient processes that occur in the feed system of the engine as the pump accelerates to its normal speed. V.L.

A84-48416#
OSCAR SATELLITES, AMATEUR RADIO IN SPACE
J. M. HENRY (AMSAT - Canada, Vanier, Ontario, Canada) IN: Canadian Domestic and International Satellite Communications Conference, 1st, Ottawa, Canada, June 14-17, 1983, Proceedings . Amsterdam and New York, North Holland Publishing Co., 1984, p. 6.7.1-6.7.5.

The history of amateur radio satellites is reviewed. Attention is given to the Canadian role in the development of the Orbiting Satellite Carrying Amateur Radio OSCAR payload carried aboard the Discoverer 36 satellite. Recent progress in developing new generation amateur radio satellites is addressed with reference to the AMSAT satellite which will retransmit emergency location transmitter signals from aircraft in distress. The position of the ELT is determined by computer processing of doppler information. I.H.

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CHEMISTRY AND MATERIALS

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

A84-46916#
THE THERMAL STABILITY OF AVIATION FUEL
J. S. MILLS and F. R. EDWARDS (Shell Research, Ltd., Thornton Research Centre, Chester, Middx., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-69)

The propensity of aviation turbine fuels to produce deposits in the oil-cooler and filter sections of aircraft fuel systems has been examined using a rig that simulates the fuel system of an aircraft and which employs realistic flow rates. All the fuels examined were found to be thermally stable up to temperatures in excess of those currently attained in engine oil coolers. Comparison with results obtained with the JFTOT indicates that this is not suited for use as a research tool. Author

A84-46917#
A NEW GAS TURBINE COMBUSTOR ALLOY
D. L. KLARSTROM, H. M. TAWANCY, D. E. FLUCK, and M. F. ROTHMAN (Cabot Corp., Kokomo, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-70)

A wrought, nickel-base superalloy based on the Ni-Cr-W system has been developed for applications in the hot section of gas turbine engines. The new alloy is solid solution strengthened and very thermally stable. It particularly resists the formation of detrimental intermetallic compounds and contains little or no cobalt. Various mechanical and oxidation properties of the new alloy were measured, and the microstructural features were characterized. These were compared with those for other solid solution strengthened, high-temperature alloys. A number of advantages of the new alloy are defined. Author

A84-46934#
HIGH PERFORMANCE CERAMICS FOR HEAT ENGINE APPLICATIONS
M. L. TORTI, J. G. HANNOOSH, S. D. HARTLINE, and D. B. ARVIDSON, JR. (Norton Co., Worcester, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-92)

Properties, availability, and component experience with high performance ceramics for heat engine applications will be reviewed. The monolithic systems SiC and Si3N4, as well as ZrO2 - based coating systems, will be described. Author

A84-46940#
THE EFFECT OF ELECTROSTATIC SPRAY MODIFICATION ON COMBUSTION IN GAS TURBINES
J. A. MILLER, W. W. MANNING, O. BIBLARZ, A. ZAJDMAN, and J. A. MAVROUDIS (U.S. Naval Postgraduate School, Monterey, CA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-102)

The feasibility of using electrostatic or electrohydrodynamic fields as a practical means of altering gas turbine injector spray characteristics has been investigated. Results indicate that with accelerating potentials typical of sparkplug voltages sufficient modification of spray characteristics is produced to suggest a means for reoptimization of combustor performance when fuels other than that for which a given combustor has been designed must be burned. Author

A84-46945#
CORRELATIONS OF SOOT FORMATION IN TURBOJET ENGINES AND IN LABORATORY FLAMES
R. J. GILL, D. B. OLSON, and H. F. CALCOTE (AeroChem Research Laboratories, Inc., Princeton, NJ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(Contract F08635-82-C-0130)
(ASME PAPER 84-GT-108)

Attention is given to the correlation of smoke-related performance in both jet engine and research combustors with several fuel properties, which included percent hydrogen, percent aromatic, percent polycyclic aromatic, smoke point, and the threshold soot index. Smoke-related data encompassed smoke number, liner temperature rise, and radiation flux to the combustor wall. No single fuel property was generally useful in evaluating smoke-related performance, but it is demonstrated that fuel composition plays a dominant role in determining smoke-related engine parameters. It is recommended that fuels used for engine testing programs be chemically analyzed in greater detail. O.C.

A84-46962#
OPTICAL MEASUREMENTS OF SOOT SIZE AND NUMBER DENSITY IN A SPRAY-ATOMIZED, SWIRL-STABILIZED COMBUSTOR
C. P. WOOD and G. S. SAMUELSEN (California, University, Irvine, CA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 10 p. refs
(Contract F08635-83-C-0052)
(ASME PAPER 84-GT-153)

In-flame optical measurements of soot particulates in a turbulent, recirculating (i.e., complex flow) model laboratory combustor are described. A nonintrusive optical probe based on large-angle (60 and 20 deg) intensity ratio scattering was used to yield a point measurement of soot particulate in the size range of 0.08 to 0.38 micron. A shale-derived JP-8 stock, isooctane, and mixtures of isooctane with various ring and aromatic compounds blended to yield the smoke point of the JP-8 stock were separately injected as a liquid spray through a twin-fluid atomizer. One blend was also introduced prevaporized through a hollow-cone nozzle.

The addition of ring compounds to the base isooctane as well as operation on JP-8 increased the amount of soot produced, although the total amount of soot produced depended on fuel type for those fuels of equivalent smoke point. The spatial distribution of soot as well as the amount produced was found to be sensitive to nozzle atomization quality and injection momentum. The amount of soot produced was reduced by a reduction in fuel loading. However, injection of fuel in a prevaporized state both increased the amount of soot produced and changed spatially the region over which soot was distributed. Author

A84-47008#
GTE SINTERED SILICON NITRIDE
C. L. QUACKENBUSH and J. T. SMITH (GTE Laboratories, Inc., Waltham, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-228)

A status of GTE sintered silicon nitride for advanced heat engines is presented. This includes an update of: sintering and final properties for a number of GTE silicon nitride compositions, microstructure, density, surface finish, strength, Weibull modulus, oxidation resistance, fracture toughness etc. The status of heat engine components fabricated by injection molding or isopressed/green machining and their performance are reviewed along with correlations between the shape fabrication technique, strength, and Weibull modulus. Costs and availability are included where possible. Future directions for increased reliability in silicon nitride structural ceramics are summarized. Author

A84-47039#
A LONG-TERM FIELD TEST OF ADVANCED GAS TURBINE AIRFOIL COATINGS UNDER A SEVERE INDUSTRIAL ENVIRONMENT
K. G. KUBARYCH (Solar Turbines, Inc., San Diego, CA), D. H. BOONE (California, University, Berkeley, CA), and R. L. DUNCAN (Electric Power Research Institute, Palo Alto, CA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. Research supported by the Electric Power Research Institute. refs
(ASME PAPER 84-GT-277)

Severe hot corrosion of gas turbine blades and vanes can result from the use of fuels contaminated with sodium and sulfur. A program has been initiated to survey currently available commercial as well as advanced developmental hot corrosion resistant coatings and select a list of coatings for application to Solar Centaur first-stage blades and vanes. A subsequent engine test program will be run on high-sulfur marine diesel fuel doped with sodium to produce severe hot corrosion conditions. The coatings will be tested in a rainbow fashion for a period up to 15,000 hours. Author

A84-48713
CYCLE COUNTING FOR FATIGUE CRACK GROWTH ANALYSIS
R. SUNDER, S. A. SEETHARAM, and T. A. BHASKARAN (National Aeronautical Laboratory, Bangalore, India) International Journal of Fatigue (ISSN 0142-1123), vol. 6, July 1984, p. 147-156. Research supported by the Aeronautical Research and Development Board. refs

Fatigue crack propagation tests were carried out on an Al-Cu alloy under specially designed complex load sequences. Electron fractography of the fatigue fracture surfaces suggests that rainflow cycle counting is applicable to the analysis of fatigue crack growth under complex load sequences. Author

A84-48766
ELECTRON-BEAM WELD SOLIDIFICATION STRUCTURES AND PROPERTIES IN AL-3LI-X ALLOYS
D. M. BOWDEN and P. J. MESCHTER (McDonnell Douglas Research Laboratories, St. Louis, MO) Scripta Metallurgica (ISSN 0036-9748), vol. 18, Sept. 1984, p. 963-968. Research sponsored by the McDonnell Douglas Independent Research and Development Program. refs

The effects of various alloy additions to binary Al-3Li on electron-beam weld solidification structures and tensile properties are presented. The additions include Zr for grain refinement, Mg for solid solution strengthening, Cu per precipitation strengthening, and Co for dispersion. The loss of substructure and the strengthening effect provided by subgrain appear to be major problems in welding Al-3Li-X alloys. The study may be of importance to aircraft structural applications. S.H.

A84-49444
FLAME RADIATION IN GAS TURBINE COMBUSTION CHAMBERS
A. H. LEFEBVRE (Purdue University, West Lafayette, IN) International Journal of Heat and Mass Transfer (ISSN 0017-9310), vol. 27, Sept. 1984, p. 1493-1510. refs

A brief description of the nature of flame radiation in gas-turbine combustors is followed by a discussion on the methods and models available for estimating nonluminous and luminous emissivity. Since luminous radiation emanates from soot particles in the flame, consideration is given to the processes of soot formation and soot oxidation, and to the influence of chemical composition on the soot-forming tendencies of fuels. Experimental data on the effects on flame radiation of variations in the combustor operating conditions of pressure, temperature, velocity, and fuel/air ratio are discussed. The important influences on flame radiation of fuel properties and fuel spray characteristics are also considered. Author

N84-33465# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
MATERIALS SUBSTITUTION AND RECYCLING
Loughton, England Apr. 1984 298 p refs In ENGLISH and FRENCH Meeting held in Vimeiro, Portugal, 14-19 Oct. 1983
(AGARD-CP-356; ISBN-92-835-0352-X) Avail: NTIS HC A13/MF A01

The rarity of several metals such as cobalt, chromium, tantalum and niobium, which are used in high temperature materials for jet turbine induces a need for stock-piling, conservation, substitution and recycling. This meeting was focused on the last two aspects, with special reference to superalloys with low critical element contents and substitutes to superalloys on one side, the identification of the sensitive impurities, the problems related to the increase of their concentration, and the possible ways to solve them on the other.

N84-33469# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany).
TOWARDS A CYCLE WITHOUT LOSS: COBALT IN THE AIRCRAFT INDUSTRY
C. VOIGT *In* AGARD Mater. Substitution and Recycling 7 p Apr. 1984 refs
Avail: NTIS HC A13/MF A01

The flow cycle of cobalt in products used in the aircraft industry was investigated. The manufacturing processes, uses and ultimate destinations of the materials containing cobalt (superalloys, ultrahigh strength steels, tool steels and special alloys) were quantitatively analyzed. The ways in which cobalt is lost within the material cycle were determined. Cobalt recovery rates for process scrap and obsolete scrap are presented. It turns out that, ultimately, the dilution of cobalt in iron is to a degree that it is improved scrap separation at all steps of the material cycle. The influence of no scrap technologies is discussed. R.J.F.

N84-33471*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
UNDERSTANDING THE ROLES OF THE STRATEGIC ELEMENT COBALT IN NICKEL BASE SUPERALLOYS
J. B. STEPHENS and R. L. DRESHFIELD *In* AGARD Mater. Substitution and Recycling 15 p Apr. 1984 refs
Avail: NTIS HC A13/MF A01

Research progress in understanding the effects of cobalt and some possible substitute on microstructure, mechanical properties, and environmental resistance of turbine alloys is discussed. The United States imports over 90 percent of its cobalt, chromium, tantalum and columbium, all key elements in high temperature nickel base superalloys for aircraft gas turbine disks and airfoils. NASA, through joint government/industry/university teams, undertook a long range research program aimed at reducing or eliminating these strategic elements by examining their basic roles in superalloys and identifying viable substitutes. R.J.F.

N84-33472# Wiggin Alloys Ltd., Hereford (England).
OXIDE DISPERSION STRENGTHENED ALLOYS
G. A. J. HACK *In* AGARD Mater. Substitution and Recycling 16 p Apr. 1984 refs
Avail: NTIS HC A13/MF A01

The principle of oxide dispersion strengthening was applied to precious metals, nickel, ferritic steels, aluminum alloys and superalloys. Conventional melting processes are unsuitable for the production of ODS alloys and alternative methods are required to incorporate oxides, etc., various base compositions. One of these methods, mechanical alloying is particularly appropriate to large scale commercialization and readily accommodate reactive alloying elements. The commercial production, properties and applications of ODS superalloys are described. The strength contribution of the oxides gives the alloy designer more freedom to optimize for oxidation and sulphidation resistance to minimize the use of strategic metals; for example, the alloys described are all cobalt free. R.J.F.

N84-33473# Vanderbilt Univ., Nashville, Tenn. Dept. of Metallurgy and Management of Technology.
SUBSTITUTION AND CONSERVATION TECHNOLOGY FOR CHROMIUM
A. G. GRAY *In* AGARD Mater. Substitution and Recycling 11 p Apr. 1984
Avail: NTIS HC A13/MF A01

Information is given on application areas where substitution conservation appear feasible in a supply crisis based on present available technology. Likewise, applications where research is needed to expand the substitution potential are indicated. Opportunities for conservation and displacement with emerging technologies are discussed. Finally, the value of an organized effort on substitution preparedness to gather and develop information on chromium substitution and conservation technology and have it ready as a contingency plan are presented. Chromium is a highly strategic and critical metal because of its significant import dependence and its essential uses for defense, energy and industrial products. It is used in such diversified applications as stainless steels and tool steels; alloy steels to provide hardenability in heat treatment, in air frames, and in landing heat and corrosion resistant alloys; superalloys for jet engines; alloy cast iron; electroplating; and corrosion treatment for aluminum alloys. R.J.F.

N84-33474# National Physical Lab., Teddington (England).
POTENTIAL OF METAL-MATRIX COMPOSITES AS SUPERALLOY SUBSTITUTES
M. MCLEAN and T. KHAN (ONERA) *In* AGARD Mater. Substitution and Recycling 10 p Apr. 1984 refs
Avail: NTIS HC A13/MF A01

A review of metal-matrix composites for high temperature applications was made in order to identify materials that are insensitive to the supply of critical elements. The potential of metal-matrix composites as gas-turbine blade materials was largely judged on the increased temperature capabilities they offer over the strongest current superalloys. However, several composites that were rejected on this basis are either independent of or have low concentrations of critical alloying elements. Consequently they should be reassessed as reserve materials matching the performance of existing widely used superalloys that depend on strategically vulnerable constituents. An alternative approach might be to consider the potential of regenerating the original creep performance of certain monocarbide reinforced nickel based composites such as Cotac 744 developed at ONERA - after service exposure. In this context the combination of perfectly elastic fibers in a creeping matrix would imply that high temperature deformation of these materials is almost completely recoverable. Hence, one should judge the potential of these materials in the light of total life expectancy through both the processing and regeneration conditions rather than from their simple creep behavior alone. R.J.F.

N84-33482# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Paris (France).
PROBLEMS PRESENTED TO ENGINE BUILDERS BY THE RECYCLING OF METALLIC MATERIALS [PROBLEMES POSES AUX MOTORISTES PAR LE RECYCLAGE DES MATERIAUX METALLIQUES]
Y. HONNORAT and J. NOUAILLES *In* AGARD Mater. Substitution and Recycling 7 p Apr. 1984 refs In FRENCH
Avail: NTIS HC A13/MF A01

Fabrication of the principal parts of aircraft engines implies assurance of a safe life that is not always completely verifiable by nondestructive quality control. Besides, the products of fabrication are often very weak and the cost of parts is greatly influenced by the economy of the material. The engine builder must then recycle scrap which is even more profitable since the recycling circuit is much shorter. Recycling is apt to generate problems of quality for which precautions should be taken. Examples from using forged titanium alloys and heat resistant nickel base alloys in the lost process illustrate the mechanisms by which recycling of scrap influences the quality of parts. The respective roles of different partners, the alloyist, the coarse part fabricator, the engine builder, and the recyclist are delineated. *This means that acceptance control techniques offer the engine* builder to master the problem are explained. Transl. by A.R.H.

N84-33483# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.
COATING DEVELOPMENTS TO RESTRICT STRATEGIC MATERIALS USAGE
R. J. HECHT and D. S. HALFPAP *In* AGARD Mater. Substitution and Recycling 7 p Apr. 1984
Avail: NTIS HC A13/MF A01

The development of protective coatings that enabled the implementation of less environmentally stable alloys with no loss, and sometimes an increase, in component capability and life is described. Development of tailored MCrAly overlay coatings, improved diffusion aluminides, thermal barriers, and alternate wear resistant coatings allows the coating corrosion and oxidation life to be more independent of the base superalloy composition and hence allow more latitude in alloy selection. The resulting coating developments and their effects on reducing strategic element use are presented. E.A.K.

N84-33527# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
NATURAL WEATHERING OF SELECTED ORGANIC MATRIX COMPOSITES Phase Report
E. T. VADALA and R. E. TRABOCCO 13 Jun. 1983 30 p (Contract F61-542)
(AD-A144091; NADC-82227-60) Avail: NTIS HC A03/MF A01 CSCL 11D

A study was made of selected graphite organic matrix composite materials exposed to natural weathering at Panama and Warminster. Commercially available composite prepregs were fabricated into panels using principally a 8 ply layup (+ or 45 deg) and a 16 ply layup (0 deg + or - 45 deg 90 deg). Panels

were retrieved periodically and mechanical property determinations were made at room temperature, 82.2 deg C (180 deg F) and 121.1 deg C (250 deg F). Tension, flexure, compression, short beam shear and in-plane shear tests were primarily used to assess the damage. At room temperature, the in-plane shear strength property of the + or - 45 deg panels was unaffected by exposure. At elevated temperature, however, this matrix dominated property generally decreased with increasing exposure time. Data indicated that the combination of moisture and elevated temperature caused a decrease in the matrix dominated mechanical properties of the 16 ply panels. Some graphite organic matrix composites degraded at a faster rate than others. The use of a paint coating seemed to decrease the irreversible degradation due to moisture and ultraviolet irradiation. A one time exposure aboard different aircraft carriers was made of one of the graphite/epoxy composite systems. The static mechanical properties of the exposed panels were also degraded at the elevated temperature. GRA

N84-33528# Department of the Air Force, Washington, D.C.
DAMAGED RADAR RADOME REPAIR DEVICE Patent Application
H. E. SNYDER, inventor (to Air Force) 1 Jun. 1984 16 p
(AD-D011158; US-PATENT-APPL-SN-616454) Avail: NTIS HC A02/MF A01 CSCL 17I

Method and apparatus for repairing damaged tapered radar radomes. The method comprises the steps of preparing the damaged skin layers, affixing corresponding patches thereto and trimming same, where only the radome skin has been damaged, and, when both skin and core have been damaged, includes preparing the damaged skin layers and core, affixing an oversized repair core section in said prepared core, trimming the repair core section to an appropriate local configuration, affixing repair patches to the prepared skin layers and trimming same. An apparatus in practice of the present invention comprises a support affixable to the surface of the radome, at least one circumferential track device coupled to the support, at least one meridional track device coupled to the circumferential track device, and a router carriage assembly coupled to the meridional track device. A particular router device capable of precision vertical adjustment to .0005 in is also disclosed for practice with the above apparatus. GRA

N84-33529# Los Alamos Scientific Lab., N. Mex.
TEMPERATURE AND HEAT-FLUX DISTRIBUTIONS IN A STRIP-HEATED COMPOSITE SLAB
G. F. JONES 1984 19 p refs Presented at the 22nd ASME/AIChE Natl. Heat Transfer Conf., Niagara Falls, N.Y., 5-8 Aug. 1984
(Contract W-7405-ENG-36)
(DE84-006016; LA-UR-84-166; CONF-840816-2) Avail: NTIS HC A02/MF A01

The steady temperature and heat flux distributions for a composite slab consisting of a strip-heated, large conductivity fin in intimate contact with a small conductivity, convectively cooled substrate are obtained. Such a problem has application to the strip heating of process equipment and laboratory experiments where uniform thermal conditions are desired and where the conductivity of the substrate is small. Analytical methods are used to obtain closed-form solutions for the local temperature and heat flux for the full, two-dimensional problem and for the boundin case of no transverse conduction within the substrate. A design procedure to determine the strip-heater spacing necessary for a prescribed maximum variation in heat flux at the convectively cooled surface is presented. An application example is given and the results discussed. Expressions for the steady temperature and heat flux are also obtained for the limiting cases of infinite heat transfer coefficient and zero-thickness substrate. DOE

N84-33562# Royal Aircraft Establishment, Farnborough (England).
POWDER METALLURGY FOR THE ECONOMICAL MANUFACTURE OF AERONAUTICAL COMPONENTS IN TITANIUM ALLOY
J. DEVILLARD Apr. 1983 27 p refs Transl. into ENGLISH from Materiaux et Tech. (France), no. 69, ot, 10-11, 1981 p 373-382
(AD-B076255; RAE-TRANS-2106; BR88809) Avail: NTIS HC A03/MF A01

The conditions required for producing reproducible sintered parts in Ti alloys are given and the four principal technologies used are outlined. An economic study is made of the PSV (pulverization uner vacuum) process which involves electron bombardment of a fast turning alloy electrode under vacuum to produce fine droplets which solidify to small spheres. A unit capable of producing 100 tonnes of powder per year is described. Processes (e.g., hydrostatic compression) for the densification of Ti alloy powders are considered with special reference to costs. Some of the mechanical properties of PSV Ti alloys sintered by hot isostatic compression are presented. Author

N84-33583# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
ENGINEERING PROPERTY COMPARISONS OF POWDER METALLURGY (PM) ALLOY X7901-T7E69 AND INGOT METALLURGY (IM) ALLOY FORGINGS
L. SCHRA Jun. 1984 15 p refs Document previously announced as N84-24782
(Contract NIVR-1743)
(NLR-MEMO-SM-83-050-U; NLR-TR-82054-U-ADD) Avail: NTIS HC A02/MF A01

Fracture toughness and stress corrosion tests of aircraft aluminum alloys are summarized. Considerably better resistance to crack extension of the IM alloys 7075-T73 and 7050-T736 as compared to the PM alloy X7091-T7E69 is found in the fracture toughness tests for the same test orientation as applied in spectrum fatigue tests. This may be (part of) the explanation for the early static crack extension and the low fatigue crack propagation life with flight simulation loading of PM alloy X7091-T7E69 specimens. The stress corrosion tests under atmospheric conditions show a higher resistance to stress corrosion cracking for the PM alloy X7091-T7E69 than for the IM alloys. Author (ESA)

N84-33595*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IMPROVED THERMAL BARRIER COATING SYSTEM Patent Application
S. STECURA, inventor (to NASA) 14 Aug. 1984 8 p
(NASA-CASE-LEW-14057-1; NAS 1.71:LEW-14057-1; US-PATENT-APPL-SN-640712) Avail: NTIS HC A02/MF A01 CSCL 11G

An oxide thermal barrier coating is described which comprises ZrO3 - Yb2O3 that is plasma sprayed onto a previously applied bond coating. The zirconia is partially stabilized with about 12.4 v/o ytterbia to insure cubic, monoclinic, and tetragonal phases. NASA

N84-33608*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FTIR ANALYSIS OF AVIATION FUEL DEPOSITS
L. S. HELMICK and G. T. SENG Sep. 1984 31 p refs
(NASA-TM-83773; E-2200; NAS 1.15:83773) Avail: NTIS HC A03/MF A01 CSCL 07D

Five modes of operation of the Nicolet 7199 Fourier Transform Infrared Spectrophotometer have been evaluated for application in analysis of the chemical structure of accelerated storage/thermal deposits produced by jet fuels. Using primarily the absorption and emission modes, the effects of fuel type, stress temperature, stress time, type of spiking agent, spiking agent concentration, fuel flow, and post-depositional treatment on the chemical nature of fuel deposits have been determined. Author

N84-33611# Research Inst. of National Defence, Umea (Sweden). Dept. 4.

METHOD FOR EVALUATION OF PETROLEUM PRODUCTS CORROSIVITY USING PIEZOELECTRIC CRYSTALS, PART 1

R. ROFFEY, H. NILSSON, and G. OLOFSSON Apr. 1984 37 p refs In SWEDISH; ENGLISH summary Sponsored by Swedish National Board of Economic Defence

(FOA-C-40189-B4-PT-1; ISSN-0347-2124) Avail: NTIS HC A03/MF A01; Research Institute of National Defence, Stockholm KR 50

A method using piezoelectric crystals covered with silver was developed for testing the corrosivity of jet fuel. If piezoelectric crystals are exposed to corrosive compounds (e.g., sulfur compounds) which react with silver, the change in oscillations is proportional to the mass difference. The method is complementary to and more sensitive than the standard method for silver corrosivity (IP standards 227/73). Author (ESA)

N84-34515# Joint Publications Research Service, Arlington, Va.

AN APPROACH FOR ESTIMATING THE IMPACT OF CARBON-REINFORCED PLASTIC Abstract Only

K. K. DUDKA, I. N. PREOBRAZHENSKIY, and A. S. SHESTAKOV *In its* USSR Rept.: Mater. Sci. and Metallurgy, No. 94 (JPRS-85025) p 7 28 Dec. 1983 Transl. into ENGLISH from Mekh. Kompozitnykh Materialov (Riga), no. 4, Jul. - Aug. 1983 p 624-628

Avail: NTIS HC A04/MF A01

Fiber reinforced composite materials for aircraft require both usual design qualities and special impact strength. Devices designed for testing impact resistance, consisting of a high pressure chamber, a pneumatic rifle, a muzzle break and meters are presented. The test samples were of KMU-4L carbon reinforced plastic laminated at 0, 0 to 90 degrees or + or - 45 degrees. At 0.0396 joule force from fired balls, the test samples showed local damage. With increased load, increasing degrees of cracking occurred. Results indicated that the test plastic was a brittle material under impact. Maximum loss of durability came at energies approaching penetrating force. Prior compression loading brought loss of bearing strength. Varying angles of laminating led to different blow absorption values. Comparison of these results with those for fiberglass suggested the feasibility of composites of carbon-reinforced plastics and low-module fiberglass. Author

N84-34571* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

PROCESS FOR IMPROVING MECHANICAL PROPERTIES OF EPOXY RESINS BY ADDITION OF COBALT IONS Patent

D. M. STOAKLEY and A. K. STCLAIR, inventors (to NASA) 25 Sep. 1984 8 p Filed 03 Nov. 1983 Supersedes N84-20701 (11 - 20, p 1637)

(NASA-CASE-LAR-13230-1; NAS 1.71:LAR-13230-1; US-PATENT-4,473,674; US-PATENT-APPL-SN-548584; US-PATENT-CLASS-523-454; US-PATENT-CLASS-523-458; US-PATENT-CLASS-525-484; US-PATENT-CLASS-528-92; US-PATENT-CLASS-528-407) Avail: US Patent and Trademark Office CSCL 11D

A resin product useful as an adhesive, composite or casting resin is described as well as the process used in its preparation to improve its flexural strength mechanical property characteristics. Improved flexural strength is attained with little or no change in density, thermal stability or moisture resistance by chemically incorporating 1.2% to 10.6% by weight Co(3) ions in an epoxidized resin system.

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

N84-34617# Aeronautical Research Labs., Melbourne (Australia).

THE USE OF ADHESIVE-BONDED RIVETS TO LESSEN THE REDUCTIONS IN FATIGUE LIFE CAUSED BY RIVET HOLES

J. Y. MANN, R. A. PELL, R. JONES, and M. HELLER 1984 41 p refs

(ARL-STRUC-REPT-399; AR-003-011) Avail: NTIS HC A03/MF A01

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. An extruded bar and rolled plate made of aluminum alloy were used as fatigue specimens. Of the various techniques examined only that involvinng adhesively-bonded rivets provided any significant improvements in fatigue life. It resulted in a reduction in fatigue crack propagation rate of about 50% 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%) is much less than the 50% 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. R.S.F.

N84-34631# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.

INVESTIGATION OF THERMAL COKING RATES OF AIR FORCE JET FUELS Final Report, Mar. 1982 - Jan. 1984

W. J. PURVIS Mar. 1984 161 p

(Contract F33615-82-C-2210)

(AD-A144421; PWA/FR-17211; AFWAL-TR-84-2004) Avail: NTIS HC A08/MF A01 CSCL 21B

This study evaluated the rates of deposit for selected jet fuels as a function of temperature and the effect of several current fuel additives on the rates of thermal deposition. Tests were run on the fuels with various concentrations of the additives and various levels of aromatic content. Deposits were collected on stainless steel coupons using an experimental coking apparatus that was developed for this program. It was found that the breakpoint temperature decreased and the concentration of peroxide increased as the aromatic content of the fuels increased. The rate of formation of deposits increased with decreases in the breakpoint temperature. The presence of different fuel additives had substantial effects on the rate of deposition. GRA

N84-34633# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio. Aero-propulsion Lab.

DECISION RECOMMENDATION BOARD (DRB) REPORT. TRANSITION OF SHALE JP-4 TO THE OPERATIONAL VALIDATION PHASE Final Report, Aug. 1983 - May 1984

B. P. BOTTERI, A. V. CHURCHILL, and C. G. BLEIDORN 15 May 1984 23 p

(AD-A144504; AFWAL-TR-84-2050) Avail: NTIS HC A02/MF A01 CSCL 21D

HQ USAF Program Management Directive (18 Sep. 1980), for PE71112F established an Air Force commitment to begin the operational validation of JP-4 fuel made from shale oil in 1984. The Air Force Systems Command was designated as participating command and given specific responsibilities for providing product quality, performance, system safety and environmental and health assurances prior to the start of any operational validation testing. The Shale JP-4 Decision Recommendation Board (DRB) was established in August 1983 to provide an independent assessment of the acceptability of transitioning shale JP-4 fuel to the operational validation phase. This report addresses the acceptability of transitioning shale JP-4 to Mountain Home AFB, Idaho, and Hill AFB, Utah, the two bases selected by the Air Staff for the Validation Program. Extensive shale JP-4 fuel properties characterization and

aircraft system testing have been conducted by AFSC primarily under the Aero Propulsion Lab's PE63215F. GRA

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ENGINEERING

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

A84-46601
ITC/USA/ '83; PROCEEDINGS OF THE INTERNATIONAL TELEMETERING CONFERENCE, SAN DIEGO, CA, OCTOBER 24-27, 1983
Conference sponsored by the International Foundation for Telemetering. Research Triangle Park, NC, Instrument Society of America (ITC Proceedings. Volume 19), 1983, 889 p. For individual items see A84-46602 to A84-46676.

Current developments in the technology of space telemetry (T) and instrumentation are discussed in reviews and reports of theoretical and experimental investigations and practical experience. Topics examined include T and communication antennas, digital implementation of T equipment, satellite control and T, high-power solid-state microwave technology, microprocessor applications, mm-wave systems, NAVSTAR GPS, industrial instrumentation and T, high-'G' T systems, optical instrumentation and communication systems, oceanography, and recorder/reproducer technology. Consideration is given to transducers, T data-processing systems, frequency management, software applications, T/communications transmitters, data compression, T-systems applications, and NASA space data-handling standards for the 1990s. T.K.

A84-46724
DEVELOPMENT OF AN ENVIRONMENTAL STRESS INDICATOR FOR AIRBORNE AVIONICS EQUIPMENT
J. F. WAGNER, III (USAF, Systems Command, Andrews AFB, MD) Journal of Environmental Sciences (ISSN 0022-0906), July-Aug. 1984, p. 31, 32.

A recurring problem, which causes excessive Air Force operating and support costs, is related to failures of various types of equipment, especially avionics equipment. A study has shown that at least one half of these failures are environmentally induced by temperature, vibration, and humidity stresses. The present investigation is concerned with a program which is being conducted to evaluate the concept of an environmental stress indicator which measures and records stresses induced on avionics equipment. The first phase of the program has now been completed. It involved the packaging of temperature, humidity, shock, and vibration sensors into a prototype indicator. A description is given of the results obtained in a test of the indicator. Overall results showed the indicator performed successfully and the concept is feasible. G.R.

A84-46759
STUDY OF SUPERCHARGER TURBOCOMPRESSORS [CONTRIBUTION AL'ETUDE DES TURBOCOMPRESSEURS DE SURALIMENTATION]
G. J. PAPACHRISTOS Lyon, Ecole Centrale, Docteur-Ingenieur Thesis, 1983, 205 p. In French. refs

The factors affecting the performance of radial turbochargers for industrial-vehicle engines are analyzed; a test bench for turbocompressors is developed; a multimonodimensional theoretical model of turbocompressor performance is constructed; and experimental and theoretical results for small centripetal gas turbines are presented in graphs and tables and compared. The effects of the roughness of the internal surfaces, the geometry of the turbine, the incidence, and the angle of the flow at the exit of the rotor are evaluated, and it is found that the output predicted by the model calculations is systematically lower than that measured on the test bench. Procedures to correct this discrepancy are discussed. T.K.

A84-46875
NUMERICAL SOLUTION OF THE CAUCHY PROBLEM FOR GENERALIZED EQUATIONS OF AEROELASTICITY [O CHISLENNOM RESHENII ZADACHI KOSHI DLIA OBOBSHCHENNYKH URAVNENII AEROUPRUGOSTI]
N. V. DENISENKO (Akademiia Nauk Belorusskoi SSR, Institut Matematiki, Minsk, Belorussian SSR) Akademiia Nauk BSSR, Doklady (ISSN 0002-354X), vol. 28, no. 8, 1984, p. 684-687. In Russian.

A84-46876#
THE PREDICTION OF FLOW THROUGH LEADING EDGE HOLES IN A FILM COOLED AIRFOIL WITH AND WITHOUT INSERTS
E. S. TILLMAN (Bridgeport, University, Bridgeport, CT), E. O. HARTEL, and H. F. JEN (Avco Corp., Heat Transfer Dept., Stratford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p.
(ASME PAPER 84-GT-4)

A method for predicting cooling air flow rates using tests on cylindrical models of typical turbine blade leading edges has been extended to include blades with inserts and blades with reversed-angled holes. When an insert is used, the pressure loss across the insert can be determined from flow tests and added to other losses in the flow path to determine cooling flow rates. Calculated and experimentally determined flow rates are compared with good agreement. The second experiment was performed to determine internal loss coefficients for reverse-angled holes oriented so the flow makes a reverse turn to enter the holes. The reversed flow case produced significantly greater internal loss coefficients than when the same holes were oriented in the direction of flow. These results were used to predict flow from arrays of reverse-angled holes and from a cylinder containing both reverse-angled holes and nonreversed holes. In all cases, good agreement was found between predicted and measured flow rates. Author

A84-46879#
EXPERIMENTAL ANALYSIS OF DAMPER BEHAVIOR OF SQUEEZE FILM DAMPERS FOR GAS TURBINE ENGINES
S. C. KAUSHAL, K. LAKSHMIKANTAN (GTRE, Bangalore, India), and V. A. KUMAR (National Aeronautical Laboratory, Bangalore, India) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 5 p. refs
(ASME PAPER 84-GT-8)

This paper discusses the experimental evaluation of performance of squeeze film dampers without centralizing retaining springs. Rotor amplitudes in the damper plane and damping coefficient have been considered to assess the system performance. Tests were conducted on two damper configurations that were to go in the rotor assembly of a certain gas turbine engine. Land width and film thickness were varied, and experiments were conducted for different values of excitation frequency, oil supply pressure, and unbalance. The test program showed that the parameters are to be individually optimized to obtain overall better performance in the damper systems without centralizing springs. The damper configurations subjected to severe dynamic conditions with overhung mass were also experimentally analyzed. Author

A84-46880#
AN EXPERIMENTAL INVESTIGATION OF OIL-BUFFERED SHAFT SEAL FLOW RATES
W. N. SHADE and D. E. HAMPSHIRE (Cooper Energy Services, Mount Vernon, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 11 p. refs
(ASME PAPER 84-GT-9)

An experimental investigation was conducted to identify an optimum oil-buffered shaft seal for use on centrifugal compressors, with the primary objective being minimal seal oil exposure to process gases that cause seal oil degradation or are toxic. Types of seals tested included smooth bore cylindrical bushings, spiral groove cylindrical bushings, radial outward-flow face seals, and radial inward-flow face seals. The influence of shaft speed, gas pressure, seal oil differential pressure, oil bypass flow rate, and oil supply temperature on process side seal oil flow rate was determined. The investigation revealed some surprising relationships between seal oil flow rates and the escape of process gas. Author

A84-46882#
MEASUREMENTS OF SQUEEZE FILM BEARING FORCES TO DEMONSTRATE THE EFFECT OF FLUID INERTIA
J. A. TICHY (Rensselaer Polytechnic Institute, Troy, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(Contract DAAG29-80-K-0064)
(ASME PAPER 84-GT-11)

Squeeze film dampers are often used in high speed rotating machinery to reduce vibration problems. Theoretical treatments accounting for fluid inertia in squeeze films have predicted large discrepancies from lubrication theory, but these results have not found wide acceptance in gas turbine design circles. Recent experimental results on the behavior of rotor dynamic systems, however, strongly support the existence of large fluid inertia forces. In the present direct measurements of damper forces, Reynolds numbers of up to 10 are obtained at eccentricity ratios 0.2 and 0.5. Lubrication theory is found to underestimate the measured forces by a factor of as much as 2. Qualitative agreement is noted with predictions of earlier, improved theories which include fluid inertia forces. O.C.

A84-46893*# Arizona State Univ., Tempe.
A BLADE LOSS RESPONSE SPECTRUM FOR FLEXIBLE ROTOR SYSTEMS
H. D. NELSON (Arizona State University, Tempe, AZ) and M. ALAM American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(Contract NAG3-6)
(ASME PAPER 84-GT-29)

A shock spectrum procedure is developed to estimate the peak displacement response of linear flexible rotor-bearing systems sugjected to a step change in unbalance (i.e., a blade loss). A progressive and a retrograde response spectrum are established. These blade loss response spectra are expressed in a unique non-dimensional form and are functions of the modal damping ratio and the ratio of rotor spin speed to modal damped whirl speed. Modal decomposition using complex modes is utilized to make use of the unique feature of the spectra for the calculation of the peak blade loss displacement response of the rotor system. The procedure is applied to three example systems using several modal superposition strategies. The results of each are compared to true peak displacement obtained by a separate transient response program. Author

A84-46905#
PERFORMANCE CHARACTERISTICS OF SHROUDED AND UNSHROUDED IMPELLERS OF A CENTRIFUGAL COMPRESSOR
H. HARADA (Ebara Corp., Fujisawa, Japan) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-46)

The overall performance of shrouded and unshrouded identical impellers of a centrifugal compressor were tested and compared. A closed loop test stand with Freon gas as the working fluid was employed for the experiments. The inlet and outlet velocity distributions of both impellers were measured using a three-hole cobra probe and a hot-film probe to determine the velocity distribution and unsteady flows due to wakes and inlet stall. Author

A84-46907#
HIGHLY COMPACT CERAMIC RECUPERATOR FOR ENGINE APPLICATIONS
R. N. KLEINER, L. R. STRASBAUGH, and L. E. COUBROUGH (Coors Porcelain Co., Golden, CO) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. Research supported by the General Motors Corp. refs
(ASME PAPER 84-GT-50)

A highly compact, all prime-surfaced, internally manifolded plate-and-fin ceramic recuperator has been developed which, despite its comparatively low cost, yields performance equivalent to that of metallic plate-and-fin recuperators employing expensive refractory alloys that must be brazed or welded. These ceramic recuperators are applicable to both gas turbine engines and Stirling engines. Attention is presently given to the corrugated ceramic plates' fabrication and consolidation process. O.C.

A84-46909#
INITIAL DEVELOPMENT OF THE AGT 100 ADVANCED GAS TURBINE
R. A. JOHNSON (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-58)

The first year of development of an advanced unique gas turbine engine has been completed. Mechanical shakedown, through 100 percent speed, was accomplished with minimum failure damage to hardware. Design changes corrected problems encountered. Significant numbers of ceramic components were engine tested. The value of a flexible electronic control system, a parallel regenerator rig program, and ceramic component proof testing has been demonstrated. Critical test measurements, available computer models, and the totality of the engine environment were shown to be vital ingredients of the development process. Author

A84-46914#
FIBER METAL ABRADABLE SEALS
R. P. TOLOKAN and M. S. BEATON (Brunswick Corp., Technetics Div., DeLand, FL) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p.
(ASME PAPER 84-GT-67)

Fiber metal abradable seals are used to control clearances in the compressor and turbine sections of gas turbine engines. Fiber metal seals are good abradables that rub by the low energy mechanism of brittle fiber fracture over a wide range of rub conditions. Rub mechanisms are significantly influenced by features in the seal microstructure. High temperature fiber seals have been developed with temperature capability to 1650 F (1170 K). These seals have been characterized to determine abradability, mechanical properties, temperature resistance and permeability. Author

A84-46918#
COOLING CHARACTERISTICS OF FILM-COOLED TURBINE BLADES
T. ABE, N. DOI, T. KAWAGUCHI, T. YAMANE (Mitsui Engineering and Shipbuilding Co., Ltd., Okayama, Japan), T. KUMAGAI, and T. YOSHIDA (National Aerospace Laboratory, Chofu, Tokyo, Japan) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Research supported by the Ministry of International Trade and Industry. refs
(ASME PAPER 84-GT-73)

Experiments have been conducted in order to measure the cooling effectiveness of 'pin-fin' turbine blades applicable to an advanced gas turbine's first stage blading. Chordwise cooling distributions determined in these three-dimensional hot cascade tests showed only a small deviation from the high average value, and closely corresponded with analytical predictions. It is noted that in the case of film-cooling blades such as those employing a 'shower head' configuration, it is essential that the cascade tests define the ratio between coolant and mainstream temperatures at values that match real conditions. This facilitates cooling airflow distribution simulations at low temperatures. O.C.

A84-46919#
FLOW IN THE INDUCER OF A CENTRIFUGAL COMPRESSOR MEASURED WITH A LASER VELOCIMETER
H. HAYAMI, Y. SENOO (Kyushu University, Fukuoka, Japan), and H. UEKI (Nagasaki University, Nagasaki, Japan) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-74)

The flow field in the inducer of a high-pressure-ratio centrifugal compressor has been measured with a laser-2-focus velocimeter (L2FV) at two flow rates that were on each side of the apparent inducer-stall limit at 70 percent speed. The limit was determined based on the pressure pattern between inducer blades along the shroud. The measured time-mean velocity distribution is compared with the prediction based on an inviscid quasi-three-dimensional flow analysis and the viscous effects are clarified. Furthermore, the nature of flow unsteadiness is discussed on the basis of the L2FV data. Using the observed data it is concluded that the inducer works well even at the apparent inducer-stall condition. Author

A84-46924#
CERAMIC COMPONENTS FOR THE AGT 100 ENGINE
H. E. HELMS and P. W. HEITMAN (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-81)

Engineering use of ceramic components in heat engines is approaching a state-of-readiness for production in the near future. Use of ceramic components should begin with less demanding structural production parts and evolve to include the most demanding structural production parts. The AGT 100 program is one of several advanced technology efforts leading to this production goal. Author

A84-46925#
A COMPUTER AIDED DESIGN METHOD FOR VANED DIFFUSERS IN CENTRIFUGAL COMPRESSORS
F. S. BHINDER (Hatfield Polytechnic, Hatfield, Herts., England) and M. M. H. AL-MODAFAR (Iraqi Air Force, Baghdad, Iraq) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-83)

A procedure for designing the vaned diffusers incorporating wedge type vanes has been described. By transforming the geometrical data into the usual parameters for straight two-dimensional diffusers, the influence of some of the important variables on pressure recovery can be investigated. The results can then be used to select the values of these variables for optimum pressure recovery. Author

A84-46928#
PREDICTION OF STIFFNESS AND DAMPING COEFFICIENTS FOR CENTRIFUGAL COMPRESSOR LABYRINTH SEALS
H. R. WYSSMANN, T. C. PHAM, and R. J. JENNY (Sulzer-Escher Wyss, Ltd., Zurich, Switzerland) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(ASME PAPER 84-GT-86)

A theory is presented for the calculation of stiffness and damping coefficients of the fluid-rotor interaction in centrifugal compressor labyrinth seals based on turbulent flow calculations. The theory has been confirmed by measurements on labyrinth test stands and on a centrifugal compressor impeller shroud seal at pressures up to 140 bar. Predicted stability limits based on the theory are in agreement with those observed in real compressors. Author

A84-46931#
EFFECT OF NEW BLADE COOLING SYSTEM WITH MINIMIZED GAS TEMPERATURE DILUTION ON GAS TURBINE PERFORMANCE
K. KAWAIKE, N. KOBAYASHI, and T. IKEGUCHIH (Hitachi, Ltd., Mechanical Engineering Research Laboratory, Hitachi, Japan) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-89)

Recent developments in high-performance and high-reliability gas turbine engines necessitate enforced cooling to maintain the blade temperature at reasonably low levels associated with increased turbine inlet temperature and compressor pressure ratio. However, the gas turbine performance is strongly penalized by the consumption of cooling flow, resulting in temperature dilution of hot mainstream, aerodynamic mixing loss, and pumping power loss. In this paper, a new practical blade cooling system using state-of-the-art engineering, which aims at minimizing the dilution effect, is presented. Trade-off studies between performance and reliability in terms of blade metal temperature are performed to evaluate cooling systems. Analytical comparison of different cooling systems demonstrates that the proposed cooling system provides significant improvements in performance gain and growth potential over conventional air cooling systems. Author

A84-46933#
CENTRIFUGAL COMPRESSOR SURGE BEHAVIOUR
J. WACHTER and K.-H. ROHNE (Stuttgart, Universitaet, Stuttgart, West Germany) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. Research supported by the Deutsche Forschungsgemeinschaft. refs
(ASME PAPER 84-GT-91)

The unsteady behavior of compressor systems near the surge line and during surge was investigated. Experimental examinations were carried out using a three stage centrifugal compressor of industrial design in different types of piping systems. The results obtained were compared with different theoretical models. It is demonstrated that the compressor system behavior can be calculated adequately, if sufficient data concerning the transient characteristic of the compressor are available. Author

A84-46935#
STALLED FLOW PERFORMANCE FOR AXIAL COMPRESSORS. I AXISYMMETRIC CHARACTERISTIC
S. G. KOFF and E. M. GREITZER (MIT, Cambridge, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 11 p. Research supported by Pratt and Whitney Aircraft. refs
(ASME PAPER 84-GT-93)

A study of stalled flow performance of multistage compressors is presented. A new compressor characteristics is developed, describing the axisymmetric pumping performance over the entire compressor flow range, including reversed flow. This axisymmetric characteristic is required in any current rotating stall model. It is possible for the axisymmetric performance to rise above the measured stall point pressure rise, thus indicating greater unstalled pressure rise potential. In this context, the axisymmetric characteristic in forward flow is viewed as paralleling diffuser performance. A simple two-dimensional reversed flow model is presented, and is shown to be in reasonable agreement with available high backflow compressor data. The model predicts that the blade stagger angle greatly influences the reversed flow characteristics. Calculations are carried out using the rotating stall model of Moore and the axisymmetric characteristic developed herein, and a technique is suggested for estimating the axisymmetric curve over the entire flow range. Author

A84-46951#
THE ACTIVE MAGNETIC BEARING ENABLES OPTIMUM DAMPING OF FLEXIBLE ROTOR
H. HABERMANN and M. BRUNET (Societe de Mecanique Magnetique, Vernon, Eure, France) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-117)

The active magnetic bearing has a ferromagnetic ring which is fixed on the rotor and floats in the magnetic field produced by four electromagnets which are mounted in two opposing pairs. The current is transmitted to the electromagnetic coils through amplifiers, and the electromagnets control the rotor's position according to signals transmitted from the sensors. The rotor, which is maintained in equilibrium by electromagnetic forces, has its position determined through continuous monitoring of displacement by sensors through an electronic control system. The modification of the electromagnetic force in terms of amplitude and phase improves such properties as automatic balancing, adjustable damping, high and adjustable stiffness, and permanent diagnosis of machine operation. The active magnetic bearing eliminates the need for lubricating systems, and has the capability of shaft dynamic control of a flexible rotor. Accurate positioning of the shaft, cancellations of vibrations due to unbalance, crossing of shaft bending frequency, and the solving of problems caused by gyroscopic effects may be achieved. J.P.

A84-46952#
STALLED FLOW PERFORMANCE FOR AXIAL COMPRESSORS. II - ROTATING STALL CHARACTERISTIC
S. G. KOFF (MIT, Cambridge, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. Research supported by the Pratt and Whitney Group. refs
(ASME PAPER 84-GT-120)

This paper describes a study of stalled flow performance of multistage compressors. The study is focused on the performance in rotating stall, in particular, the impact of stall inception and stall recovery. It is argued that the recovery point measured in post-stall compressor tests results from a compression system instability, rather than from an unstable rotating stall flow. If so, recoverability from rotating stall may be improved by altering system parameters. Furthermore, the full-span rotating stall characteristic is extrapolated beyond the measured recovery point. On this basis, the compressor stall point is viewed as a bifurcation, where a change in flow mode exists, perhaps analogous to the critical point in the axial compression of thin shells. An application for the extended rotating stall characteristic is in a model of transient compression system behavior. Author

A84-46953#
PERFORMANCE COMPARISON BETWEEN TRANSPIRATION AIR COOLED TURBINE 3000 F (1649 C) STATOR VANES AND SOLID UNCOOLED VANES
G. B. MANNING (U.S. Department of Energy, Washington, DC), S. MOSKOWITZ, and R. COLE (Curtiss-Wright Corp., Wood-Ridge, NJ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(Contract DE-AC01-76ET-10348)
(ASME PAPER 84-GT-121)

Testing was conducted to compare the aerodynamic performance of a turbine vane using transpiration air-cooling capable of operation at 3000 F (1649 C) gas temperature with a vane of identical profile with no cooling provisions to determine the effect of cooling on vane kinetic energy efficiency and loss coefficient. The test configuration was a 10-vane section of full scale first stagae turbien stator annulus designed for 1.6 pressure ratio, cooling air flow equal to 6.1 percent of primary flow, 3000 F (1649 C) turbine inlet temperature and primary-to-coolant temperature ratio of 2.7. To enable comparison with other investigations, tests were conducted at three pressure ratios from 1.4 to 1.6, three coolant flows from 75 to 120 percent of design, and three primary-to-coolant temperature ratios from 2.70 to 1.15. Efficiency, loss coefficent and flow capacity test results were in good agreement with predicted values for both the transpiration air cooled and uncooled vanes. The testing demonstrated that it is necessary to conduct test evaluations of transpiration air-cooled components at or near design coolant-to-gas stream temperature *ratio in order to achieve correct results.* Author

A84-46957*# Carnegie-Mellon Univ., Pittsburgh, Pa.
THE INTERACTION BETWEEN MISTUNING AND FRICTION IN THE FORCED RESPONSE OF BLADED DISK ASSEMBLIES
J. H. GRIFFIN (Carnegie-Mellon University, Pittsburgh, PA) and A. SINHA (Pennsylvania State University, University Park, PA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(Contract NAG3-231)
(ASME PAPER 84-GT-139)

This paper summarizes the results of an investigation to establish the impact of mistuning on the performance and design of blade-to-blade friction dampers of the type used to control the resonant response of turbine blades in gas turbine engines. In addition, it discusses the importance of friction slip force variations on the dynamic response of shrouded fan blades. Author

A84-46961#
SOME RECENT ADVANCES IN THE UNDERSTANDING AND PREDICTION OF TURBOMACHINE SUBSONIC STALL FLUTTER
R. M. CHI and A. V. SRINIVASAN (United Technologies Research Center, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 10 p. refs
(ASME PAPER 84-GT-151)

In this paper, some recent advances in the understanding and prediction of subsonic flutter of jet engine fan rotor blades are reviewed. Among the topics discussed are (1) the experimental evidence of mistuning in flutter responses, (2) new and promising unsteady aerodynamic models for subsonic stall flutter prediction, (3) an overview of flutter prediction methodologies, and (4) a new research effort directed toward understanding the mistuning effect on subsonic stall flutter of shrouded fans. A particular shrouded fan of advanced design is examined in the detailed technical discussion. Author

A84-46963*# Arizona State Univ., Tempe.
EFFECT OF NONUNIFORM GEOMETRIES ON FLOW DISTRIBUTIONS AND HEAT TRANSFER CHARACTERISTICS FOR ARRAYS OF IMPINGING JETS
L. W. FLORSCHUETZ and H. H. TSENG (Arizona State University, Tempe, AZ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. NASA-supported research. refs
(ASME PAPER 84-GT-156)

Two-dimensional arrays of circular jets impinging on a surface parallel to the jet orifice plate are considered. The jet flow, after impingement, is constrained to exit in a single direction along the channel formed by the jet orifice plate and the impingement surface. Experimental results for the effects of streamwise nonuniform array geometries on streamwise flow distributions and heat transfer characteristics are presented. A flow distribution model for nonuniform arrays is developed and validated by comparison with the measured flow distributions. The model is then employed to compare nonuniform array streamwise resolved heat transfer coefficient data with previously reported uniform array data and with a previously developed correlation based on the uniform array data. It was found that uniform array results can, in general, serve as a satisfactory basis from which to predict heat transfer coefficients at individual spanwise rows of nonuniform arrays. However, significant differences were observed in some cases over the first one or two rows downstream of the geometric transition line of the nonuniform array. Author

A84-46966#
EXPERIMENTAL STUDIES OF DEPOSITION BY ELECTROSTATIC CHARGE ON TURBINE BLADES
R. RAJ (City College, New York, NY) and S. MOSKOWITZ (Curtiss-Wright Corp., Wood-Ridge, NJ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(Contract DE-AC01-76ET-10348)
(ASME PAPER 84-GT-159)

Experimental tests were conducted to determine the electrical charge related deposition on turbine blades in a hot gas stream. Transpiration air cooled, water cooled, and uncooled turbine specimens were tested. The results indicate that the gas stream charge is proportional to fluid particle velocity and particle concentration. The ionic concentration of the gas increases with increase in gas temperature in the range of 1000 F (537 C) to 2200 F (1200 C). The deposition was found to be less for the transpiration air cooled test sample at 1300 F (704 C) metal temperature and the excessively water cooled test sample at 350 F (176 C) than for the uncooled test samples. There is some evidence to indicate that by using electrostatic means, a reduction in deposition on turbine blades operating on a contaminated stream resulting from coal firing, may be possible. Author

A84-46972#
HIGH TEMPERATURE EROSION STUDY OF METALS USED IN TURBOMACHINERY
W. TABAKOFF (Cincinnati, University, Cincinnati, OH) and T. WAKEMAN (General Electric Co., Cincinnati, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(Contract DAAG29-82-K-0029)
(ASME PAPER 84-GT-168)

Gas turbine engines operating in dusty environments are exposed to severe erosion, especially the compressor and the turbine components. Predicting erosion in rotating machinery is a very complex problem. In order to provide the basis for alloy selection in future turbines using pulverized coal, an investigation is undertaken to obtain a basic understanding of the mechanisms of erosion at high temperatures. For this purpose, a test facility has been designed to simulate the aerodynamic and thermodynamic conditions in the turbine. The effects of high temperature on the erosion rate for different alloys are experimentally determined and the results obtained are presented in this paper. The findings are very important in predicting erosion rate for future turbomachinery exposed to particulate flows. Author

A84-46973#
AEROELASTIC INSTABILITIES IN LABYRINTH AIR SEAL SYSTEMS
A. V. SRINIVASAN, R. A. ARNOLDI, and A. J. DENNIS (United Technologies Research Center, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 5 p.
(ASME PAPER 84-GT-169)

An analysis is developed that can be used to calculate the aeroelastic instabilities of labyrinth air seal systems. The formulation considers both the stator and rotor as flexible components and the fluid within the cavity has both axial and swirl components of velocity. The interaction of the leakage flow (through the clearance between lips of the seal and the stator) with the vibratory modes of the rotor and stator provides the mechanism for possible aeroelastic instability. A limited parametric study shows that increasing the stiffness of either the rotor or the stator has the same stabilizing influence as including, in the analysis, swirl flow component of the leakage flow. Further, at frequencies where coincidence between stator and rotor modes occurs, there could be a sharp drop in available aerodynamic damping. These results, which need experimental confirmation, can influence the design of these important components of jet engines. Author

A84-46975#
AERODYNAMICALLY EXCITED VIBRATIONS OF A PART-SPAN SHROUDED FAN
A. V. SRINIVASAN and D. G. CUTTS (United Technologies Research Center, East Hartford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(Contract F33615-79-C-2054)
(ASME PAPER 84-GT-172)

The structural response of a part-span shrouded fan due to an aerodynamic excitation was measured using strain gages. The excitation was provided by means of a 4-lobed distortion screen mounted upstream of the rotor. Vibration measurements made with tuned and mistuned conditions at integral order speeds have been analyzed to determine the aeromechanical response characteristics of the assembly. The results from the experimental investigation are presented and discussed. Author

A84-46977#
TURBINE HEAT FLUX MEASUREMENTS - INFLUENCE OF SLOT INJECTION ON VANE TRAILING EDGE HEAT TRANSFER AND INFLUENCE OF ROTOR ON VANE HEAT TRANSFER
M. G. DUNN (Calspan Advanced Technology Center, Buffalo, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(Contract F33615-81-C-2017)
(ASME PAPER 84-GT-175)

The present heat flux distribution measurements were obtained for a complete gas turbine both with and without injection, and for nozzle guide vanes with and without a rotor, using a shock tube as a short duration heated air source together with miniature thin film gages. A comparison is made between results obtained with a rotor operating at 100 percent of corrected speed and those taken with the rotor replaced by a row of flow straighteners. The results obtained suggest that the reduction of heat flux due to injection is a function of the blowing parameter, the temperature ratio, and the physical location relative to the tip or hub endwall, and that the presence of the rotor has a significant effect on the vane trailing edge Stanton number, increasing it by 15-25 percent. O.C.

A84-46983#
FLOW IN A CENTRIFUGAL FAN IMPELLER AT OFF-DESIGN CONDITIONS
T. WRIGHT (Westinghouse Fluid Systems Laboratory, West Lafayette, IN), K. T. S. TZOU (Westinghouse Research and Development Center, Pittsburgh, PA), and S. MADHAVAN (Westinghouse Electric Corp., Sturtevant Div., Hyde Park, MA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. Research supported by the Westinghouse Electric Corp. refs
(ASME PAPER 84-GT-182)

A fully three-dimensional finite element analysis of inviscid, incompressible blade channel flow is the basis of the present study of both predicted and measured surface velocity and pressure distributions in the internal flow channels of a centrifugal fan impeller, for volume flow rates of 80-125 percent the design flow rate. The experimental results made extensive use of blade and sidewall surface pressure taps installed in a scale model of an airfoil-bladed centrifugal fan impeller. The results obtained illustrate the ability of both flow analyses to predict the dominant features of the impeller flow field, including peak blade surface velocities and adverse gradients at flows far from the design point. Insight is also gained into the limiting channel diffusion values for typical centrifugal cascade performance, together with the influence of viscous effects, as seen in deviations from ideal flow predictions. O.C.

A84-46992#
A DISCUSSION OF THE FACTORS AFFECTING SURGE IN CENTRIFUGAL COMPRESSORS
R. L. ELDER and M. E. GILL (Cranfield Institute of Technology, Cranfield, Beds., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-194)

The process of surge in a centrifugal compressor has been studied and found to be dependent on a number of complex and often interrelated factors. A major factor defining surge in high-speed, vaned diffuser designs appears to be the flow in the semivaneless space. By developing work initiated by others it has been possible to propose some explanation of previously presented apparently conflicting data. In addition, a more complex mathematical model capable of assessing additional factors is proposed. Using this model good agreement with experimental surge has been obtained. This model takes into consideration pressure losses in the impeller, diffuser, and collector, and by using this model it was possible to identify the stalling elements that are responsible for overall compressor instability. Author

A84-47001#
FULL COVERAGE DISCRETE HOLE WALL COOLING - COOLING EFFECTIVENESS
G. E. ANDREWS, M. L. GUPTA, and M. C. MKPADI (Leeds University, Leeds, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 10 p. Sponsorship: Science and Engineering Research Council of England. refs
(Contract SERC-GR/B/0033,6)
(ASME PAPER 84-GT-212)

The development of a test facility for investigating full coverage discrete hole wall cooling for gas turbine combustion chamber wall cooling is described. A low temperature test condition of 750 K mainstream temperature and 300 K coolant temperature was used to investigate the influence of coolant flow rate at a constant cross flow Mach number. Practical combustion conditions of 2100 K combustor temperature and 700 K coolant temperature are investigated to establish the validity of applying the low temperature results to practical conditions. For both situations a heat balance programme, taking into account the heat tranfer within the wall was used to compute the film heat transfer coefficients. The mixing of the coolant air with the mainstream gases was studied through boundary layer temperature and CO2 profiles. It was shown that entrainment of hot flame gases between the injection holes resulted in a very low 'adiabatic' film cooling effectiveness. Author

A84-47002#
SEAL OIL DEGASSING IN GAS TURBINE CENTRIFUGAL COMPRESSORS
F. M. STEELE (Hilliard Corp., Elmira, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p.
(ASME PAPER 84-GT-214)

The design of a seal oil degassing system for a gas turbine centrifugal compressor primarily depends on the flow rate of oil through all seals, the composition of gas used in the seals, and the amount and composition of gas absorbed in oil as it leaves the seals. Degassing is accomplished by atmospheric distillation, vacuum distillation, and sparging, in which bubbles of an inert gas such as nitrogen rise through an oil and gas mixture and escape from the surface bearing a concentration of the mixture in proportion to its component partial pressures. O.C.

A84-47011#
TURBOROTOR HYBRID GAS TURBINE TWO-PHASE ENGINE
M. S. RASHEV American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 11 p. refs
(ASME PAPER 84-GT-231)

Attention is given to the design features and performance characteristics of a novel gas turbine cycle, the Turborotor Hybrid Gas turbine Two-phase Engine (THGTE), whose core section has been modified through the introduction of several turborotors whose curved blades define 'chamber-reservoirs' and 'energy transfer passageways'. The THGTE exhibits a specific weight that is lower than that of a conventional engine of comparable output by a factor of 2. Due to its essentially diesel-cycle mode of operation, overall fuel efficiency is in the range of 0.58 even without the use of a heat exchanger, and specific power output is enhanced by a factor of 3, due to combustion at higher efficiencies than those of a conventional gas turbine engine. A first approximation analysis is provided for the THGTE. O.C.

A84-47032#
AIRFOIL HEAT TRANSFER CALCULATION USING A LOW REYNOLDS NUMBER VERSION OF A TWO-EQUATION TURBULENCE MODEL
J. H. WANG (Wang Associates, Milford, CT), H. F. JEN, and E. O. HARTEL (Avco Corp., Avco Lycoming Stratford Div., Stratford, CT) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-261)

A two-dimensional boundary-layer program, STAN5, was modified to incorporate a low Reynolds number version of the K-epsilon, two-equation turbulence model for the predictions of flow and heat transfer around turbine airfoils. The K-epsilon two-equation model with optimized empirical correlations was used to account for the effects of free stream turbulence and transitional flow. The model was compared with experimental flat plate data and then applied to turbine airfoil heat transfer prediction. A two-zone model was proposed for handling the turbulent kinetic energy and dissipation rate empirically at the airfoil leading edge region. The result showed that the predicted heat transfer coefficient on the airfoil agreed favorably with experimental data, especially for the pressure side. The discrepancy between predictions and experimental data of the suction surface normally occurred at transitional and fully turbulent flow regions. Author

A84-47036*# Carborundum Co., Niagara Falls, N. Y.
PROGRESS IN NET SHAPE FABRICATION OF ALPHA SIC TURBINE COMPONENTS
T. B. SWEETING, F. J. FRECHETTE, and J. W. MACBETH (Carborundum Co., Niagara Falls, NY) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 7 p. refs
(Contract DEN3-17; DEN3-168; DEN3-167)
(ASME PAPER 84-GT-273)

An update of the status of ceramic component development of the AGT Programs is presented. Activity on AGTO Program focussed on the following: successful transition from the prototype to engine configuration rotor, investigation of alternate rotor molding techniques, and completion of scroll assemblies. Progress on the Garrett AGT Program was highlighted by the introduction of plastic molding and extrusion to parts which were previously fabricated by slip casting and isopressing respectively. Author

A84-47038#
EXPERIMENTAL STUDIES ON CHEMICAL REACTIVITY AND DIMENSIONAL GROWTH IN MACHINING OF TITANIUM ALLOYS
B. K. SUBHAS (GTRE, Bangalore, India) and R. A. KATTI (Indian Space Research Organization, Satellite Centre, Bangalore, India) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 5 p. refs
(ASME PAPER 84-GT-276)

Machining of aero-gas turbine components made of titanium alloys, using different combination of tools, cutting fluids and machining parameters revealed two important characteristics namely, chemical reactivity and dimensional growth. The former is pronounced when machined with carbide tools using Sulphur based cutting oils. The reactivity was not noticeable when machined either with CBN or cermet tools, contrary to the reports in the literature. This mechanism of chemical reaction has been studied including the development of microcracks at 400 F. The other phenomenon of dimensional growth is also analyzed in detail and machining parameters to reduce this growth are arrived at. The heat treatment is also envisaged to help in depriving of this detrimental dimensional growth by relieving the machining stresses. Also the scope for further research in this area is clearly defined. Author

A84-47040#
VALIDATION OF FLOW COEFFICIENTS MEASUREMENT BY LASER VELOCIMETER IN STRAIGHT-THROUGH LABYRINTH SEAL MODELS WITH FULL SIZE TEST RIG RESULTS
G. DEMILIA (L'Aquila, Universita, L'Aquila, Italy) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 9 p. refs
(ASME PAPER 84-GT-280)

A test rig has been constructed for the baryrinth seals used in high pressure centrifugal compressors in order to systematically study their flow characteristics under varying conditions. Attention is given to geometrical parameters that optimize seal performance, minimizing leakage for a fixed length of the labyrinth. Larger scale models of the same seals were then tested in a smoke tunnel under conditions satisfying the Reynolds similarity, in order to measure the velocity distributions within the straight-through labyrinth seal models by means of a laser Doppler velocimeter. The results obtained indicate correlations between real seals and the larger models. O.C.

A84-47044#
FILM COOLING FROM TWO ROWS OF HOLES INCLINED IN THE STREAMWISE AND SPANWISE DIRECTIONS
B. JUBRAN (University of Wales Institute of Science and Technology, Cardiff, Wales) and A. BROWN (Royal Military College of Science, Shrivenham, Wilts., England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 8 p. refs
(ASME PAPER 84-GT-286)

This paper describes the results of an experimental investigation into the film cooling effectiveness of two rows of holes inclined in the stream and spanwise directions. The effects of hole and row spacings and combinations of inclinations are investigated in the presence of free-stream pressure gradients and turbulence for a typical range of blowing rates. Author

A84-47071
AN EXPERIMENTAL VERIFICATION OF HEAT FLUX MEASUREMENTS USING TWO-LAYER THERMOINDICATING COATINGS [EKSPERIMENTAL'NYI KONTROL' IZMERENIIA TEPLOVYKH POTOKOV S POMOSHCH'IU DVUKHSLOINYKH TERMOINDIKATORNYKH POKRYTII]
V. N. GUSEV, T. V. KLIMOVA, and L. G. CHERNIKOVA TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 21-30. In Russian. refs

Heat fluxes and heat transfer coefficients are commonly determined on the basis of exact solutions to the heat conduction equation. Since these solutions are not always valid, particularly in the case of three-dimensional flow over models, their validity is usually determined on the basis of rough theoretical estimates. It is proposed here that the method of two-layer thermoindicating coatings, rather than theoretical estimates, be used for the experimental verification of local heat fluxes and heat transfer coefficients determined from one-dimensional solutions to the heat conduction equation. V.L.

A84-47084
A CRITERION FOR COMPARING MATERIALS FOR A 'HOT' STRUCTURE [OB ODNOM KRITERII SRAVNENIIA MATERIALOV DLIA 'GORIACHEI' KONSTRUKTSII]
V. V. LAZAREV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 5, 1983, p. 109-113. In Russian.

A criterion is proposed for comparing candidate materials for a structure subjected to unsteady heating during service. The criterion is based on estimating the susceptibility of materials to temperature-induced stresses. The application of the criterion to D16, AK4, and V95 aluminum alloys, 25KhGSA, 35KhMA, and SN-3 steels, and VT1, VT5, and VT6 titanium alloys is illustrated by results of a numerical experiment. V.L.

A84-47091
OPTIMUM DISTRIBUTION OF THE LOAD-BEARING MATERIAL IN A SWEPT WING WITH A STRUT [OPTIMAL'NOE RASPREDELENIE SILOVOGO MATERIALA V STRELOVIDNOM KRYLE S PODKOSOM]
N. V. BANICHUK, V. I. BIRIUK, and I. I. KOANDE TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 6, 1983, p. 46-53. In Russian. refs

The minimum-weight design problem for a wing with a strut is solved here using the variational approach. The wing is treated as a beam loaded mostly in bending, while the strut is treated as a rod loaded in tension-compression. The effect of various structural parameters on the optimum distribution of stiffness over the span of the wing and the corresponding value of the weight functional is investigated on the basis of a numerical solution to the problem. V.L.

A84-47092
THE 'CLOSE' PROBLEM METHOD AND ITS APPLICATION TO THE ST. VENANT TORSION PROBLEM FOR A ROD [METOD 'BLIZKOI' ZADACHI I EGO PRIMENENIE K RESHENIIU ZADACHI SEN-VENANA O KRUCHENII STERZHNEI]
IA. M. PARKHOMOVSKII TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 6, 1983, p. 54-65. In Russian.

An approximate method is proposed for solving boundary value problems for elliptic equations. In accordance with this method, the problem under consideration is replaced by a problem that is close, in certain respects, to the problem considered and that has an exact solution. The method proposed here is used to solve the St. Venant torsion problem for isotropic prismatic rods. Solutions are presented for several types of cross-section. V.L.

A84-47553
PREDICTION OF THE LIFE OF ALL-METAL VIBRATION ISOLATORS MADE OF MR MATERIAL [PROGNOZIROVANIE DOLGOVECHNOSTI TSEL'NOMETALLICHESKIKH VIBROIZOLIATOROV IZ MATERIALA MR]
A. I. BELOUSOV and A. A. TROINIKOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 13-18. In Russian. refs

A method is proposed for predicting the life of vibration isolators made of MR, a nonwoven porous material composed of metal wires. The method is based on monitoring the changes occurring in the elastic friction characteristics of the isolators during long-term cyclic deformation. Expressions relating the fatigue life of the isolators to the loading conditions, design parameters of the elastic damping element, and material characteristics are presented. V.L.

A84-47573
A THEORETICAL RATIONALIZATION OF AN EXPERIMENTAL STUDY OF THE EFFECT OF RADIATION ON FREE CONVECTION [TEORETICHESKOE OBOSNOVANIE OPYTNOGO ISSLEDOVANIIA VLIIANIIA IZLUCHENIIA NA SVOBODNUIU KONKEKTSIIU]
L. I. KUDRIASHEV, N. L. MENSHIKH, and S. V. ELFIMOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 87-90. In Russian.

In studies of complex heat transfer in the instrument bays of flight vehicles, where the radiant heat flux is comparable with or greater than the convective flux due to free convection, a full linearization of the system of governing equations results in an error exceeding the accuracy of the approximation used. In the present study, a partial linearization of the governing equations is used instead, which lowers the order of nonlinearity of the boundary condition of the third kind. The approach used here is illustrated by an example. V.L.

A84-47578
A STUDY OF THE EFFECT OF TRANSVERSE FLOW AT THE OUTLET OF PERFORATIONS ON HEAT TRANSFER INSIDE THE PERFORATIONS [ISSLEDOVANIE VLIIANIIA SNOSIASHCHEGO POTOKA NA VYKHODE IZ OTVERSTII PERFORATSII NA TEPLOOTDACHU V NIKH]
V. A. TRUSHIN, K. M. ISKAKOV, and Z. S. ISKHAKOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 101, 102. In Russian.

An analysis of heat transfer inside the perforations of air-cooled turbine blades suggests that transverse gas flow at the outlet of the perforations may be one of the factors affecting the heat transfer process. To investigate the effect of transverse flow, experiments have been carried out on perforated plates 1, 2, 3, and 4 mm thick with 0.6-1.4-mm-diameter perforations. It is found that in the Reynolds number range 2,000-50,000, transverse gas flow at the outlet of the perforations (injection ratio, 0.6-2.8) has no effect on heat transfer inside the perforations. V.L.

A84-47579
AN ANALYSIS OF THE NATURAL VIBRATIONS OF FUSELAGE-TYPE COMPLEX STRUCTURES AS SYSTEMS WITH IMPOSED CONSTRAINTS [RASCHET NA SOBSTVENNYE KOLEBANIIA SLOZHNYKH KONSTRUKTSII TIPA FIUZELIAZH KAK SISTEM S NALOZHENNYMI SVIAZIAMI]
V. P. BORISOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 1, 1984, p. 102-105. In Russian. refs

Fuselage-type structures are treated here as complex systems with certain constraints imposed on their mobility. By representing a dynamic matrix as the sum of two matrices, a hybrid multicycle method is developed for solving the natural vibration problem. It is shown that sufficiently accurate solutions are obtained when the iteration process is limited to 3-4 cycles. V.L.

A84-48000
A COMBINED METHOD FOR SOLVING THE DIRECT PROBLEM OF THE HYDRODYNAMICS OF THE AIRFOIL CASCADES OF TURBOMACHINES [KOMBINIROVANNYI METOD RESHENIIA PRIAMOI ZADACHI GIDRODINAMIKI RESHETOK PROFILEI TURBOMASHIN]
S. N. ISAKOV, I. N. PIROGOVA, and N. U. TUGUSHEV (Ural'skii Politekhnicheskii Institut, Sverdlovsk, USSR) Energetika (ISSN 0579-2983), Aug. 1984, p. 65-72. In Russian. refs

The problem of flow of an incompressible fluid over an airfoil cascade can be solved by a variety of methods including the method of conformal mapping and the method of integral equations. Here, an approach combining these two methods is proposed which makes it possible to significantly improve the accuracy of the solution and to widen the range of cascade types which can be calculated. A software implementation of the combined method is described, and results obtained for 14 cascades are shown to have a relative mean error of 11.8 percent. V.L.

A84-48140*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTS IN DILUTION JET MIXING
J. D. HOLDEMAN (NASA, Lewis Research Center, Cleveland, OH), R. SRINIVASAN, and A. BERENFELD (Garrett Turbine Engine Co., Phoenix, AZ) AIAA Journal (ISSN 0001-1452), vol. 22, Oct. 1984, p. 1436-1443. Previously cited in issue 16, p. 2352, Accession no. A83-36277. refs

A84-49082#
INDUSTRIAL APPLICATION OF PLASMA SPRAYED THERMAL BARRIER COATINGS AND HIGH TEMPERATURE CORROSION PROTECTIVE COATINGS
E. BRENNER (Plasma-Technik AG, Wohlen, Switzerland) IN: International Symposium on Composite Metallic Materials, 5th, Smolenice, Czechoslovakia, November 8-11, 1983, Proceedings . Bratislava, Czechoslovakia, Slovenska Akademia Vied, 1983, p. 350-356. refs

Recent developments in plasma-sprayed coating systems for gas turbines designed to withstand high thermal and mechanical, as well as chemical and erosive stresses are reviewed. In particular, attention is given to the following coating systems: thermal barrier coatings (e.g., Ni-Cr-Al-Y, Co-Cr-Al-Y, Zr02-Ca0, and CaO-SiO2), atmospheric plasma-sprayed high-temperature corrosion protective coatings (Ni-Cr-B-Si), and vacuum plasma-sprayed M-CrAlY hot gas corrosion protective coatings. The processes and equipment used for depositing the coatings are discussed, along with their principal properties and applications. V.L.

A84-49124*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LARGE-SCALE STRUCTURAL OPTIMIZATION
J. SOBIESZCZANSKI-SOBIESKI (NASA, Langley Reserach Center, Hampton, VA) IN: Developments in mechanics. Volume 12 - Midwestern Mechanics Conference, 18th, Iowa City, IA, May 16-18, 1983, Proceedings . Iowa City, IA, University of Iowa, 1983, p. 345-347.

Problems encountered by aerospace designers in attempting to optimize whole aircraft are discussed, along with possible

solutions. Large scale optimization, as opposed to component-by-component optimization, is hindered by computational costs, software inflexibility, concentration on a single, rather than trade-off, design methodology and the incompatibility of large-scale optimization with single program, single computer methods. The software problem can be approached by placing the full analysis outside of the optimization loop. Full analysis is then performed only periodically. Problem-dependent software can be removed from the generic code using a systems programming technique, and then embody the definitions of design variables, objective function and design constraints. Trade-off algorithms can be used at the design points to obtain quantitative answers. Finally, decomposing the large-scale problem into independent subproblems allows systematic optimization of the problems by an organization of people and machines. M.S.K.

A84-49190#
FORCES CAUSED BY THE RADIAL OUT-FLOW BETWEEN PARALLEL DISKS
J. F. FOSS (Michigan State University, East Lansing, MI) and C. E. WARK ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 106, Sept. 1984, p. 292-297. refs

An experimental program, to determine the magnitude of the force on the impact disk for the radial out-flow between parallel disks, has been carried out for moderate Reynolds numbers. The present results are compared with a previously published, ad hoc, analytical formulation whose coefficients were established for low Reynolds numbers. Acceptable agreement exists for the low Reynolds number range of the present study; progressively significant disagreement is observed as the Reynolds number is increased. The present force data, when combined with previous observations and interpreted via appropriate theoretical considerations, reveal a complex blending of flow phenomena for the Reynolds number, diameter ratio, and plate separation values of the present study. Author

A84-49440
NUMERICAL MODELING OF NORMAL TURBULENT PLANE JET IMPINGEMENT ON SOLID WALL
C.-Y. GUO (Colorado, University, Denver, CO) and W. H. C. MAXWELL (Illinois, University, Urbana, IL) Journal of Engineering Mechanics (ISSN 0733-9399), vol. 110, Oct. 1984, p. 1498-1509. refs

Attention is given to a numerical turbulence model for the impingement of a well developed normal plane jet on a solid wall, by means of which it is possible to express different jet impingement geometries in terms of different boundary conditions. Examples of these jets include those issuing from VTOL aircraft, chemical combustors, etc. The two-equation, turbulent kinetic energy-turbulent dissipation rate model is combined with the continuity equation and the transport equation of vorticity, using an iterative finite difference technique in the computations. Peak levels of turbulent kinetic energy occur not only in the impingement zone, but also in the intermingling zone between the edges of the free jet and the wall jet. O.C.

A84-49545#
A METHOD FOR THE CONSTRUCTION OF A FLUTTER MODEL WING HAVING GIVEN INFLUENCE COEFFICIENTS
J. ONODO (Tokyo, University, Tokyo, Japan) (Japan Society for Aeronautical and Space Sciences and Japan Society of Mechanical Engineers, Structure Conference, 24th, Kanazawa, Japan, July 15-17, 1982) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, May 1984, p. 1-11. refs

Techniques for the optimization of low-aspect-ratio wing flutter models with predetermined influence coefficients and two-dimensional flexibility adjustments are described and demonstrated for the case of a sounding-rocket tail fin. In the first iterative procedure, a numerically determined framework design based on an FEM model is milled from Al alloy; its influence coefficients are measured and compared with the model predictions; and the framework is remilled and remeasured until the error is reduced below a threshold value. In the second iterative procedure, additional lump masses are added at the nodes; the external shape is matched to the actual wing with polyurethane foam; the effect of these steps on the stiffness is estimated; and the steps are repeated until the desired characteristics are obtained. Drawings, diagrams, and tables of numerical data are presented for the sample design. T.K.

A84-49585#
OPTICAL BLADE VIBRATION MEASUREMENTS OF AXIAL-FLOW COMPRESSOR
K. JIMBOH, T. CHIKATA, H. AONO, and Y. HAGIWARA (Ishikawajima-Harima Heavy Industries Co., Ltd., Research and Development Dept., Tokyo, Japan) IN: Society for Experimental Stress Analysis, Spring Conference, Cleveland, OH, May 15-19, 1983, Proceedings . Brookfield Center, CT, Society for Experimental Stress Analysis, 1984, p. 228-234. refs

New optical blade vibration detectors and the associated display devices have been developed. The result of measurement both in the model blades working in the vacuum chamber and the test fan blades are presented. The comparison of the test results with strain gages' is made to demonstrate the usefulness of the system. Author

N84-33475# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. *Government Products Div.*
MANUFACTURING DEVELOPMENTS TO REDUCE STRATEGIC MATERIALS USAGE
M. M. ALLEN, D. S. HALFPAP, and M. A. SIEGEL *In* AGARD Mater. Substitution and Recycling 8 p Apr. 1984
Avail: NTIS HC A13/MF A01

Manufacturing development programs to reduce the usage in gas turbine engines are examined. Several programs which provided significant of cobalt, titanium, and tantalum results in reducing raw materials requirements, that have been reduced to practice are described. The programs include forging and casting complex parts to near net shape, recycling of machining scrap and used parts, repair and refurbishment of damaged or worn parts, and component retirement for cause. In addition to reduction of strategic material usage, the programs resulted in lower cost parts due to reduced material input requirements and less machining. E.A.K.

N84-33615# Department of the Air Force, Washington, D.C.
SYSTEM FOR THE REMOVAL OF AIRBORNE CONTAMINANTS FROM AIRCRAFT ENVIRONMENTAL CONTROL SYSTEMS Patent Application
D. R. BARNES and R. J. WATTS, inventors (to Air Force) 16 May 1984 11 p
(AD-D011172; US-PATENT-APPL-SN-610897) Avail: NTIS HC A02/MF A01 CSCL 06K

The system comprises a high pressure moisture remover, a conduit interconnecting the moisture remover with the compressor of the turbine engine of the aircraft which provides a source of pressurized air, a high pressure diffuser connected to the outlet of the moisture remover to diffuse the dried pressurized air stream to lower pressure, and an electrostatic precipitator downstream of the diffuser for removing particulate contaminants from the air stream. Alternatively, a low pressure moisture remover may be included downstream of the diffuser. A reactor and absorber may be included in the system to supplement the processes in the removal of chemical contaminants. Vent lines and discharge ports may be connected to the system where convenient, such as to the moisture remover, precipitator and absorber, in order to discharge overboard of the aircraft the liquid effluent and particles removed from the air stream. GRA

N84-33649# Sperry Corp., Clearwater, Fla.
RADIO FREQUENCY DISTRIBUTION ASSEMBLY, OPERATIONS AND MAINTENANCE MANUAL
Sep. 1983 45 p
(Contract N00014-82-C-2147)
(AD-A143864; SJ-8230-36063-2) Avail: NTIS HC A03/MF A01 CSCL 09E

The Naval Research Laboratory (NRL) Radio Frequency Distribution Assembly (RFDA) is an interface between the Sperry four-channel, fast-switching synthesizer and the EF-111 jamming system antenna ports. The RFDA will distribute the RF energy while providing controlled RF amplitude to simulate the antenna patterns of the EF-111 Electronic Warfare (EW) systems. The RFDA is capable of operating over the frequency range of 0.5 to 18 GHz, and can rapidly switch between varying frequencies and attenuation levels. GRA

N84-33744 Mississippi State Univ., State College.
A DISCRETE ELEMENT PREDICTION APPROACH FOR TURBULENT FLOW OVER ROUGH SURFACES Ph.D. Thesis
R. P. TAYLOR 1983 139 p
Avail: Univ. Microfilms Order No. DA8413962

A discrete element model for turbulent flow over rough surfaces was rigorously derived from basic principles. This model includes surface roughness effects as a constituent part of the partial differential equations which describe momentum and energy transport in turbulent flows. The model includes the necessary empirical information on the interaction between the roughness elements and the flow around and between the elements in a general way which does not require experimental data on each specific surface. This empirical information is input via algebraic models for the local element drag coefficient and Nusselt number. These models are calibrated by comparison with base data sets from surfaces with three-dimensional (distributed) roughness elements. Dissert. Abstr.

N84-33750# McDonnell-Douglas Research Labs., St. Louis, Mo.
CONTROL OF JET FLOWFIELD DYNAMICS Annual Technical Report, 1 Jan. 1983 - 1 Jan. 1984
V. KIBENS and R. W. WLEZIEN 29 Feb. 1984 46 p
(Contract F49620-83-C-0048)
(AD-A143631; MDC-Q1214; AFOSR-84-0551TR) Avail: NTIS HC A03/MF A01 CSCL 20D

Passive control of shear layer turbulence was investigated experimentally for low subsonic velocity jets from circular nozzles by studying effects of modifying nozzle exit geometry. Indeterminate origin (I.O.) nozzles used, including slanted, stepped and crenelated exit geometries, were so designated because streamwise location of the nozzle lip varies with azimuthal position, unlike standard nozzles for which the entire termination is at the same streamwise location. Flow visualization and detailed hot-wire measurements were used to observe development and interaction of large-scale turbulent structures in shear layers originating from various sectors of the I.O. nozzles, to determine the influence of instability wave patterns on ensuing flowfield characteristics and to relate observed evolution of three-dimensional large-scale turbulent structures to global properties of the jet flowfield such as velocity profiles and shear layer spreading rates as a function of streamwise distance and azimuthal angle. Results showed pronounced asymmetries in shear layer growth rates, which could be controlled by varying nozzle parameters. The asymmetries were also confirmed by measurements of azimuthal variation of shear layer turbulent energy as well as mean-velocity profiles. Detailed features of energy transfer from the mean flow into successively larger flow structures were traced by spectral mapping techniques and by mapping energy levels contained in subharmonics of the shear-layer instability frequency at various azimuthal flow sectors. GRA

N84-33757# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
SPECIAL COURSE ON STABILITY AND TRANSITION OF LAMINAR FLOW
Loughton, England Jun. 1984 227 p refs Course held in Rhode-Saint-Genese, Belgium, 26-30 Mar. 1984; sponsored by AGARD and the Von Karman Inst. of Fluid Dynamics
(AGARD-R-709; ISBN-92-835-0355-4) Avail: NTIS HC A13/MF A01

Stability and transition of laminar flows to understand laminar turbulent transition was studied. Incompressible two dimensional and compressible flows in transonic, supersonic, and hypersonic regimes and available results for three dimensional flows were discussed. Material presented and discussed at the Special Course held at the von Karman Institute, Belgium sponsored by the Institute and the AGARD fluid dynamics panel.

N84-33758# Office National d'Etudes et de Recherches Aerospatiales, Toulouse (France). Centre d'Etudes et de Recherches.
DESCRIPTION AND PREDICTION OF TRANSITION IN TWO-DIMENSIONAL, INCOMPRESSIBLE FLOW
D. ARNAL *In* AGARD Spec. Course on Stability and Transition of Laminar Flow 71 p Jun. 1984 refs
Avail: NTIS HC A13/MF A01

Transition problems in two dimensional, incompressible flows were surveyed. The phenomena which lead to turbulence under the influence of various factors are described: free stream turbulence, sound, pressure gradient, oscillations of the external flow, roughness, suction, wall curvature. Linear and nonlinear stability theories are discussed. Results of the application of the structure and to the growth of turbulent spots and the progressive disappearance of intermittency phenomenon are reviewed. Practical methods for calculating the transition onset and the transition region itself are described. Methods based on linear stability theory, empirical criteria, intermittency methods and turbulence models are presented. E.A.K.

N84-33759*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
BOUNDARY-LAYER LINEAR STABILITY THEORY
L. M. MACK *In* AGARD Spec. Course on Stability and Transition of Laminar Flow 81 p Jun. 1984 refs
Avail: NTIS HC A13/MF A01 CSCL 20D

Most fluid flows are turbulent rather than laminar and the reason for this was studied. One of the earliest explanations was that laminar flow is unstable, and the linear instability theory was first developed to explore this possibility. A series of early papers by Rayleigh produced many notable results concerning the instability of inviscid flows, such as the discovery of inflectional instability. Viscosity was commonly thought to act only to stabilize the flow, and flows with convex velocity profiles appeared to be stable. The investigations that led to a viscous theory of boundary layer instability was reported. The earliest application of linear stability theory to transition prediction calculated the amplitude ratio of the most amplified frequency as a function of Reynolds number for a Blasius boundary layer, and found that this quantity had values between five and nine at the observed Ret. The experiment of Schubauer and Skramstad (1947) completely reversed the prevailing option and fully vindicated the Gottingen proponents of the theory. This experiment demonstrated the existence of instability waves in a boundary layer, their connection with transition, and the quantitative description of their behavior by the theory of Tollmien and Schlichting. It is generally accepted that flow parameters such as pressure gradient, suction and heat transfer qualitatively affect transition in the manner predicted by the linear theory, and in particular that a flow predicted to be stable by the theory should remain laminar. The linear theory, in the form of the e9, or N-factor is today in routine use in engineering studies of laminar flow. The stability theory to boundary layers with pressure gradients and suction was applied. The only large body of numerical results for exact boundary layer solutions before the advent of the computer age by calculating the stability characteristics of the

Falkner-Skan family of velocity profiles are given. When the digital computer reached a stage of development which permit the direct solution of the primary differential equations, numerical results were obtained from the linear theory during the next 10 years for many different boundary layer flows: three dimensional boundary layers; free convention boundary layers; compressible boundary layers; boundary layers on compliant walls; a recomputation of Falkner-Skan flows; unsteady boundary layers; and heated wall boundary layers. E.A.K.

N84-33760# Case Western Reserve Univ., Cleveland, Ohio. Dept. of Mechanics and Aerospace Engineering.
ENVIRONMENT AND RECEPTIVITY
E. RESHOTKO *In* AGARD Spec. Course on Stability and Transition of Laminar Flow 11 p Jun. 1984 refs
Avail: NTIS HC A13/MF A01

In an environment where initial disturbance levels are small, the transition Reynolds number of a boundary layer is dependent upon the nature and spectrum of the disturbance environment, the signatures in the boundary layer of these disturbances and their excitation of the normal modes, receptivity, and finally the linear and nonlinear amplification of the growing modes. The progress in understanding receptivity to free stream vorticity and acoustic disturbances is reviewed. The technique of the initial value problem, which promises to be a significant additional tool for providing guidance toward the resolution of receptivity issues is outlined. E.A.K.

N84-33764# Case Western Reserve Univ., Cleveland, Ohio. Dept. of Mechanics and Aerospace Engineering.
LAMINAR FLOW CONTROL - VISCOUS SIMULATION
E. RESHOTKO *In* AGARD Spec. Course on Stability and Transition of Laminar Flow 10 p Jun. 1984 refs
Avail: NTIS HC A13/MF A01

Laminar flow control which offers the possibility of major reductions in aircraft drag is described. The theoretical background for the possible stabilizations of the laminar boundary layer due to shaping, suction and cooling is presented. The effects of vehicle and environmental factors on the implementation of that technology are examined. Viscous simulation is the technology of adjusting boundary layer conditions on a wind tunnel model so that results can be reliably extrapolated to flight conditions. The need for an underlying simulation methodology, some alternate methodologies, the needed boundary/layer controls/trips for implementation, and the process of scaling wind tunnel results to flight conditions are outlined. E.A.K.

N84-33808* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DIESEL ENGINE CATALYTIC COMBUSTOR SYSTEM Patent
L. W. REAM, inventor (to NASA) 22 May 1984 7 p Filed 6 Jun. 1980 Supersedes N80-26659 (18 - 17, p 2274)
(NASA-CASE-LEW-12995-1; NAS 1.71:LEW-12995-1; US-PATENT-4,449,370; US-PATENT-APPL-SN-157150; US-PATENT-CLASS-60-606; US-PATENT-CLASS-60-303) Avail: US Patent and Trademark Office CSCL 20A

A low compression turbocharged diesel engine is provided in which the turbocharger can be operated independently of the engine to power auxiliary equipment. Fuel and air are burned in a catalytic combustor to drive the turbine wheel of turbine section which is initially caused to rotate by starter motor. By opening a flapper value, compressed air from the blower section is directed to catalytic combustor when it is heated and expanded, serving to drive the turbine wheel and also to heat the catalytic element. To start, engine valve is closed, combustion is terminated in catalytic combustor, and the valve is then opened to utilize air from the blower for the air driven motor. When the engine starts, the constituents in its exhaust gas react in the catalytic element and the heat generated provides additional energy for the turbine section.

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

N84-33812# Department of the Air Force, Washington, D.C.
CONSTANT SPEED DRIVE WITH COMPENSATION USING DIFFERENTIAL GEARS Patent Application
B. E. FRANZ, inventor (to Air Force) 18 Apr. 1984 33 p
(AD-D011156; US-PATENT-APPL-SN-601514) Avail: NTIS HC A03/MF A01 CSCL 10B

The electrical supply system on aircraft may employ a constant speed drive (CSD) to convert variable engine speed to constant speed for operation of synchronous 400 Hz electrical generators. The heart of these devices is a differential which mechanically sums the input of two shafts and outputs this sum to a third shaft. Connected to this third shaft is a constant speed synchronous generator. Connected to one of the input shafts is the turbine generator (most likely through gearing). The second input shaft is connected to a speed compensating drive which accounts for engine speed changes. The speed compensating device disclosed herein is an electrically compensating motor/generator arrangement. Bidirectional power flow in the electric compensation link uses two high-speed, permanent-magnet, three-phase machines inter-connected by a power conditioning network. One machine is operated as a brushless dc machine, while the other functions as a variable speed synchronous machine. Steady-state performance of two types of power conditioning are presented--a dc link inverter and a cycloconverter link. Author (GRA)

N84-33832*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A FORMULATION OF ROTOR-AIRFRAME COUPLING FOR DESIGN ANALYSIS OF VIBRATIONS OF HELICOPTER AIRFRAMES
R. G. KVATERNIK and W. C. WALTON, JR. Jun. 1982 135 p refs
(NASA-RP-1089; L-14243; NAS 1.61:1089) Avail: NTIS HC A07/MF A01 CSCL 01C

A linear formulation of rotor airframe coupling intended for vibration analysis in airframe structural design is presented. The airframe is represented by a finite element analysis model; the rotor is represented by a general set of linear differential equations with periodic coefficients; and the connections between the rotor and airframe are specified through general linear equations of constraint. Coupling equations are applied to the rotor and airframe equations to produce one set of linear differential equations governing vibrations of the combined rotor airframe system. These equations are solved by the harmonic balance method for the system steady state vibrations. A feature of the solution process is the representation of the airframe in terms of forced responses calculated at the rotor harmonics of interest. A method based on matrix partitioning is worked out for quick recalculations of vibrations in design studies when only relatively few airframe members are varied. All relations are presented in forms suitable for direct computer implementation. E.A.K.

N84-33835*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
REFINED METHODS OF AEROELASTIC ANALYSIS AND OPTIMIZATION Progress Reports, Feb. - Sep. 1984
H. ASHLEY Sep. 1984 24 p refs
(Contract NGL-05-020-243)
(NASA-CR-173967; NAS 1.26:173967) Avail: NTIS HC A02/MF A01 CSCL 20K

Graduate research activity in the following areas is reported: the divergence of laminated composite lifting surfaces, subsonic propeller theory and aeroelastic analysis, and cross sectional resonances in wind tunnels. R.S.F.

N84-34412# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
IN-FLIGHT ACCURACY AND COVERAGE TESTS OF ESM- AND ECM-SYSTEMS
H. BOTHE and K. KLEIN *In* AGARD Flight Test Tech. 9 p Jul. 1984 refs
Avail: NTIS HC A16/MF A01

Electronic Support Measurement Systems (EMS) and Systems for Electronic Counter Measures (ECM) of military aircraft require antennas for signal transmission and reception. The coverage of these antennas is an important parameter in the effectiveness of the systems. As the radiation patterns of aircraft antennas are interfered to a high degree by the structure and configuration of the aircraft, flight tests are conducted in order to prove the coverage of the above-mentioned systems. In addition, the accuracy of ESM systems, which measure the direction of arrival of an incoming radio frequency signal on board, is mostly influenced by the characteristics of the receiving antennas and hence has to be determined in flight too. A system was developed which covers the aforesaid requirements. It consists of 3 subsystems: a ground emitter system illuminating the target up to frequencies of 18 GHz; an on-board receiving system, which detects the signals received by the antennas of the system under test; and a data acquisition and transmission system, which transfers on-board and ground data to a digital computer for quick-look and data processing. Results of accuracy and coverage tests are given. R.J.F.

N84-34417# Royal Aircraft Establishment, Bedford (England).
USING AN AIRBORNE CO2 CW LASER FOR FREE STREAM AIRSPEED AND WINDSHEAR MEASUREMENTS
A. A. WOODFIELD and J. M. VAUGHAN (Royal Signals and Radar Establishment, Malvern, England) *In* AGARD Flight Test Tech. 18 p Jul. 1984 refs
Avail: NTIS HC A16/MF A01

Applications of a Laser True Airspeed System (LATAS) in flight are described with examples from trials with an exceptionally reliable and rugged system installed on the HS 125 research aircraft. The LATAS system is briefly described. Its remote sensing capability makes it particularly useful for measuring airflow conditions before they are disturbed by the aircraft. This is demonstrated with results from flight tests of LATAS as a self contained pressure error measurement system (when combined with total pressure and total temperature measurements), and also results from windshear measurements in a severe thunderstorm downburst (microburst). The possible extension of the system to measure turbulence by using a conical scanning beam is described, and several other possible uses such as an airspeed sensor that can discriminate instantaneously between small amplitude gusts and large disturbances for driving an intelligent autothrottle or a combined 3 axis air data and 3 axis ground velocity sensor for helicopters. R.J.F.

N84-34662# Lincoln Lab., Mass. Inst. of Tech., Lexington.
THE LINCOLN LABORATORY-AEROSPACE MEDICAL RESEARCH LABORATORY DIGITAL SPEECH TEST FACILITY
J. TIERNEY and H. SCHECTER (Electronic Systems Div., Hanscom AFB, Mass.) 25 May 1984 29 p
(Contract F19628-80-C-0002)
(AD-A144303; TR-683; ESD-TR-84-014) Avail: NTIS HC A03/MF A01 CSCL 17B

A narrowband digital speech communication test facility has been established and operates between Lincoln Laboratory and the Wright-Patterson Aerospace Medical Research Laboratory. Noise fields simulating the acoustic environments of E3A and F-15 aircraft are established and Air Force personnel use the link operating at 2400 bps with a vocoder designed at Lincoln Laboratory, and a commercial telephone line modem. The facility includes a digital signal processing computer which can introduce bit errors and delay into the transmit and receive data. Communication scenarios are used to exercise the vocoder-modem channel with the dynamics and vocabulary of typical operational exchanges. Answers to a standard questionnaire provide acceptability data for the 2400 bps JTIDS class 2 voice channel. For the tests run so far, the 2400 bps voice is acceptable in the sense of positive user response to the questionnaire. Further testing using error and delay simulations will follow. An F-15 to F-15 link will be simulated at AMRL using a pair of vocoders operating back-to-back and in separate noise chambers. Author (GRA)

N84-34678# Naval Weapons Support Center, Crane, Ind. Weapons Quality Engineering Center.
EVALUATION OF AIRCRAFT BATTERY CHARGE, DISCHARGE, AND ANALYZATION REQUIREMENTS FOR GROUND SUPPORT EQUIPMENT Final Report, Apr. 1982 - Nov. 1983
T. E. OHAVER 27 Jul. 1984 93 p
(AD-A144243; WQEC/C-83-423; NAEC-92-184) Avail: NTIS HC A05/MF A01 CSCL 10C

This report provides an up-to-date listing of all aircraft batteries that are presently being used as well as those that will be used in the future. Test results and associated recommendations pertaining to the servicing requirements and associated charge, discharge, and analyzation equipment are delineated. Vented lead acid battery charging equipment performs satisfactorily and should continue to be utilized until these batteries are phased out by sealed lead acid batteries. GRA

N84-34707 Department of the Air Force, Washington, D.C.
METHOD FOR DYNAMICALLY RECORDING DISTORTION IN A TRANSPARENCY Patent
H. L. TASK and L. V. GENCO, inventors (to Air Force) 24 Jul. 1984 6 p
(AD-D011209; US-PATENT-4,461,570;
US-PATENT-APPL-SN-386488; US-PATENT-CLASS-356-239)
Avail: US Patent and Trademark Office CSCL 14E

A method for dynamically recording distortion in a transparency includes a support fixture for mounting the transparency for movement about a predetermined horizontal or vertical axis, with a camera disposed in back of the transparency while a test target is disposed in front of it. The test target has a plurality of small light sources arranged in a rectangular matrix pattern toward which the camera is aimed through the transparency. By opening the camera shutter for a period of time as the transparency is moved through a predetermined angle, a photographic record of distortion at a plurality of regions in the transparency is produced.
Author (GRA)

N84-34765*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
A COMPARISON OF EXPERIMENTAL AND THEORETICAL RESULTS FOR LEAKAGE, PRESSURE DISTRIBUTION, AND ROTORDYNAMIC COEFFICIENTS FOR ANNULAR GAS SEALS Progress Report
C. O. NICKS and D. W. CHILDS Sep. 1984 100 p refs
(Contract NAS8-33716)
(NASA-CR-174000; NAS 1.26:174000) Avail: NTIS HC A05/MF A01 CSCL 11A

The importance of seal behavior in rotordynamics is discussed and current annular seal theory is reviewed. A Nelson's analytical-computational method for determining rotordynamic coefficients for this type of compressible-flow seal is outlined. Various means for the experimental identification of the dynamic coefficients are given, and the method employed at the Texas A and M University (TAMU) test facility is explained. The TAMU test apparatus is described, and the test procedures are discussed. Experimental results, including leakage, entrance-loss coefficients, pressure distributions, and rotordynamic coefficients for a smooth and a honeycomb constant-clearance seal are presented and compared to theoretical results from Nelson's analysis. The results for both seals show little sensitivity to the running speed over the test range. Agreement between test results and theory for leakage through the seal is satisfactory. Test results for direct stiffness show a greater sensitivity to fluid pre-rotation than predicted. Results also indicate that the deliberately roughened surface of the honeycomb seal provides improved stability versus the smooth seal. R.S.F.

N84-34771*# Massachusetts Inst. of Tech., Cambridge.
PERIODIC CONTROL OF THE INDIVIDUAL-BLADE-CONTROL HELICOPTER ROTOR Ph.D. Thesis
R. M. MCKILLIP, JR. Aug. 1984 192 p refs
(Contract NSG-2266)
(NASA-CR-166607; NAS 1.26:166607) Avail: NTIS HC A09/MF A01 CSCL 20K

Results of an investigation into methods of controller design for an individual helicopter rotor blade in the high forward-flight speed regime are described. This operating condition poses a unique control problem in that the perturbation equations of motion are linear with coefficients that vary periodically with time. The design of a control law was based on extensions to modern multivariate synthesis techniques and incorporated a novel approach to the reconstruction of the missing system state variables. The controller was tested on both an electronic analog computer simulation of the out-of-plane flapping dynamics, and on a four foot diameter single-bladed model helicopter rotor in the M.I.T. 5x7 subsonic wind tunnel at high levels of advance ratio. It is shown that modal control using the IBC concept is possible over a large range of advance ratios with only a modest amount of computational power required. Author

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GEOSCIENCES

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

A84-46814* Massachusetts Inst. of Tech., Cambridge.
THE ACCURACY OF ALTIMETRIC SURFACES
C. WUNSCH and V. ZLOTNICKI (MIT, Cambridge, MA) Geophysical Journal (ISSN 0016-8009), vol. 78, Sept. 1984, p. 795-808. refs
(Contract NAG6-9; NSF OCE-80-18514)

Estimates of the shape of the sea surface as determined from satellite altimeters have become of increasing importance in geophysics, geodesy and physical oceanography. The most effective error reduction procedures used in producing these surfaces have been some version of a crossing-arc analysis. The problem with this procedure is the absence of an easy means of evaluating the noise structure of the final result. By recasting the problem as one of objective mapping (optimal estimation) the error reduction is optimized and an explicit estimate is obtained of the wave-number structure of the final altimetric surface. Examples, suitable to a small computer, have been generated to show that the error reduction along the sub-satellite tracks is very great, with most of the residual lying in long wavelengths. Author

A84-46821* National Center for Atmospheric Research, Boulder, Colo.
MICROBURST WIND STRUCTURE AND EVALUATION OF DOPPLER RADAR FOR AIRPORT WIND SHEAR DETECTION
J. W. WILSON, R. D. ROBERTS, C. KESSINGER, and J. MCCARTHY (National Center for Atmospheric Research, Boulder, CO) Journal of Climate and Applied Meteorology (ISSN 0733-3021), vol. 23, June 1984, p. 898-915. NSF-NOAA-supported research; U.S. Department of Transportation. refs
(Contract DOT-FA01-82-Y-10513; NASA ORDER H-59314-B)

The horizontal and vertical structure of airflow within microbursts has been determined using Doppler weather radar data from the Joint Airport Weather Studies (JAWS) Project. It is shown that the downdraft typically associated with microbursts is about 1 km wide and begins to spread horizontally at a height below 1 km. The median time from initial divergence at the surface to maximum differential wind velocity across the microburst is five minutes. The height of maximum differential velocity is about 75 m, and the median velocity differential is 22 m/s over an average distance of 3.1 km. The outflow of the air is asymmetric, averaging twice as strong along the maximum axis compared to the mininum axis. Some technical requirements for a radar system to detect microbursts and to provide aircraft with early warnings of the onset of windshear are identified. I.H.

A84-47099
FULL-SCALE STUDIES OF THE BOUNDARY LAYER STRUCTURE [NATURNYE ISSLEDOVANIIA STRUKTURY POGRANICHNOGO SLOIA]
B. IU. ZANIN and V. V. KOZLOV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 6, 1983, p. 109-112. In Russian. refs

The problem of the laminar-turbulent transition in the boundary layer has been studied in a series of full-scale experiments using a sailplane. The experiments included (1) measurements of incoming flow turbulence when flying at various altitudes and in clouds and (2) observations of the structure of the boundary layer on the upper surface of the wing and of the effect of incoming flow turbulence on the transition from a laminar boundary layer to a turbulent one. Frequency spectra and oscillograms of boundary layer perturbations on the sailplane wing are presented for different flight altitudes. V.L.

N84-33934# National Oceanic and Atmospheric Administration, Boulder, Colo. wave Propagation Lab.
RADAR CROSS SECTION MEASUREMENTS OF WINGTIP VORTICES
R. B. CHADWICK, J. JORDAN, and T. DETMAN *In* ESA IGARSS 84. Remote Sensing: From Res. towards Operational Use, Vol. 1 p 479-483 Aug. 1984 refs Sponsored by FAA
Avail: NTIS HC A24/MF A01

Experiments with an experimental clear-air radar near an airport were done to demonstrate that short range 10 cm radar can reliably detect and locate wing tip vortices shed by large jets. The radar was calibrated in return power and velocity so that radar cross sections and velocity widths could be calculated. Histograms of radar cross section (in terms of refractivity structure constant) and a weighted spectral width parameter are given for 44 vortex and 44 non vortex cases. The nonvortex data were taken just before the vortex-producing aircraft entered the antenna beam. The time variation of these two parameters for one particular case is presented. Arguments on the size of the return-producing portion of the vortex are outlined. The expected maximum range of a radar similar to that used in this experiment is shown.
Author (ESA)

N84-34750# Royal Signals and Radar Establishment, Malvern (England).
WIND MEASUREMENT WITH COHERENT LASER RADAR AT 10 MICRONS
J. M. VAUGHAN and A. A. WOODFIELD *In* ESA Space Laser Appl. and Technol. (SPLAT) 8 p May 1984 refs
Avail: NTIS HC A14/MF A01

Air and spaceborne systems for wind measurement with coherent laser radars are described. The continuous wave laser True Airspeed System airborne equipment shows excellent reliability and performance throughout three years of flight trials in a great variety of meteorological conditions. A pulsed laser system is proposed for global wind field monitoring. Feasibility studies of this WINDSAT equipment were made for shuttle and satellite mounted operation. Questions of laser performance and atmospheric backscattering strength are discussed.
Author (ESA)

N84-34800# Federal Aviation Administration, Washington, D.C. Office of Environment and Energy.
THE HIGH ALTITUDE POLLUTION PROGRAM (1976 - 1982) Final Report
N. SUNDARARAMAN Jan. 1984 139 p
(AD-A144390; FAA/EE-84-10) Avail: NTIS HC A07/MF A01 CSCL 13B

The High Altitude Pollution Program (HAPP) was initiated by the Federal Aviation Administration in 1976 in order to assess the

effects of aircraft engine emissions on the upper atmosphere. Its predecessor, the Climatic Impact Assessment Program (1971-1975) conducted by the U.S. Department of Transportation, focused international attention on the ozone depletion problem. This final report documents the conclusions of the studies funded by HAPP from 1976 until the program was terminated in 1982. Scientific considerations of the impacts of aircraft engine emissions on the stratosphere and troposphere are discussed. Major HAPP accomplishments in the areas of engine emissions, laboratory studies, field measurements, and modeling are summarized. Current evaluations of the effects of aircraft engine NOx emissions (through 1984) are also contained in the report. Based upon the studies undertaken, it appears that there is no immediacy of concern with regard to ozone and climatic changes that may result from the operations of civilian aircraft at this time. GRA

N84-34828*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
GASP CLOUD- AND PARTICLE-ENCOUNTER STATISTICS AND THEIR APPLICATION TO LPC AIRCRAFT STUDIES. VOLUME 1: ANALYSIS AND CONCLUSIONS
W. H. JASPERSON (Control Data Corp., Minneapolis, Minn.), G. D. NASTROM (Control Data Corp., Minneapolis, Minn.), R. E. DAVIS, and J. D. HOLDEMAN (NASA. Lewis Research Center) Oct. 1984 92 p refs
(NASA-TM-85835; L-15789; NAS 1.15:85835) Avail: NTIS HC A05/MF A01 CSCL 04B

Summary studies are presented for the entire cloud observation archieve from the NASA Global Atmospheric Sampling Program (GASP). Studies are also presented for GASP particle concentration data gathered concurrently with the cloud observations. Cloud encounters are shown on about 15 percent of the data samples overall, but the probability of cloud encounter is shown to vary significantly with altitude, latitude, and distance from the tropopause. Several meteorological circulation features are apparent in the latitudinal distribution of cloud cover, and the cloud encounter statistics are shown to be consistent with the classical mid-latitude cyclone model. Observations of clouds spaced more closely than 90 minutes are shown to be statistically dependent. The statistics for cloud and particle encounter are utilized to estimate the frequency of cloud encounter on long range airline routes, and to assess the probability and extent of laminar flow loss due to cloud or particle encounter by aircraft utilizing laminar flow control (LFC). It is shown that the probability of extended cloud encounter is too low, of itself, to make LFC impractical.
Author

N84-34851*# Mississippi Univ., University.
SEVERE STORM ELECTRICITY
R. T. ARNOLD and W. D. RUST (National Severe Storms Lab., Norman, Okla.) *In* NASA. Marshall Space Flight Center NASA/MSFC FY-84 Atmospheric Processes Res. Rev. p 87-88 Sep. 1984
Avail: NTIS HC A10/MF A01 CSCL 04B

Successful ground truth support of U-2 overflights was been accomplished. Data have been reduced for 4 June 1984 and some of the results have been integrated into some of MSFC's efforts. Staccato lightning (multiply branched, single stroke flash with no continuing current) is prevalent within the rainfree region around the main storm updraft and this is believed to be important, i.e., staccato flashes might be an important indicator of severe storm electrification. Results from data analysis from two stations appear to indicate that charge center heights can be estimated from a combination of intercept data with data from the fixed laboratory at NSSL. An excellent data base has been provided for determining the sight errors and efficiency of NSSL's LLP system. Cloud structures, observable in a low radar reflectivity region and on a scale smaller than is currently resolved by radar, which appear to be related to electrical activity are studied. B.W.

N84-34865*# California Univ., Davis. Dept. of Land, Air and Water Resources.
EVALUATION OF AIRBORNE LIDAR WIND MEASUREMENTS Research Summary Report
J. J. CARROLL *In* NASA. Marshall Space Flight Center NASA/MSFC FY-84 Atmospheric Processes Res. Rev. p 125-127 Sep. 1984 refs
Avail: NTIS HC A10/MF A01 CSCL 04B

The verification of the Doppler lidar wind measurement is continued. The in situ measurements on a 500 meter tall tower are used to check the lidar determined winds (flight 4), followed by other tests applied to the extensive data sets of flights 19 and 21. After checking for possible software errors in the processing programs, the inconsistency was not solved. The source of the errors appears to be the uncertainty in the calculation of the contribution of the aircraft motion to the lidar measured line of sight speed. Possible techniques for estimating the aircraft motion errors from the aircraft data are investigated. B.G.

N84-34885*# Colorado State Univ., Fort Collins. Cooperative Inst. for Research in the Atmosphere.
INVESTIGATION OF ARC CLOUD LINES
J. F. W. PURDOM and P. C. SINCLAIR *In* NASA. Marshall Space Flight Center NASA/MSFC FY-84 Atmospheric Processes Res. Rev. p 197-199 Sep. 1984
Avail: NTIS HC A10/MF A01 CSCL 04B

The natural mechanisms that lead to the development of deep convective storms through the integration of radio scan satellite data with research aircraft observations is discussed. The aircraft measurements are designed to provide detailed air motion and thermodynamic data near and in the arc cloud line region at the same time GOES rapid scan data is taken. Inspection of the data indicates: (1) Arc cloud lines are important in both the production of convergence and vorticity, and in the interaction with intense thunderstorms which may act to trigger tornado activity. (2) The lateral extent of the vertical motion field compared to the cloud scale indicates that the main driving force for the initial cloud development along the arc-line is controlled by the thunderstorm outflow(s) interacting with the convectively unstable air of the environment. (3) Arc cloud lines and their associated DSL region can pose extreme hazards to aircraft operations. (4) An arc cloud line's major threat to space shuttle operations lie in its ability to generate new thunderstorm activity along the shuttle glide path.
E.R.

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MATHEMATICAL AND COMPUTER SCIENCES

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

A84-46576
SIMULATION AND MODELLING; PROCEEDINGS OF THE EIGHTH INTERNATIONAL SYMPOSIUM, ORLANDO, FL, NOVEMBER 9-11, 1983
M. H. HAMZA, ED. Symposium sponsored by the International Association of Science and Technology for Development. Anaheim, CA and Calgary, Canada, Acta Press, 1984, 178 p. For individual items see A84-46577 to A84-46582.

Among the topics discussed are data flow modelling techniques, the use of microcomputers in engineering education, microprocessor control of reactive power compensation in distribution systems, the effect of nonlinear loads on power system dynamic stability under different excitations, a multiobjective analysis of the petrochemical industry, the modelling of cost and effectiveness for tactical aircraft survivability, health care manpower supply vs. demand, and distribution system reliability cost analysis.

Also considered are the behavior of a multipoint network under a character-oriented protocol, a graphics method for simulating robot manipulator kinematics, an econometric forecasting model, computer-based strategic portfolio planning, the entropy of the Arabic language, and the optimal control of U.S. wheat production. O.C.

A84-46694
THE IRIS WORKSTATION
R. NICKEL (Silicon Graphics, Inc., Mountain View, CA) IEEE Computer Graphics and Applications (ISSN 0272-1716), vol. 4, Aug. 1984, p. 30-34.

The new generation of Integrated Raster Imaging System (IRIS) engineering workstations is described, IRIS consists of three pipelined components: the CPU, the Geometry Engine subsystem and the raster subsystem. The geometry subsystem provides two-dimensional and three-dimensional geometric processing with either 32-bit floating-point or integer formats. The raster subsystem controls up to 24 bit planes of image memory which can be used in either single- or double-buffeted modes. The incorporation of Very-Large-Scale-Integration (VLSI) circuits in the design of the IRIS workstation has resulted in order-of-magnitude performance improvements. The workstation can function as a stand-alone unit or communicate to a network of IRIS systems. A schematic diagram of the Geometry Engine pipeline is provided as well as several sample color images generated by the system. I.H.

A84-46964#
DESIGN OF NONINTERACTING MULTIVARIABLE FEEDBACK CONTROL SYSTEMS WITHOUT DECOUPLING FILTERS
C. J. MADAY (North Carolina State University, Raleigh, NC) and D. A. BAKER American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(Contract N00014-83-K-0064)
(ASME PAPER 84-GT-157)

Important classes of feedback control systems which are characterized by more than one input and more than one output are found in connection with precision machining operations, automatic control of gas turbines, and in-process control of chemical processes. Such multivariable systems with multiinputs and multioutputs are the subject of many recent and current investigations. Questions arise regarding the nature of the desired time response. In multivariable systems with significant coupling, such as gas turbines, one performance criterion is the lack of interaction among the output variables when it is necessary to change only one of them. A comparison is conducted of the performance of two feedback control strategies, taking into account decoupling filters with proportional-integral-derivative control and integral error plus state feedback control. G.R.

A84-47545
ANALOG-DIGITAL SIMULATION OF VARIABLE TIME LAG [ANALOGO-TSIFROVOE MODELIROVANIE PEREMENNOGO ZAPAZDYVANIIA]
V. V. KAZHAEV, E. V. PROKOFEV, and L. L. SIBIRIAKOVA (Gor'kovskii Gosudarstvennyi Universitet, Gorki, USSR) Elektronnoe Modelirovanie (ISSN 0204-3572), vol. 6, July-Aug. 1984, p. 116-118. In Russian. refs

A hybrid procedure for the simulation of variable time lag is developed which is applicable to the study of phenomena in aircraft and spacecraft systems. The characteristics of the simulation method are described, and the method is applied to the study of the transverse oscillations of a variable-length string. A block diagram of the proposed system is presented. B.J.

A84-49385
AN ANALYSIS OF CAD/CAM APPLICATIONS WITH AN INTRODUCTION TO CIM
R. N. STOVER (CADD/CAM Advisors, Inc., Lanham, MD) Englewood Cliffs, NJ, Prentice-Hall, Inc., 1984. 303 p. refs

Current CAD/CAM technology is surveyed, and a number of specific applications are described and illustrated with diagrams, photographs, and drawings. The developmental history of CAD/CAM systems and computer-graphics (CG) equipment is traced, and consideration is given to current CG hardware and software; the advantages of CAD/CAM; and the processes involved in typical line-drawing, data representation, graphics, and imagery applications. Case studies include electronic circuit design, factory automation, mechanical drafting, aircraft design and construction, architectural engineering, productivity improvement, and the production of aeronautical navigation charts. A glossary of terms is provided. T.K.

N84-34177# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
REPORT OF THE WORKING GROUP ON LARGE-SCALE COMPUTING IN AERONAUTICS
Jun. 1984 110 p
(AGARD-AR-209; ISBN-92-835-1474-2; AD-A146085) Avail: NTIS HC A06/MF A01

The economics that computational fluid dynamics have brought to aerodynamic design, in reducing the cost of wind tunnel testing and reduction in development time, are considerable. Emphasis will be placed on modelling flows of increasing complexity. There are inviscid and thin layer calculations, Reynolds averaged Navier-Stokes solutions and large eddy simulation. Three aspects of rocket technology are currently inhibited by inadequate computing resources modelling of combustion instability, holographic diagnosis of exhaust emissions; and modelling of kinetics from flame front to exhaust nozzle. Large scale computers would allow such modelling. The use of computers in aeronautics is dependent upon the power and storage capacity of the computers, ability to generate coordinate systems for complex configurations, algorithms for the solution of flow field equations, and the capability to model turbulent flows. Transonic small perturbation methods are used to calculate transonic flows. Nonlinear field methods are used for flows over complex shapes. The finite element method is also used. For future requirements, the major task of computing facilities will come from applications in the design of aircraft, helicopters, and missiles. S.B.

N84-34183# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
PASCAL-MP: A LANGUAGE FOR THE ALGEBRAIC AND NUMERICAL MANIPULATION OF POLYNOMIALS [PASCAL-MP: UMA LINGUAGEM PARA MANIPULACAO ALGEBRICA E NUMERICA DE POLINOMIOS]
J. C. LOMBARDI, E. L. F. SENNE, and S. A. TAVARES Apr. 1984 5 p refs In PORTUGUESE; ENGLISH summary Trabalho a ser submetido ao 4th Congr. SBC - SEMISH - Seminario Integrado de Software e Hardware, a Realizar-se de 21-27 Jul. 1984, Vicosa, M. G.
(INPE-3057-PRE/477) Avail: NTIS HC A02/MF A01

The programming language PASCAL-MP, developed with the purpose of facilitating programming of systems envolving algebraic and numerical manipulation of multiple variable polynomials frequently seen in aerodynamics, celestial mechanics and structural calculus problems is presented. Author

N84-34187*# Boeing Co., Seattle, Wash.
BGRID: A BLOCK-STRUCTURED GRID GENERATION CODE FOR WING SECTIONS
H. C. CHEN and K. D. LEE Nov. 1981 46 p refs
(Contract NAS2-10676)
(NASA-CR-166317; NAS 1.26:166317) Avail: NTIS HC A03/MF A01 CSCL 09B

The operation of the BGRID computer program is described for generating block-structured grids. Examples are provided to illustrate the code input and output. The application of a fully implicit AF (approximation factorization)-based computer code, called TWINGB (Transonic WING), for solving the 3D transonic full potential equation in conservation form on block-structured grids is also discussed. Author

N84-34195# Aeronautical Research Labs., Melbourne (Australia).
AN ASSEMBLY LANGUAGE PROGRAM FOR CALCULATING RANDOM DECREMENT SIGNATURES
P. M. COX Dec. 1983 23 p
(AD-A143908; ARL-STRUC-MEMO-369) Avail: NTIS HC A02/MF A01 CSCL 09B

Random decrement signatures are widely used in vibration analysis such as the testing of aircraft structures both in flight and on the ground. A method of calculating such a signature has been programmed in assembly language for a NOVA 3 computer using data transfered from a NICOLET FFT analyzer. The program was written for a mini-computer so that it could be used for in-the-field analysis. As the method involves a large amount of data manipulation, assembly language was used, instead of FORTRAN, because it is more efficient in terms of speed and storage. The input analog signals to the analyzer are transferred to the computer after digitizing. The signatures calculated are displayed on an oscilloscope using the digital/analog converters in the analyzer. The final result can be plotted on a digital plotter. After the signatures have been calculated the power spectra are determined using Fourier analysis. The analyzer is used to perform the Fourier transforms as this is faster than the algorithm on the NOVA 3. The program runs interactively allowing the operator to terminate the random decrement averaging process when desired. The results obtained from random vibration test on a CT4 tailplane, are given as an example of graphical output from this program. GRA

N84-34199*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SOFTWARE IMPLEMENTED FAULT-TOLERANT (SIFT) USER'S GUIDE
D. F. GREEN, JR., D. L. PALUMBO, and D. W. BALTRUS Aug. 1984 52 p
(NASA-TM-86289; NAS 1.15:86289) Avail: NTIS HC A04/MF A01 CSCL 09B

Program development for a Software Implemented Fault Tolerant (SIFT) computer system is accomplished in the NASA LaRC AIRLAB facility using a DEC VAX-11 to interface with eight Bendix BDX 930 flight control processors. The interface software which provides this SIFT program development capability was developed by AIRLAB personnel. This technical memorandum describes the application and design of this software in detail, and is intended to assist both the user in performance of SIFT research and the systems programmer responsible for maintaining and/or upgrading the SIFT programming environment. Author

N84-34991# Softech, Inc., Waltham, Mass.
INTEGRATED COMPUTER-AIDED MANUFACTURING (ICAM) ARCHITECTURE, PART 3. VOLUME 7: MFG01 GLOSSARY Final Report, Sep. 1980 - Oct. 1982
R. HEINE, R. PREWETT, S. COLEMAN, L. BEEBE, and B. DAVIS Wright-Patterson AFB, Ohio AFWAL Sep. 1983 235 p
(Contract F33615-80-C-5109)
(AD-A144426; AFWAL-TR-82-4063-VOL-7) Avail: NTIS HC A11/MF A01 CSCL 09B

The Integrated Computer Aided Manufacturing (ICAM) Architecture Part 3 was initiated to maintain and update the existing manufacturing architecture as well as develop training courses to assist in the transition of IDEF applications, concepts and procedures to other Air Force programs. This volume presents all the terms from the function and information models of manufacturing. Author (GRA)

N84-34999# LTV Aerospace Corp., Dallas, Tex. Vought Aero Products Div.
ICAM (INTEGRATED COMPUTER AIDED MANUFACTURING) CONCEPTUAL DESIGN FOR COMPUTER-INTEGRATED MANUFACTURING. VOLUME 4, PART 5, TASK D: QUALITY ASSURANCE/QUALITY, CONTROL/TECHNICAL REQUIREMENT/TASKS, QUALITY ASSURANCE MODELING AND ANALYSIS, ARCHITECTURE FOR PRODUCT ASSURANCE, (TTD) Final Technical Report, 1 Oct. 1981 - 29 Jun. 1984
D. L. NORWOOD, R. H. WETTACH, B. R. SHEPHERD, W. D. VINSON, and R. R. PRESTON Jun. 1984 102 p
(Contract F33615-81-C-5119)
(AD-A144691; REPT-2-20150/4R-2; TTD110513000; AFWAL-TR-84-4020-VOL-4) Avail: NTIS HC A06/MF A01 CSCL 13H

This document, Volume 4, Part 5 of the Final Technical Report contain the QA Architecture for Product Assurance Document. This document presents the models and architecture of the QA AS-IS system. It is a technology transfer oriented report that simplifies the modernization process considerably by providing a logical process to sequence improvement events, prioritize those operations that merit immediate attention, eliminate replications of procedures, and establish a pattern or road map that is designed to be a pertinent while at the same time flexible enough to adapt to any given situation. GRA

N84-35025# Wisconsin Univ., Madison.
***TRIANGULAR EXTRAPOLATION* Summary Report**
P. ALFELD (Utah Univ., Salt Lake City) Jun. 1984 26 p
(Contract DAAG29-80-C-0041; DE-AL02-82ER-12046)
(AD-A144660; MRC-TSR-2707) Avail: NTIS HC A03/MF A01 CSCL 12A

The general problem area addressed in this report is that of the interpolation of scattered bivariate data as these arise for example in the Computer Aided Geometric Design of geometric objects like the shape of a ship, or the fuselage and wings of an aircraft. Many existing techniques proceed by triangulating the domain and then defining the interpolant piecewise on each triangle. This approach has the drawback that the interpolant cannot be readily evaluated outside of the triangulated domain. This report deals with the problem of extending such a triangular interpolant. Existing methods are reviewed, new methods are introduced, and the methods are compared. It appears that at present no completely satisfactory techniques exist and that the subject requires more research. GRA

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PHYSICS

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

A84-47031#
THE BRITALUS BRAYTON CYCLE ENGINE
R. DECHER (Combustion Research and Technology, Inc.; Washington, University, Seattle, WA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 29th, Amsterdam, Netherlands, June 4-7, 1984. 6 p. refs
(ASME PAPER 84-GT-258)

The Britalus engine's Brayton cycle employs piston displacement compression and expansion for high efficiency and, unlike conventional gas turbines, can be scaled to small sizes in virtue of compression and expansion adiabatic efficiencies that are intrinsically higher irrespective of scale. After discussing engine design parameters as they relate to part load performance requirements, a parametrical treatment is presented for the expander inlet temperature, which functions as a power level index,

to determine the limitations imposed by heat transfer features. O.C.

A84-47054
NUMERICAL SOLUTION OF THE PROBLEM CONCERNING THE FOCUSING OF SHOCK WAVES PRODUCED BY A SUPERSONIC AIRCRAFT [CHISLENNOE RESHENIE ZADACHI O FOKUSIROVANII UDARNYKH VOLN, SOZDAVAEMYKH SVERKHZVUKOVYM SAMOLETOM]
A. V. POTAPKIN and IU. N. IUDINTSEV TsAGI, Uchenye Zapiski (ISSN 0321-3429), vol. 14, no. 4, 1983, p. 26-36. In Russian. refs

A method is proposed for calculating the parameters of a sonic boom associated with the focusing of shock waves. In accordance with the approach proposed here, results of quasi-linear theory are used as the starting data for a numerical calculation of the gas parameters behind focused shock waves in the regions where quasi-linear theory does not apply. The algorithm for computing the focusing of shock waves is based on Godunov's difference scheme used in conjunction with a dynamic difference grid coupled with isolated shock waves. For the problem of a sonic boom from a thin body in supersonic flight with acceleration along a straight trajectory, the regions where quasi-linear theory is valid are determined. Expressions are obtained which relate the amplification factors of the focused shock waves to the flight conditions. V.L.

A84-48754
THE BEHAVIOR OF DYNAMIC SYSTEMS NEAR THE LIMITS OF THE STABILITY REGION (2ND REVISED AND ENLARGED EDITION) [POVEDENIE DINAMICHESKIKH SISTEM VBLIZI GRANITS OBLASTI USTOICHIVOSTI /2ND REVISED AND ENLARGED EDITION/]
N. N. BAUTIN Moscow, Izdatel'stvo Nauka, 1984, 176 p. In Russian. refs

The bifurcations of the equilibrium states of certain autonomous systems of differential equations are examined for those cases where a change in stability is involved, with particular attention given to the focus-type equilibrium states involving the appearance or disappearance of limit cycles. The concepts of hazardous and nonhazardous limits are introduced, and criteria for distinguishing these types of limits are presented. The criteria proposed are based on the determination of Liapunov numbers. V.L.

N84-34230*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF BOUNDARY LAYER REFRACTION ON THE NOISE FROM A HIGH-SPEED PROPELLER
J. H. DITTMAR, R. J. BURNS, and D. J. LECIEJEWSKI Sep. 1984 31 p refs
(NASA-TM-83764; E-2257; NAS 1.15:83764) Avail: NTIS HC A03/MF A01 CSCL 20A

Models of supersonic propellers were previously tested for acoustics in the Lewis 8- by 6-Foot Wind Tunnel using pressure transducers mounted in the tunnel ceiling. The boundary layer on the tunnel ceiling is believed to refract some of the propeller noise away from the measurement transducers. Measurements were made on a plate installed in the wind tunnel which had a thinner boundary layer than the ceiling boundary layer. The plate was installed in two locations for comparison with tunnel ceiling noise data and with fuselage data taken on the NASA Dryden Jetstar airplane. Analysis of the data indicates that the refraction increases with: increasing boundary layer thickness; increasing free stream Mach number; increasing frequency; and decreasing sound radiation angle (toward the inlet axis). At aft radiation angles greater than about 100 deg there was little or no refraction. Comparisons with the airplane data indicated that not only is the boundary layer thickness important but also the shape of the velocity profile. Comparisons with an existing two-dimensional theory, using an idealized shear layer to approximate the boundary layer, showed that the theory and data had the same trends. Analysis of the data taken in the tunnel at two different distances from the propeller indicates a decay with distance in the wind tunnel at high Mach numbers but the decay at low Mach numbers is not as clear. Author

N84-34231*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A THEORETICAL MODEL FOR THE CROSS SPECTRA BETWEEN PRESSURE AND TEMPERATURE DOWNSTREAM OF A COMBUSTOR
J. H. MILES and E. A. KREJSA 1984 61 p refs Presented at the 107th Meeting of the Acoustical Society of America, Norfolk, Vir., 6-10 May 1984
(NASA-TM-83671; E-2114; NAS 1.15:83671) Avail: NTIS HC A04/MF A01 CSCL 20A

A theoretical model developed to calculate pressure-temperature cross spectra, pressure spectra, temperature spectra and pressure cross spectra in a ducted combustion system is presented. The model assumes the presence of a fluctuating-volumetric-heat-release-rate disk source and takes into account the spatial distribution of the steady-state volumetric-heat flux. Using the model, pressure, velocity, and temperature perturbation relationships can be obtained. The theoretical results show that, at a given air mass flow rate, the calculated pressure-temperature cross spectra phase angle at the combustor exit depends on the model selected for the steady-state volumetric-heat flux in the combustor. Using measurements of the phase angle, an appropriate source region model was selected. The model calculations are compared with the data. The comparison shows good agreement and indicates that with the use of this model the pressure-temperature cross spectra measurements provide useful information on the physical mechanisms active at the combustion noise source. Author

N84-34234# Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
THE EFFECT OF AIRCRAFT WITH NOISE CERTIFICATES ACCORDING TO CLASS ICAO ANNEX 16 ON THE DETERMINATION OF NOISE PROTECTION DOMAINS FOLLOWING THE LAW ON PROTECTION AGAINST AIRCRAFT NOISE [ZUR BERUECKSICHTIGUNG VON FLUGZEUGEN MIT LAERMZULASSUNG NACH ICAO ANNEX 16 BEI DER ERMITTLLUNG VON LAERMSCHUTZBEREICHEN NACH DEM GESETZ SCHUTZ GEGEN FLUGLAERM]
U. ISERMANN, K. MATSCHAT, and E. A. MUELLER Dec. 1983 16 p In GERMAN Presented at 13th DGLR-Fachausschusses Stroemungskustik/Fluglaerm, Goettingen, West Germany, 18 Nov. 1983
(MPIS-117/1983) Avail: NTIS HC A02/MF A01

A proposal of the German Federal Ministry of the Environment to adapt the calculation method for noise domains to the expected future air traffic situation is explained. It is explained how the equivalent continuous noise level (L(eq)) is calculated as a function of the different parameters. The new division in aircraft groups is presented. The accuracy of the L(eq) prediction depends on the accuracy of the air traffic prognosis. Comparison between calculated and measured values shows differences from 0 to 0.4 dB at an airport, and from 1.5 to 3 dB at distant measuring points. Author (ESA)

N84-34786# Weapons Systems Research Lab., Adelaide (Australia). Weapon Systems Div.
AUTONOMOUS SURVEILLANCE IN THE VISUAL SPECTRAL REGION
B. E. FURBY and B. D. RONEY *In* Materials Research Labs. Extracts from Symp.: Countersurveillance 1983 p 48-68 May 1984 refs
Avail: NTIS HC A09/MF A01

An autonomous surveillance system is one which is capable of detection, identification, and tracking of fast targets in real time. The equipment needed to carry out these operations includes a TV camera, digitizer and a digital computer. The design of the computer hardware and the development of the software are very difficult because several Mbits of data must be processed in real time. At present suitable algorithms are being evaluated for the

identification and tracking of ship targets and the results of the two techniques developed are described. Fourier descriptors provide a method of identification which can be superior to the human operator and real time correlation tracking methods are approaching useful times by reducing the number of points in the window. Author

N84-35085*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SUPERSONIC JET SHOCK NOISE REDUCTION
J. R. STONE 1984 45 p refs Presented at 9th Aeroacoust. Conf., Williamsburg, Va., 15-17 Oct. 1984
(NASA-TM-83799; E-2299; NAS 1.15:83799) Avail: NTIS HC A03/MF A01 CSCL 20A

Shock-cell noise is identified to be a potentially significant problem for advanced supersonic aircraft at takeoff. Therefore NASA conducted fundamental studies of the phenomena involved and model-scale experiments aimed at developing means of noise reduction. The results of a series of studies conducted to determine means by which supersonic jet shock noise can be reduced to acceptable levels for advanced supersonic cruise aircraft are reviewed. Theoretical studies were conducted on the shock associated noise of supersonic jets from convergent-divergent (C-D) nozzles. Laboratory studies were conducted on the influence of narrowband shock screech on broadband noise and on means of screech reduction. The usefulness of C-D nozzle passages was investigated at model scale for single-stream and dual-stream nozzles. The effect of off-design pressure ratio was determined under static and simulated flight conditions for jet temperatures up to 960 K. Annular and coannular flow passages with center plugs and multi-element suppressor nozzles were evaluated, and the effect of plug tip geometry was established. In addition to the far-field acoustic data, mean and turbulent velocity distributions were measured with a laser velocimeter, and shadowgraph images of the flow field were obtained. Author

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SOCIAL SCIENCES

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

A84-46810#
HOVERCRAFT HEAVE STABILITY
M. J. HINCHEY (Newfoundland, Memorial University, St. John's, Canada) and P. A. SULLIVAN (Toronto, University, Toronto, Canada) *Canadian Aeronautics and Space Journal* (ISSN 0008-2821), vol. 30, June 1984, p. 130-151. Research supported by the Transport Development Centre and Natural Sciences and Engineering Research Council of Canada. refs

One problem frequently encountered by developers of air cushion technology is the tendency of their systems to self oscillate, usually in heave. This paper reviews the various mathematical procedures that have been developed for studying the phenomenon. Considerable effort is devoted to establishing physical insights. It is hoped that this will make the paper of use to developers. Analysis shows that the compressibility of the air mass enclosed by the flexible skirt is the major source of instability: it allows the cushion pressure force to lag behind the heave displacement, and this sets up the hunting-like motion. Author

N84-35132# Institute for Defense Analyses, Alexandria, Va.
OPERATING COSTS OF AIRCRAFT AND FLIGHT SIMULATORS Final Report, Feb. 1983 - Mar. 1984
J. ORLANSKY, M. I. KNAPP, and J. STRING Mar. 1984 32 p (Contract MDA903-84-C-0031)
(AD-A144241; AD-E500672; IDA-P-1733; IDA/HQ-83-25682)
Avail: NTIS HC A03/MF A01 CSCL 05I

This paper presents data and analyses of the operating costs of flight simulators and aircraft used in military training. The results should be useful in cost-effectiveness analyses of ongoing flight training programs. The effectiveness of flight simulators for training, however, is not addressed in this paper; hence, the findings of this study alone do not provide the basis for judgements or decisions that require both cost and effectiveness data. The average variable operating costs of 39 simulators in use in the FY 1980-1981 time period fall within a narrow range ($116 to $170 per operating-hour), despite the diversity of simulator types and associated aircraft missions (e.g., bomber, fighter, cargo), and aircraft sizes or types (i.e., fixed-wing or rotary-wing). The simulator-to-aircraft operating cost ratios were about the same in the FY 1975-1976 and FY 1980-1981 time periods (27 and 39 combinations, respectively); the median value was 8 percent. No relationship was found between the type of simulators, as categorized by the Services (e.g., Part Task Trainer, Cockpit Procedures Trainer, Weapon Systems Trainer) and its operating costs. GRA

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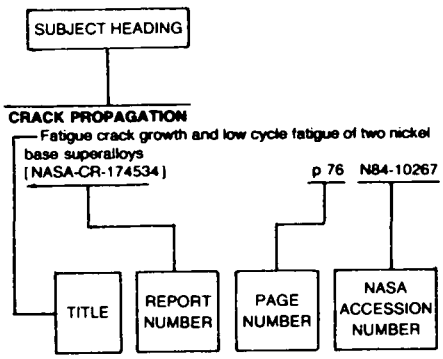
GENERAL

A84-47690
FROM AUTOPILOT TO STRAPDOWN - ELECTROTECHNOLOGY IN INERTIAL GUIDANCE AND CONTROL
R. B. SCHROER (Martin Marietta Aerospace, Denver, CO) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, July 1984, p. 445-454. refs

Electrotechnology has been a significant factor in the evolution of guidance and control (G&C) over the last half century. Ship stabilizers that used rotating wheels for brute force control were electrically driven. However, the first pilotless aircraft, developed in World War I, was controlled primarily with pneumatic servos. Inertial guidance and electronic control systems surfaced at Peenemunde around World War II. Advances in fire control servos led to development of the floated gyro and ushered in precision inertial navigators. Digital electronics replaced analog designs, so that the level of G&C sophistication increased dramatically. As digital computers became smaller and more powerful their use proliferated. The manned space program in the 60's saw substantial improvements in electronics reliability and performance. The successful first launch of the Space Shuttle, with all its complexity, is a tribute to electronics progress. It is difficult to predict what G&C advances electrotechnology will bring in the next 50 years. Author

Typical Subject Index Listing



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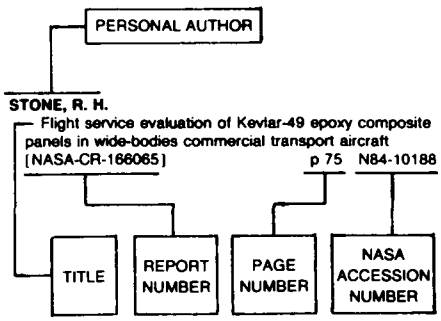

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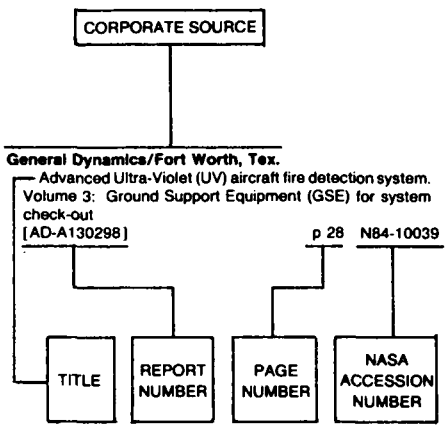

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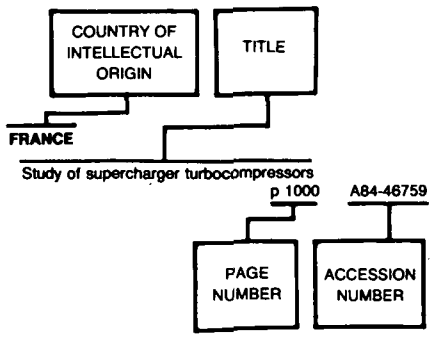

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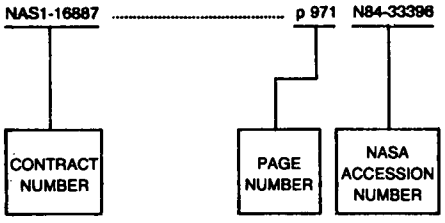

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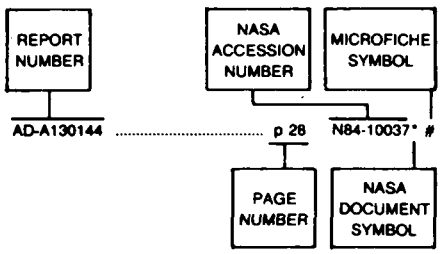

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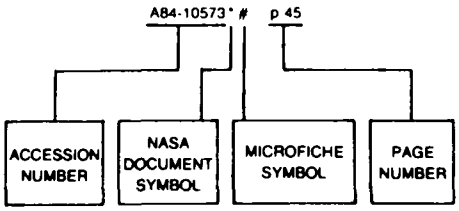

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