NASA

Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037(184)
February 1985

National Aeronautics and Space Administration

SPECIAL NOTICE ENCLOSED

NEW FOREIGN TECHNOLOGY INDEX INCLUDED IN THIS ISSUE

ACCESSION NUMBER RANGES

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

STAR (N-10000 Series)	N85-10001 - N85-11975
IAA (A-10000 Series)	A85-10001 - A85-12656

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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.
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NASA SP-7037(184)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 184)

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 January 1985 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 425 reports, journal articles, and other documents originally announced in January 1985 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

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

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

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

An annual cumulative index will be published.

AVAILABILITY OF CITED PUBLICATIONS

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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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N85-10007*# *Boeing Commercial Airplane Co., Seattle, Wash.*
DEVELOPMENT AND APPLICATIONS OF ALGORITHMS FOR CALCULATING THE TRANSONIC FLOW ABOUT HARMONICALLY OSCILLATING WINGS
F. E. EHLERS, W. H. WEATHERILL, and E. L. YIP Oct. 1984 152 p refs
(Contract NAS1-16297)
(NASA-CR-172376; NAS 1.26:172376) Avail: NTIS HC A08/MF A01 CSCL 01A

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

TYPICAL CITATION AND ABSTRACT FROM *IAA*

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A85-11976#
INDUCED DRAG AND LIFT OF WING BY THE PIECEWISE CONTINUOUS KERNEL FUNCTION METHOD
I. LOTTATI (Technion - Israel Institute of Technology, Haifa, Israel) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 883, 834. refs

A piecewise version of the continuous kernel function method (PCKFM) was used to calculate the induced drag on three-dimensional wings in subsonic flow. The method is used to calculate the induced drag and lift of a large number of wings, and the results are found to be in good agreement with values obtained with other methods. The PCKFM is applied to a comparison of the drag and lift coefficients characteristic of nontwisted planar forward and swept front and back wings in the equivalent M- or W-type configuration. It is found that the spanwise distribution of load and the induced drag are influenced by the seep angle of the lifting surface. The spanwise pressure distribution of the M-type wing offers advantages for improving the configuration performance characteristics. I.H.

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 184)

FEBRUARY 1985

01

AERONAUTICS (GENERAL)

A85-10554

IN SITU AIRCRAFT INSPECTION BY PULSED LASER HOLOGRAPHY [CONTROLE 'IN SITU' SUR AVION PAR HOLOGRAPHIE A LASERS PULSES]

H. FAGOT (Saint-Louis, Institut Franco-Allemand de Recherches, Saint-Louis, Haut-Rhin, France) Sciences et Techniques de l'Armement (Memorial de l'Artillerie Francaise), vol. 57, no. 4, 1983, p. 625-639. In French. Sponsorship: Direction des Recherches, Etudes et Techniques.
(Contract DRET-79-291)

The application of pulsed laser holography to analyzing the mechanical behavior of an aircraft structure undergoing induced vibrations is described. Two lasers each furnish a 20 nsec output of less than 100 mJ energy, shone on an aircraft wing subjected to a mechanical shock. One beam serves as a reference, the other for interference fringe patterns. The technique was tested using a 1 m x 0.5 m aluminum honeycomb wing segment subjected to a 30 mJ shock, and on several external panels of a Vulture aircraft. It is shown that defects in the parts cause easily recognizable irregularities in the fringe patterns. High power lasers would be needed for sections larger than 1 sq m. The technique is concluded valid for NDT in the hangar. M.S.K.

A85-11245

AIRCRAFT MAINTENANCE [TEKHNICHESKAIA EKSPLAUATATSIIA SAMOLETOV]

N. V. ANIKIN and IU. V. NAZAROV Moscow, Izdatel'stvo Transport, 1984, 200 p. In Russian.

The organization of the aviation engineering service, the general rules of aircraft maintenance, and specific technical servicing procedures are discussed. Attention is given to various types of maintenance, maintenance-related documentation, the maintenance of piping, filters, control systems, airframe, chassis, and hydraulic systems and maintenance procedures under different climatic conditions. Other topics discussed include tools, fixtures, and ground equipment, the structure of an airfield, and take-off preparation. The examples used in the discussion concern An-24 and Tu-154, two of the most popular types of aircraft. V.L.

A85-12082

COMPOSITE FLEXBEAM TAIL ROTOR PRACTICAL

S. H. WIESENBERG (U.S. Army, Aviation Systems Command, St. Louis, MO) ManTech Journal, vol. 9, no. 2, 1984, p. 3-10. Army-supported research.

The results of a project to refine and verify the manufacturing processes and production configuration for a composite flexbeam tail rotor for the AH-64 Apache Attack Helicopter are reported. The design ground rules are given and the rotor structure is depicted and described. The protection against lightning, ballistic impact, and erosion is addressed, and the structural analysis is reported. Fabrication techniques for the rotor are summarized, and full-scale tests and results for the flexbeam root-end and flexbeam/pitch case attachment area are given. A joint shear strength check is summarized, and the results of wind tunnel tests and structural fatigue tests are discussed. C.D.

N85-10001*# National Academy of Sciences - National Research Council, Washington, D. C.

AERONAUTICS TECHNOLOGY POSSIBILITIES FOR 2000: REPORT OF A WORKSHOP

Oct. 1984 241 p refs Workshop held in Austin, Tex., Jan. 1984
(Contract NASW-3455)
(NASA-CR-174018; NAS 1.26:174018) Avail: NTIS HC A11/MF A01 CSCL 01B

The potential of aeronautical research and technology (R&T) development, which could provide the basis for facility planning and long range guidance of R&T programs and could establish justification for support of aeronautical research and technology was studied. The projections served specific purposes: (1) to provide a base for research and future facilities needed to support the projected technologies, and development advanced vehicles; (2) to provide insight on the possible state of the art in aeronautical technology by the year 2000 for civil and military planners of air vehicles and systems. Topics discussed include: aerodynamics; propulsion; structures; materials; guidance, navigation and control; computer and information technology; human factors; and systems integration. E.A.K.

N85-10002# Aeronautical Systems Div., Wright-Patterson AFB, Ohio. Directorate of Support Systems Engineering.

AERONAUTICAL SYSTEMS TECHNOLOGY NEEDS: ESCAPE, RESCUE AND SURVIVAL, TEST FACILITIES AND TEST EQUIPMENT AND TRAINING-SIMULATION EQUIPMENT Annual Report, Jan. 1983 - Jan. 1984

D. C. KITTINGER Apr. 1984 68 p
(AD-A145059; ASD/(ENE)-TR-84-5003; ASD-TR-5006) Avail: NTIS HC A04/MF A01 CSCL 01C

This report is part of a compilation of formalized Technology Needs (TNs) covering Support Systems as identified in the Aeronautical Systems Division. They are based on development/operational experience, systems studies, and new concepts -- all related to future system applications. Their presentation is to serve a threefold purpose: (1) guidance for technology programs, (2) prove developmental potential, and (3) engineering data/requirements essential for technology use in systems. The identified needs delineate progress desired in performance, control, design flexibility, safety and cost. GRA

N85-10907*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

FOREIGN CIVIL AVIATION COMPETITION: 1976 SUMMARY AND IMPLICATIONS

W. J. ALFORD, JR. (comp.) and D. V. MADDALON (comp.) 17 Jun. 1976 48 p
(NASA-TM-X-73907; NAS 1.15:X-73907) Avail: NTIS HC A03/MF A01 CSCL 01B

A summary assessment is made of foreign civil aviation as it relates to the posture of the United States civil aviation industry. Major findings include: (1) Main competitors - European Economic Community (EEC) and Union of Soviet Socialist Republics (USSR). (2) Largest commercial market - Transport aircraft. (3) Current market status and projections - U.S. currently dominates the civil aviation market but foreign markets show greater growth trends. (4) Competitive comparisons - Status comparisons are made in technology (aerodynamics, structures and materials, propulsion, avionics, systems, design coordination, and manufacturing); production runs; marketing; and postsales support. The U.S. generally leads except in aerodynamics and propulsion. (5) Multinational ventures - Joint U.S. industry/foreign government development of advanced technology engines is well developed; airframe industry discussions are now underway. (6) Implications - Although the U.S., is currently preeminent in most areas, this may be only a temporary condition. Past U.S. success in aviation has provided many benefits to the nation. These benefits may be lost. M.A.C.

N85-10908*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ACEE PROGRAM RATIONALE AND IMPLEMENTATION
W. S. AIKEN, JR. and R. H. PETERSEN Aug. 1982 34 p
Presented at the ACEE Project Oral Status Rev., Edwards AFB, Calif., 14 Sep. 1981
(NASA-TM-84549; NAS 1.15:84549) Avail: NTIS HC A03/MF A01 CSCL 01B

The impact of the Aircraft Energy Efficiency program (ACEE) on commercial aviation is examined. In addition to the emphasis on air transport fuel efficiency, topics such as airline operating costs, air transport effects on U.S. trade, and fuel price forecasts are addressed. An overview of the program and its contribution to aviation technology is included. M.A.C.

N85-10909*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FUEL EFFICIENCY THROUGH NEW AIRFRAME TECHNOLOGY
R. W. LEONARD Aug. 1982 155 p
(NASA-TM-84548; NAS 1.15:84548) Avail: NTIS HC A08/MF A01 CSCL 01B

In its Aircraft Energy Efficiency Program, NASA has expended approximately 200 million dollars toward development and application of advanced airframe technologies to United States's commercial transports. United States manufacturers have already been given a significant boost toward early application of advanced composite materials to control surface and empennage structures and toward selected applications of active controls and advanced aerodynamic concepts. In addition, significant progress in definition and development of innovative, but realistic systems for laminar flow control over the wings of future transports has already been made. Author

N85-10910*# General Dynamics Corp., Fort Worth, Tex.
AN ENGINE TRADE STUDY FOR A SUPERSONIC STOVL FIGHTER-ATTACK AIRCRAFT, VOLUME 1 Final Report, Jun. 1981 - Feb. 1982
B. B. BEARD and W. H. FOLEY Feb. 1982 74 p refs
(Contract NAS2-10981)
(NASA-CR-166304; NAS 1.26:166304) Avail: NTIS HC A04/MF A01 CSCL 01B

The best main engine for an advanced STOVL aircraft flight demonstrator was studied. The STOVL aircraft uses ejectors powered by engine bypass flow together with vectored core exhaust to achieve vertical thrust capability. Bypass flow and core flow are exhausted through separate nozzles during wingborne flight. Six near term turbofan engines were examined for suitability for this aircraft concept. Fan pressure ratio, thrust split between bypass and core flow, and total thrust level were used to compare engines. One of the six candidate engines was selected for the flight demonstrator configuration. Propulsion related to this aircraft concept was studied. A preliminary candidate for the aircraft reaction control system for hover attitude control was selected. A mathematical model of transfer of bypass thrust from ejectors to aft directed nozzle during the transition to wingborne flight was developed. An equation to predict ejector secondary air flow rate and ram drag is derived. Additional topics discussed include: nozzle area control, ejector to engine inlet reingestion, bypass/core thrust split variation, and gyroscopic behavior during hover. E.A.K.

02

AERODYNAMICS

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

A85-10111
PROPULSIVE EFFICIENCY OF VIBRATING BODIES IN A SUBSONIC GAS FLOW [O PROPUL'SIVNOM K.P.D. VIBRIRUIUSHCHIKH TEL V DOZVUKOVOM POTOKE GAZA]
M. N. KOGAN and M. V. USTINOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1984, p. 128-132. In Russian.

The theoretically maximal propulsive efficiency is determined for vibrating wings in a subsonic flow. A form is obtained which yields an efficiency arbitrarily close to the theoretical limit for axisymmetric bodies. L.M.

A85-10113
SUPERSONIC FLOW PAST A BLUNT WEDGE [O SVERKHZVUKOVOM OBTEKANII ZATUPLENNOGO KLINA]
S. V. MANUILOVICH Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1984, p. 137-140. In Russian. refs

An asymptotic solution to the problem of uniform supersonic ideal-gas flow past a blunt wedge is considered. The method of separation of variables is used to show that, at large distances from the blunt part, the damping of flow disturbances takes place according to a power law. The exponent for the higher correction term in the shock-front expansion is determined in the case of subsonic flow behind the shock. L.M.

A85-10114
METHOD FOR CALCULATING SEPARATED SUBSONIC GAS FLOW PAST WINGS [METOD RASCHETA OTRYVNOGO OBTEKANIIA KRYL'EV DOZVUKOVYM POTOKOM GAZA]
S. M. BELOTSERKOVSKII, V. N. KORZHNEV, and S. D. SHIPILOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1984, p. 141-147. In Russian. refs

Attention is given to the steady nonlinear problem involving the subsonic flow of a compressible gas past a wing of arbitrary planform. A numerical method is developed for solving the problem which is an extension of the method of discrete vortices. The surface of the body and the vortex wake of the body are modeled by a system of discrete vortex segments, but (in contrast to the case of an incompressible fluid) the sources must be distributed outside the wing. The circulations of the attached vortices, the source intensity, and the form of the wake are determined iteratively. The separated flow past a delta wing is considered as an example. L.M.

A85-10116
FLOW STABILITY IN THE WAKE OF A THREE-DIMENSIONAL BODY [OB USTOICHIVOSTI TECHENIIA V SLEDE ZA PROSTRANSTVENNYM TELOM]
A. V. KASHKO Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1984, p. 155-158. In Russian. refs

The paper examines the problem of the effect of a small disruption of the axial symmetry of the flow in the wake of a three-dimensional body on the stability of this flow. Such variations occur, for example, in the wake of a circular cone which is at angle of attack to the oncoming flow. The problem is solved by the small-parameter method using an inviscid incompressible fluid model. The effect of disruptions of axial symmetry on the flow stability is shown to be significant. L.M.

A85-10117

HIGHER APPROXIMATIONS IN THE TRANSONIC EXPANSION OF THE SOLUTION TO THE CHAPLYGIN EQUATION [VYSSHIE PRIBLIZHENIIA V TRANSZVUKOVOM RAZLOZHENII RESHENIIA URAVNENIIA CHAPLYGINA]

I. A. CHERNOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1984, p. 169-171. In Russian. refs

A generalized procedure is developed for arriving at higher approximations in the transonic expansion of the solution to the Chaplygin equation. The generalization consists in the direct investigation of a system of partial differential equations and the representation of partial solutions for an arbitrary approximation through the principal solution of the initial approximation. This result can be treated as the construction of a certain operator of transition from the solution of the Tricomi equation to the solution of the Chaplygin equation. L.M.

A85-10321#

EXPERIMENTAL AERODYNAMICS AT HIGH SPEEDS [AERODYNAMIKA DOSWIADCZALNA W ZAKRESIE DUZYCH PREDKOSCI]

W. KANIA (Instytut Lotnictwa, Warsaw, Poland) Mechanika Teoretyczna i Stosowana (ISSN 0079-3701), vol. 21, no. 4, 1983, p. 611-644. In Polish. refs

Current trends of high-speed aerodynamic research in Poland are reviewed. The status of high-speed wind-tunnel technology is examined with attention given to wall interference effects, automated measurements, flow visualization, and the development of transonic tunnels. Consideration is then given to modeling techniques; subsonic and transonic flow past airfoils, flow past classical (NACA) profiles at high speeds, and the effects of pressure on the aerodynamic characteristics are evaluated. The testing of helicopter propeller blades and rocket components is also discussed along with the development of supersonic wind tunnel technology. B.J.

A85-10322#

EXPERIMENTAL RESEARCH IN POLAND ON TURBULENCE AND HIGH-SPEED AERODYNAMICS [OCENA KRAJOWYCH BADAN DOSWIADCZALNYCH Z ZAKRESU TURBULENCJI ORAZ AERODYNAMIKI DUZYCH PREDKOSCI]

J. S. OSTROWSKI (Warszawa, Politechnika, Warsaw, Poland) Mechanika Teoretyczna i Stosowana (ISSN 0079-3701), vol. 21, no. 4, 1983, p. 645-654. In Polish. refs

A85-10352* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

GENERATION OF INSTABILITY WAVES IN FLOWS SEPARATING FROM SMOOTH SURFACES

M. E. GOLDSTEIN (NASA, Lewis Research Center, Cleveland, OH) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 145, Aug. 1984, p. 71-94. refs

This paper analyses the coupling between an imposed disturbance and an instability wave that propagates downstream on a shear layer which emanates from a separation point on a smooth surface. Since the wavelengths of the most-amplified instability waves will generally be small compared with the streamwise body dimensions, the analysis is restricted to this 'high-frequency' limit and the solution is obtained by using matched asymptotic expansions. An 'inner' solution, valid near the separation point, is matched onto an outer solution, which represents an instability wave on a slowly diverging mean flow. The analysis relates the amplitude of this instability to that of the imposed disturbance. Author

A85-10357* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

RESONANCE IN FLOWS WITH VORTEX SHEETS AND EDGES

P. A. DURBIN (NASA, Lewis Research Center, Cleveland, OH) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 145, Aug. 1984, p. 275-285. refs

It is shown that the vortex sheet in a slot between two semi-infinite plates does not admit incompressible resonant perturbations. The semi-infinite vortex sheet entering a duct does admit incompressible resonance. These results indicate that the vortex-sheet approximation is less useful for impinging shear flows than for non-impinging flows. They also suggest an important role of downstream vortical disturbances in resonant flows. The general solution for perturbations to flow with a vortex sheet and edges is written in terms of a Cauchy integral. Requirements on the behavior of this solution at edges and at downstream infinity fix the criteria for resonance. Author

A85-10413#

THE CONDITIONS OF PHYSICAL VALIDITY FOR A SUPERSONIC FLOW AROUND A CONICAL OBSTACLE WITH A SMALL APERTURE [SUR LES CONDITIONS DE VALIDITE PHYSIQUE EN ECOULEMENT SUPERSONIQUE AUTOUR D'UN OBSTACLE CONIQUE DE FAIBLE OUVERTURE]

T. D. AN (Bucuresti, Universitatea, Bucharest, Rumania) Revue Roumaine de Mathematiques Pures et Appliquees (ISSN 0035-3965), vol. 29, no. 4, 1984, p. 291-299. In French.

A linear aerodynamics approach is used to study supersonic flows around a conical object with a small opening, and validity conditions are defined for the obstacle profiles. A conformal representation is defined for the velocity profiles, and expressions are derived for the pressure profiles and the perturbation velocity. Validity criteria are established for the half-thickness and half-length of the airfoil in the presence of positive pressure, a Mach cone, and supersonic flow. The validity conditions are extended to different half-thicknesses and angles of attack. The results of numerical simulations of the flows are provided to illustrate the effects of the pressure ratios and the Mach number. M.S.K.

A85-10465

SUPERSONIC FLOW OVER A CONE WITH POWER-LAW INJECTION THROUGH THE CONE SURFACE [NADZVUKOVE OBTIKANNIA KONUSA PRI STEPENEVOMU ZAKONI VDUVU GAZU KRIZ' IOGO POVERKHNIU]

A. M. ANTONOV and V. O. ZAKREVSKII (Kiivs'kii Institut Inzheneriv Tsivil'noi Aviatsii, Kiev, Ukrainian SSR) Akademiia Nauk Ukrains'koi RSR, Dopovidi, Seriia A Fiziko-Matematichni ta Tekhnichni Nauki (ISSN 0002-3531), Aug. 1984, p. 31-35. In Ukrainian. refs

Supersonic flow over a slender axisymmetric cone is investigated for the case of intense injection of a gas through the side surface of the cone. The analysis presented here is based on a model consisting of an internal nonviscous layer separated from external flow by a contact discontinuity surface. For power-law distribution of the injected gas, problems associated with disturbance propagation upstream of the bottom section are examined. An intermediate region is considered, and a solution is obtained which yields the initial conditions for the bottom region and information on the type of solution for the main region. The pressure coefficient distribution along the generatrix of the cone and the position of the contact surface are determined numerically for various injection and incoming flow parameters. V.L.

A85-10540

CHOKING PHENOMENA IN MULTIFLOW NOZZLES WITH AND WITHOUT VISCOSITY EFFECTS [SUR LES PHENOMENES DE BLOCAGE DANS LES TUYERES MULTI-FLUX AVEC OU SANS EFFET DE VISCOSITE]

E. FAGE, R. MARCHAL, and P. SERVANTY L'Aeronautique et l'Astronautique (ISSN 0001-9275), no. 105, 1984, p. 54-62. In French. refs

Subsonic choking upstream of the sonic throat of a biflow nozzle is investigated analytically and experimentally. The results of experiments and theoretical models for nonviscous fluids are summarized, and it is shown that the experimental observations of Paulon and Perucchini (1981-1983) can be explained by the three-dimensional nonviscous model of Fage (1976). Significant viscosity effects are postulated on the basis of the simplified one-dimensional analysis of Fage et al. (1974) and verified using a 50-cu m vacuum chamber and a cylindrical nozzle of diameter 24.3 mm and length 170-500 mm. Graphs and drawings are provided, and the advantage of using one basic theoretical model for all interactions between the coflowing streams is stressed. T.K.

A85-10546
THE FORWARD SWEPT WING AND THE GRUMMAN X-29A [L'AILE EN FLECHE INVERSE ET LE GRUMMAN X 29A]
L. ROSENTHAL (Centre de Documentation de l'Armement, Paris, France) *L'Aeronautique et l'Astronautique* (ISSN 0001-9275), no. 106, 1984, p. 35-55. In French. refs

Analyses of the aerodynamics of forward swept wing (FSW) aircraft are presented and implementation of the concept on the X-29A is discussed. FSW offers high lift and increased speed at the cost of unstable flight. Previous aeroelastic problems requiring a more rigid, and thus heavier, construction may be eliminated by the extensive use of composites such as those installed on the X-29A. The addition of canards eliminates the onset of flow separation near the root of FSW, which otherwise suffers a severe lift decrement. Wind tunnel tests have confirmed the lift increases induced on the FSW by canards. The X-29A has graphite-epoxy wings and an F404-GE-400 engine and is predicted to be 32 percent unstable in pitch. The negative stability margin will be under computerized supervision and will increase the maneuverability of the aircraft. M.S.K.

A85-10831*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AIRFOIL TRAILING EDGE FLOW MEASUREMENTS AND COMPARISON WITH THEORY, INCORPORATING OPEN WIND TUNNEL CORRECTIONS
T. F. BROOKS, M. A. MARCOLINI (NASA, Langley Research Center, Hampton, VA), and D. S. POPE (Kinetron International, Inc., Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 13 p. refs
(AIAA PAPER 84-2266)

Trailing edge data for boundary layer-near wake thickness parameters are given for airfoils and flat plates. Reynolds number effects are examined as a function of model size, velocity and boundary layer tripping. These data expand that presented previously by the authors particularly for airfoil non-zero angles of attack. Comparisons are made here with boundary layer calculations using potential flow modeling and a well documented two-dimensional finite-difference method for laminar and turbulent boundary layers. Open wind tunnel corrections to angle of attack and camber are developed and are incorporated in the potential flow modeling to assure correct comparisons for non-zero angles of attack. It was found that although the open tunnel flow turbulence affected boundary layer transition for the higher velocities the theory successfully 'brackets' the data. Comparisons demonstrate the degree of accuracy one might expect for the prediction of boundary layer thickness parameters when given only geometry and nominal flow conditions as input to boundary layer codes. Author

A85-10852#
PASSIVE CONTROL OF JETS WITH INDETERMINATE ORIGINS
R. W. WLEZIEN and V. KIBENS (McDonnell Douglas Research Laboratories, St. Louis, MO) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs
(Contract F49620-83-C-0048)
(AIAA PAPER 84-2299)

Control of the development of initially circular jets using inclined and stepped exit geometries is described. The nozzle shape is shown to produce significant modification of the mean flowfield for cases where the shear layer is thick relative to the nozzle diameter. Local enhancement and suppression of shear-layer growth are observed for certain conditions. Augmentation of shear-layer growth results from self-excitation; flow perturbations induced by the shear-layer sectors which develop over the longest run length excite the instabilities in other portions of the layer. The dominant shear-layer scales are determined by the local distance from the nozzle lip, and control is achieved by modifying the azimuthal distribution of energy in the shear-layer instability modes. Author

A85-10857#
UNSTEADY LOADING OF LEADING-EDGES IN UNSTABLE FLOWS - AN OVERVIEW
D. ROCKWELL (Lehigh University, Bethlehem, PA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 10 p. refs
(AIAA PAPER 84-2306)

This overview assesses some recent advances in the area of coherent velocity field-leading edge interactions for various types of unsteadiness incident upon the edge: distributed vorticity; single concentrations of vorticity; multiple concentrations of vorticity; and concentrated streamwise vorticity. Common to nearly all of these types of interactions is generation of secondary concentrations of vorticity. The manner in which they are generated, relative to the incident primary vorticity, is central to determining the character of the unsteady pressure field in the leading-edge interaction region. Author

A85-10858*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
TWO DIMENSIONAL BLADE-VORTEX INTERACTION FLOW VISUALIZATION STUDY
E. R. BOOTH, JR. and J. C. YU (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs
(AIAA PAPER 84-2307)

Blade-vortex interaction occurs when a rotor blade encounters the tip vortex from a previous rotor blade. To obtain details of the close encounter process, the results from a flow visualization study of an airfoil representing a rotor blade in the wake of an oscillating airfoil serving as a vortex generator are described. A distinguishing feature of this study is that the vortex filament is oriented parallel to the blade span, orthogonal to the test section free stream velocity. This orientation simulates the case of two-dimensional blade-vortex interaction, which is known to produce the most impulsive and most intensive BVI noise. Photographic data are examined to deduce qualitative and quantitative details of the close encounter interaction process with emphasis on structural changes in the vortex filament and its trajectory. Author

A85-10870*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ACOUSTIC PRESSURES EMANATING FROM A TURBOMACHINE STAGE
S. M. RAMACHANDRA (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 13 p. Previously announced in STAR as N84-30224. refs
(AIAA PAPER 84-2325)

A knowledge of the acoustic energy emission of each blade row of a turbomachine is useful for estimating the overall noise level of the machine and for determining its discrete frequency noise content. Because of the close spacing between the rotor and stator of a compressor stage, the strong aerodynamic interactions between them have to be included in obtaining the resultant flow field. This paper outlines a three-dimensional theory for determining the discrete frequency noise content of an axial compressor consisting of a rotor and a stator each with a finite number of blades. The lifting surface theory and the linearized equation of an ideal, nonsteady compressible fluid motion are used for thin blades of arbitrary cross section. The combined pressure field at a point of the fluid is constructed by linear addition of the rotor and stator solutions together with an interference factor obtained by matching them for net zero vorticity behind the stage. Author

A85-10970#

PRESSURE DISTRIBUTIONS AROUND AN AIRFOIL PLACED IN A PERIODICALLY FLUCTUATING AIR FLOW. I - A FLAT PLATE APPROXIMATION

H. YOSHIKI, N. TAKAMA (Tokyo, University, Tokyo, Japan), N. KAMIKAWA (Komatsu, Ltd., Hirakata, Osaka, Japan), and Y. TSUTSUI (Agency of Industrial Science and Technology, Mechanical Engineering Laboratory, Sakura, Ibaraki, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 27, Aug. 1984, p. 1592-1597. refs

The pressure distributions around an airfoil placed in a uniform air flow with a sinusoidally fluctuating velocity have been calculated using the flat plate approximation method and measured for a test airfoil. It is found that the distribution of pressure amplitudes is well predicted by the flat plate theory. However, the time-averaged pressure and the phase difference between pressure and velocity waves are not predicted as accurately because the airfoil thickness is not taken into account. V.L.

A85-11625*# High Technology Corp., Hampton, Va.

INSTABILITY AND TRANSITION IN SUPERSONIC BOUNDARY LAYERS

M. R. MALIK (High Technology Corp., Hampton, VA) IN: Laminar turbulent boundary layers; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1984, p. 139-147. refs

(Contract NAS1-16916)

Recently obtained flight transition data for a 5-deg half-angle cone at Mach numbers of 1.2, 1.35, 1.6, and 1.92, together with 'quiet' tunnel data at Mach 3.5, are analyzed by linear compressible stability theory. The results obtained indicate that the exponent N ranges in value between 9 and 11, which is in keeping with values previously determined for subsonic flows. Computations show that the transition in both the flight and quiet wind tunnel experiments was due to oblique first-mode disturbances. O.C.

A85-11632#

THE RULE OF FORBIDDEN SIGNALS AND APPARENT MACH NUMBER IN TRANSONIC COMPRESSOR CASCADES

D. C. PRINCE, JR. (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) IN: Computation of internal flows: Methods and applications; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1983, p. 11-22. Research supported by the General Electric Co. refs

Operational characteristics common to a large number of experimentally studied supersonic compressors are identified, and it is noted on the basis of overall flow characteristics and suction surface leading edge behavior that the 'rule of forbidden signals' is relevant to these phenomena as a fundamental principle. The rule is usually circumvented over most of the compressor blades' pressure surfaces. The circumstances associated with this circumvention, as well as those surrounding the appearance and disappearance of secondary shocks, further suggest the relevance of the reduced 'apparent Mach number' concept. The two-dimensional Method of Characteristics is found to be a useful tool in analyses of experimental observations, given sufficient allowance for a third dimension's influence on streamtube cross section area. O.C.

A85-11633#

ANALYSIS OF THE FLOW FIELD IN AN ENGINE INLET PARTICLE SEPARATOR

C. F. SHIEH, R. A. DELANEY, and D. L. TIPTON (General Motors Corp., Indianapolis, IN) IN: Computation of internal flows: Methods and applications; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1983, p. 23-28. refs

An inviscid rotational flow model was developed to predict the flow in an integral particle separator. This model was constructed with a stream function formulation for arbitrary coordinate systems. A numerical technique which combines two types of body-fitted grid systems has been used to improve the accuracy of the numerical predictions. The model includes an intrablade row analysis for application to swirl type separators. Excellent correlation has been achieved between analytical results and experimental data. Author

A85-11643#

PERIODIC INTERNAL FLOWS

J. E. MCCUNE and T. Q. DANG (MIT, Cambridge, MA) IN: Computation of internal flows: Methods and applications; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1983, p. 123-128. refs

(Contract F49620-82-K-0002)

This paper presents a mathematical technique useful in describing internal flow problems with gas turbine applications. The technique involves expanding a given flow variable, or part of it, in a series of periodic generalized functions. Via this 'smoothing' expansion technique, the highly nonlinear and singular nature of the flow field can be determined efficiently and accurately. As an illustration, an application of the technique for the design problem for a highly loaded cascade of infinitely thin blades in the two-dimensional limit is briefly described. Author

A85-11644#

DESIGN METHOD FOR HIGHLY-LOADED BLADES WITH BLOCKAGE IN CASCADE

T. Q. DANG and J. E. MCCUNE (MIT, Cambridge, MA) IN: Computation of internal flows: Methods and applications; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1983, p. 129-136. refs

(Contract F49620-82-K-0002)

This paper presents a practical application of a newly-developed three-dimensional design technique applied previously to the case of 'infinitely thin' blades. In the present study, the flow is assumed to be two-dimensional, incompressible and inviscid. The upstream inlet flow condition is taken to be uniform, and the blades have finite thickness. The overall flow deflection, the schedule of the gap-averaged tangential velocity, and the blockage (or thickness) distribution are prescribed at all points within the blade row. The blade profile is determined iteratively through the blade boundary conditions. A practical numerical code is presented to study the effects of blockage. The program gives very rapidly convergent solutions with satisfactory accuracy for practical solidity range. Author

A85-11646*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYTICAL STUDY OF BLOWING BOUNDARY LAYER CONTROL FOR SUBSONIC V/STOL INLETS

D. P. HWANG (NASA, Lewis Research Center, Cleveland, OH) IN: Computation of internal flows; Methods and applications; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1983, p. 151-157. refs

The analytical methods used to study blowing boundary-layer control (BLC) for subsonic V/STOL inlets at the NASA Lewis Research Center are briefly described. The methods are then shown to give good agreement with experimental results, both with and without blowing BLC. Finally, because of this good agreement, the methods have been used to determine analytically the optimum (minimum blowing power required) location and height for a blowing slot within a subsonic V/STOL inlet. Results of this analytical study are presented. Author

A85-11840

AERODYNAMIC IMPROVEMENT OF THE REDUCER OF A GAS TURBINE [AERODINAMICHESKOE SOVERSHENSTVOVANIE PEREKHODNOGO PATRUBKA GAZOVOI TURBINY]

I. G. GOGOLEV, R. V. KUZMICHEV, A. M. DROKONOV, I. D. ZAIKIN, and A. A. KOCHEGAROV (Brianskii Institut Transportnogo Mashinostroeniia, Briansk, USSR) Energetika (ISSN 0579-2983), Sept. 1984, p. 81-87. In Russian.

The general design of the reducer of split-shaft gas turbines is briefly examined, and design features are suggested which improve the aerodynamics of the reducer. It is shown that a further aerodynamic refinement of the reducer can be achieved through boundary layer control on the surfaces of the reducer channel. In particular, attention is given to boundary layer control with recirculation from the high-pressure zone to the low-pressure zone and automatic boundary layer control with injection. Experimental data are presented for two reducer models. V.L.

A85-11976#

INDUCED DRAG AND LIFT OF WING BY THE PIECEWISE CONTINUOUS KERNEL FUNCTION METHOD

I. LOTTATI (Technion - Israel Institute of Technology, Haifa, Israel) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 883, 834. refs

A piecewise version of the continuous kernel function method (PCKFM) was used to calculate the induced drag on three-dimensional wings in subsonic flow. The method is used to calculate the induced drag and lift of a large number of wings, and the results are found to be in good agreement with values obtained with other methods. The PCKFM is applied to a comparison of the drag and lift coefficients characteristic of nontwisted planar forward and swept front and back wings in the equivalent M- or W-type configuration. It is found that the spanwise distribution of load and the induced drag are influenced by the seep angle of the lifting surface. The spanwise pressure distribution of the M-type wing offers advantages for improving the configuration performance characteristics. I.H.

A85-11977#

EULER EQUATION SIMULATION OF PROPELLER-WING INTERACTION IN TRANSONIC FLOW

D. L. WHITFIELD (Mississippi State University, Mississippi State, MS) and A. JAMESON (Princeton University, Princeton, NJ) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 835-839. Previously cited in issue 05, p. 582, Accession no. A83-16603. refs

A85-11980#

COMPUTATION OF VORTEX FLOW AROUND A CANARD/DELTA COMBINATION

L.-E. ERIKSSON and A. RIZZI (Flygtekniska Forsoksanstalten, Bromma, Sweden) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 858-865. Research supported by the Forsvaret Materielverk. refs

The inviscid compressible and rotational flow around an isolated 55-deg swept sharp-edged delta wing, and around that same wing closely coupled with a canard, is computed at transonic speeds by using meshes of O-O type around the main wing, constructed by transfinite interpolation, and by using a time-marching finite-volume procedure to obtain steady-state solutions to the Euler equations. The canard is represented as a slit in the mesh. Results of these computations, performed on a CYBER 205 vector processor, show that the flow model predicts leading-edge vortex separation on the main wing, and in the wing-alone case the overall flow agrees qualitatively with that deduced from oil flow pictures for a similar wing. In the canard/delta case, the deflection of the flow due to the canard is verified by velocity vector plots, and the influence on the wing pressure distribution is found to be realistic. Cross-flow velocity plots show that the canard creates a vortex of its own which interacts with the flow over the main wing. Author

A85-11982*# Grumman Aerospace Corp., Bethpage, N.Y.

COMPUTATIONAL TRANSONIC ANALYSIS OF CANTED WINGLETS

B. S. ROSEN (Grumman Aerospace Corp., Bethpage, NY) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 873-878. Previously cited in issue 06, p. 708, Accession no. A84-18009. refs

(Contract NAS1-14732)

A85-11989#

A METHOD FOR DESIGNING THREE-DIMENSIONAL CONFIGURATIONS WITH PRESCRIBED SKIN FRICTION

S. G. LEKOUDIS, N. L. SANKAR, and S. F. RADWAN (Georgia Institute of Technology, Atlanta, GA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 924-926. Research supported by the Lockheed-Georgia Co. Previously cited in issue 06, p. 716, Accession no. A84-19257. refs

A85-11990#

COMMENT ON 'PAN AIR APPLICATIONS TO AERO-PROPULSION INTEGRATION'

W. C. CHIN (Applied AeroNalysis, Houston, TX) Journal of Aicraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 927; Authors' Reply, p. 927. refs

A85-12034

SIMPLIFIED TRANSONIC INTEGRAL EQUATIONS FOR LIFTING PROFILES AND WINGS

P. NIYOGI (Indian Institute of Technology, Kharagpur, India) Acta Mechanica (ISSN 0001-5970), vol. 53, Sept. 1984, p. 27-36. refs

The steady inviscid transonic flow past a thin cambered profile at low incidence is investigated analytically. The small-perturbation integral equations as formulated by Nixon and Hancock (1974) and Nixon and Patel (1975) are reduced to expressions containing only one-dimensional singular integral (eliminating the two-dimensional camber integrals) by Oswatitsch principal-value definition, substituting velocity-field distributions assumed on the basis of the distribution on the profile axis. Analogously reduced forms of the equations for the three-dimensional case, a thin lifting wing, are included. T.K.

A85-12035

INTERACTION BETWEEN A WEAK OBLIQUE SHOCK WAVE AND A TURBULENT BOUNDARY LAYER IN PURELY SUPERSONIC FLOW

A. KLUWICK and N. STROSS (Wien, Technische Universitaet, Vienna, Austria) Acta Mechanica (ISSN 0001-5970), vol. 53, Sept. 1984, p. 37-56. refs

The paper deals with the interaction of a weak oblique shock and a turbulent boundary layer at a flat plate at purely supersonic speeds. Except for a small region where nonlinear transonic effects are of importance analytical expressions for the pressure- and skin friction distributions are derived. Author

A85-12151* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

METRIC-DISCONTINUOUS ZONAL GRID CALCULATIONS USING THE OSHER SCHEME

M. M. RAI (NASA, Ames Research Center, Moffett Field; Informatics General Corp., Palo Alto, CA), K. A. HESSENIUS (NASA, Ames Research Center, Moffett Field, CA), and S. R. CHAKRAVARTHY (Stanford University, Palo Alto, CA) Computers and Fluids (ISSN 0045-7930), vol. 12, no. 3, 1984, p. 161-175. refs

Computations on zonal grids - in particular, grids with metric discontinuities resulting from the interspersion of highly clustered regions with coarse regions - are possible using a fully conservative form of the Osher upwind scheme. These zonal grids can result from an abrupt clustering of points near solution discontinuities or near other flow features that require improved resolution. The zonal approach is shown to capture shocks with almost 'shock-fitting' quality but with minimal effort. Results for inviscid flow, including quasi-one-dimensional nozzle flow, supersonic flow over a cylinder, and blast-wave diffraction by a ramp, are presented. These calculations demonstrate the powerful capabilities of the Osher scheme used in conjunction with zonal grids in simulating flow fields with complex shock patterns. Author

A85-12355#
A KERNEL FUNCTION METHOD FOR COMPUTING UNSTEADY LOAD ON THREE-DIMENSIONAL WINGS IN TRANSONIC FLOW
Y. WU (Nanjing Aeronautical Institute, Nanjing, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 140-148. In Chinese, with abstract in English. refs

A kernel function method based on linearized lifting surface theory is applied to the computation of unsteady load on three-dimensional wings, and the results are presented. Local linearization is used to treat the unsteady transonic flow about the wings. A line doublet which represents the additional lift induced by shock movement is adopted to simulate the presence of a normal shock, and the appropriate shock boundary conditions are embedded. A new method for treating subsonic chordwise integration is introduced, greatly simplifying the numerical integration. Procedures for calculating downwashes in the subsonic and supersonic regions are included. Numerical examples are given whose results area in good agreement with experimental results. C.D.

A85-12603#
FINITE ELEMENT CALCULATION OF POTENTIAL FLOW AROUND WINGS
M. BREDIF (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (Congres International des Methodes Numeriques en Mecanique des Fluides, 9th, Gif-sur-Yvette, Essonne, France, June 25-29, 1984) ONERA, TP, no. 1984-68, 1984, 7 p. refs
(ONERA, TP NO. 1984-68)

Three-dimensional potential flow around aircraft wings is modeled with a finite element, multigrid algorithm. The grid is generated algebraically in terms of spanwise planes equally spaced on the wing, dispersed in a geometric progression, and each having six subdomains. Curved lines represent leading and trailing edges. Smoothing routines reduce irregularities between subdomains. An H-mesh is produced with no degenerate elements or singular lines. Sample results are provided for subcritical and supercritical flow around an ONERA M6 wing. The code is capable of generating a mesh with over 80,000 nodes in 2 sec on a Cray 1-S computer. M.S.K.

A85-12610#
EXPERIMENTAL INVESTIGATION OF THE SWEEP EFFECTS ON A HELICOPTER BLADE TIP
R. IMBERT and J. J. THIBERT (European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984) ONERA, TP, no. 1984-81, 1984, 21 p. refs
(ONERA, TP NO. 1984-81)

Flow data were taken at half-wing helicopter blade tips at three positions and compared with predictions generated with an ONERA transonic flow code. A rectangular blade had an aspect ratio of 3, an inboard OA 209 profile and an OA 207 tip section. The eight sections of the wing span were fitted with 392 pressure taps. Data were also gathered on stress using a wall balance. The measurements were taken at +30, 0, and -30 deg, corresponding to forward flight, hover, and maneuvering conditions, respectively, with the angle of attack and Mach numbers varied accordingly. Three-dimensional effects were small in sweep. A strong flow asymmetry appeared in positive and negative sweep in the transonic regime. The supersonic zones were extended, and overspeeds and the shock intensity increased (forward sweep). The model, based on either the full potential equation or a small disturbances equation, accurately predicted the flow data. Additional viscosity calculations are also provided. M.S.K.

A85-12611#
STUDY OF THE UNSTEADY TRANSONIC FLOW ON ROTOR BLADE WITH DIFFERENT TIP SHAPES
A. DESOPPER (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984) ONERA, TP, no. 1984-82, 1984, 21 p. refs
(ONERA, TP NO. 1984-82)

An unsteady transonic small perturbations approach was used to model the flows around an advancing helicopter blade in the transonic regime. Various tip shapes were considered in lifting and nonlifting computation, the latter covering a rectangular blade and four tip configurations. A combination of sweep and anhedral tips was indicated as a means to decreasing the transonic flow intensity. Experimental data taken around the modeled tips validated the calculations, thereby commending their use as tools for designing blade tips for fast forward flight. M.S.K.

A85-12612#
THEORETICAL STUDY OF TWO DIMENSIONAL STALL IN AN INCOMPRESSIBLE FLOW
J. J. COSTES (European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984) ONERA, TP, no. 1984-83, 1984, 20 p. refs
(ONERA, TP NO. 1984-83)

Flow potentials are calculated in a numerical model for the aerodynamics of the unsteady stall occurring around a retreating helicopter blade. A steady, inviscid flow is assumed and equations of conservation of mass and momentum are defined to link acceleration to the pressure gradient. Green's function is used to model the two-dimensional source and doublet kernels and boundary conditions. A discretization is then performed for the flowfield around a circular cylinder, where the potential can be extracted at any point. Applications are illustrated for flowfields without circulation, and steady and unsteady flows around an airfoil without separation. Attention is also given to unsteady equations for free shear layers and the variation of the position of the separation on the profile upper surface. Experimental data with an oscillating airfoil indicate that accurate lift projections are achievable if an unsteady condition is defined for the separation point. M.S.K.

A85-12613#
FLIGHT TESTS OF A SWEPTBACK PARABOLIC TIP ON A DAUPHIN 365N
F. GUILLET (SocieteNationale Industrielle Aerospatiale, Paris, France) and J. J. PHILIPPE (European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984) ONERA, TP, no. 1984-84, 1984, 19 p. refs
(ONERA, TP NO. 1984-84)

Tests and computational results obtained with a prototype sweptback parabolic tip (SPT) blade for helicopters are outlined. ONERA examined the SPT concept as a potential means of reducing shock waves emitted by advancing blades, and thereby lessening noise pollution. The SPT blade had a reduced chord in the inboard section, a 30 deg swept angle on the leading edge, a parabolic line on the last 0.35 chord, and a global chord taper of 0.5. A numerical model involving the low frequency transonic small disturbance equations indicated that supersonic flow would be reduced by the blades. Data were taken in a wind tunnel and during hover and level flight tests. Noise reductions of 1.25 EPN (dB) were measured, indicating a better aerodynamic flow around the SPT blades. The blades placed greater loads on the servo-control units and experienced higher torsional forces than normal blades. However, the blades reduced the required power levels in level flight by 1-6 percent. M.S.K.

A85-12620#
IMPROVEMENT AND EXTENSION OF A COMPUTATIONAL METHOD FOR THREE-DIMENSIONAL TRANSONIC FLOWS [AMELIORATION ET EXTENSION D'UNE METHODE DE CALCUL D'ECOULEMENTS TRANSSONIQUES TRIDIMENSIONNELS]
P. MULAK and J.-J. ANGELINI (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Specialists Meeting on Transonic Unsteady Aerodynamics and its Aeroelastic Applications, Toulouse, France, Sept. 3-5, 1984) ONERA, TP, no. 1984-99, 1984, 13 p. In French. refs
(ONERA, TP NO. 1984-99)
An analytical model is defined for three-dimensional transonic flows over airfoils. The model is based on the equations for small, unsteady transonic perturbations. A functional approach based on a Taylor expansion is used to establish the limiting conditions. A shear transformation is employed to map the Cartesian grids generated onto a wing planform and a new continuity equation is obtained. Applications are illustrated in terms of a half-span supercritical wing with 30 deg sweep and a short wing with a 47.5 deg sweep. Pressure data available for both wings from the S1 Modane wind tunnel were well-matched by the model predictions, including those for the position of the shocks. M.S.K.

A85-12621#
CALCULATION OF UNSTEADY TRANSONIC SEPARATED FLOWS BY VISCOUS-INVISCID INTERACTION [CALCUL D'ECOULEMENTS INSTATIONNAIRES TRANSSONIQUES AVEC DECOLLEMENTS PAR INTERACTION VISQUEUX-NON VISQUEUX]
P. GIRODROUX-LAVIGNE and J. C. LE BALLEUR (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Specialists Meeting on Transonic Unsteady Aerodynamics and its Aeroelastic Applications, Toulouse, France, Sept. 3-5, 1984) ONERA, TP, no. 1984-100, 1984, 19 p. In French. refs
(ONERA, TP NO. 1984-100)
A technique based on viscid-inviscid flow interaction is used to describe separated and unseparated unsteady transonic flows over airfoils. A semi-implicit and time-consistent numerical formulation with semi-implicit relaxation provides strong coupling, and a local mesh clustering expresses the shock wave-boundary layer interaction. Direct and inverse mode solutions are defined for the boundary layer and wake defect integrals. The integral equations are closed by using instantaneous boundary layer profiles and defining a set of transport equations for turbulence. A small perturbation equation accounts for the inviscid flow. Sample results are calculated for flows over a NLG 7301 airfoil, a NACA 64 A 010 airfoil with shock-induced separation, and an oscillating RA 16 SC1 airfoil with a spoiler. M.S.K.

A85-12624
AN INTRODUCTION TO THEORETICAL AND COMPUTATIONAL AERODYNAMICS
J. MORAN (Minnesota, University, Minneapolis, MN) New York, John Wiley and Sons, 1984, 476 p. refs
An introduction to theoretical and computational dynamics is presented which integrates both classical and modern developments and focuses on applying the discussed methods to actual wing design. The properties of wings and airfoils in incompressible and primarily inviscid flow are examined, including a review of basic fluid mechanics. Viscous flows are considered, including both the Navier-Stokes equation and the boundary layer. Computational methods are emphasized. Computational aerodynamics is addressed, including panel methods and finite difference methods. The computation of transonic flows past thin airfoils is examined. Standard FORTRAN IV programs reinforce the textural material throughout. C.D.

N85-10003# Weapons Systems Research Lab., Salisbury (Australia).
WIND TUNNEL TESTS ON A TUBE-LAUNCHED MISSILE CONFIGURATION WITH A DEFLECTABLE NOSE CONTROL AND A NOVEL WRAP-AROUND FIN STABILISER
K. D. THOMSON Aug. 1983 35 p refs
(AR-003-696; WSRL-0327-TR) Avail: NTIS HC A03/MF A01
The Mach number range 0.80 to 2.00 on a tube launched missile configuration with a deflectable nose control and a wrap around fin stabilizer with six fans disposed in a symmetrical triform arrangement were examined. It is shown that the control effectiveness increases markedly with Mach number. Trim curves are nonlinear at subsonic speeds and approach linearity at supersonic Mach numbers. A missile configuration indicates that the nose control is powerful enough to provide a terminal control capability. In subsonic flight the missile must fly on a near ballistic trajectory. In supersonic flight the control is powerful enough to permit horizontal flight above M = 1.5 while retaining a sufficient reserve to provide a terminal correction capability. E.A.K.

N85-10004# National Aeronautical Establishment, Ottawa (Ontario). High Speed Aerodynamics Lab.
AN EXPERIMENTAL STUDY OF THE TRANSONIC EQUIVALENCE RULE WITH LIFT, PART 2
Y. Y. CHAN Mar. 1984 45 p refs Previously announced as N82-33350
(AR-LR-614-PT-2; NRC-23412-PT-2) Avail: NTIS HC A03/MF A01
The transonic equivalence rule with lift has been studied experimentally. Under the conditions defined by the rule, wing-body models with the same cross-sectional area distribution but with wings of different aspect ratios and thicknesses were tested at transonic speeds. The correlations of the lift depending wave drag and the lift parameter for the models are found to be similar. The similitude of the outer flow field under the same lifting condition is also established. The drag-rise of the equivalent body of revolution with the cross-sectional area distribution including that due to life correlates well with those of the wing-body models at the design lift condition. The experiment therefore verifies the transonic equivalence rule at lifting condition. Author

N85-10005# National Inst. for Aeronautics and Systems Technology, Pretoria (South Africa). Aeronautics Dept.
THREE DEGREE OF FREEDOM STEADY STATE POINT PERFORMANCE PROGRAM: UPDATED VERSION 1
B. WIGDOROWITZ Jun. 1983 336 p
(CSIR-NIAST-83/48; ISBN-0-7988-2691-6) Avail: NTIS HC A15/MF A01
A computer program was written in FORTRAN 5 for the computation of the three DOF steady state point performance of an aircraft. The input data consists of thrust, C sub L, C sub D and C sub Y coefficients either in table or equation form and the output is dependent on the user specifications. Author

N85-10006# National Inst. for Aeronautics and Systems Technology, Pretoria (South Africa).
IMPLEMENTATION OF THE SUPERSONIC TRIPLET SINGULARITY INTO THE USTORE COMPUTER CODE
G. J. VANDENBROEK May 1983 30 p refs
(CSIR-NIAST-83/47; ISBN-0-7988-2686-X) Avail: NTIS HC A03/MF A01
The development of the supersonic triplet singularity to alleviate interior wave propagation problems experienced with a constant source surface panel singularity distribution on bodies in supersonic flow is discussed. The applicability of the triplet is investigated. It is found that the triplet singularity works well for isolated bodies of revolution with axisymmetric panelling. The triplets are generally not effective in dealing with non-axisymmetry effects and interference effects. Author

N85-10007*# Boeing Commercial Airplane Co., Seattle, Wash.
DEVELOPMENT AND APPLICATIONS OF ALGORITHMS FOR CALCULATING THE TRANSONIC FLOW ABOUT HARMONICALLY OSCILLATING WINGS
F. E. EHLERS, W. H. WEATHERILL, and E. L. YIP Oct. 1984 152 p refs
(Contract NAS1-16297)
(NASA-CR-172376; NAS 1.26:172376) Avail: NTIS HC A08/MF A01 CSCL 01A

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

N85-10008*# National Aeronautics and Space Administration, Washington, D. C.
ON VORTEX BURSTING
H. WERLE Jun. 1984 67 p refs Transl. into ENGLISH of "Sur l'eclatement des tourbillons" rept. ONERA-NT-175 France, 1971 50 p Translation previously announced as N72-19328 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original doc. prepared by ONERA, France
(Contract NASW-3541)
(NASA-TM-77587; NAS 1.15:77587; ONERA-NT-175) Avail: NTIS HC A04/MF A01 CSCL 01A

Vortex bursting is studied by means of visualization. The physical behavior of the phenomenon is emphasized, and its similarity with boundary layer separation or wake bursting becomes apparent. The essential influence of an increasing pressure gradient on the initiation, the position and the type of bursting is clearly confirmed. The evolution of the phenomena as a function of several parameters is analyzed in the case of delta wings, alone or installed on aircraft models, and compared with the results of similar wind tunnel or flight tests. M.A.C.

N85-10009# National Aerospace Lab., Tokyo (Japan). First Airframe Div.
INTEGRAL EQUATION OF LIFTING SURFACES IN LAPLACE DOMAIN AND ANALYTIC CONTINUATION OF ITS PRESSURE KERNEL
T. UEDA Jan. 1984 40 p refs
(NAL-TR-795T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

The subsonic kernel of integral equations in Laplace domain relating the upwash and pressure distributions on a thin finite wing is extended to the entire s-plane by analytic continuation. An asymptotic of integral functions occurring the kernel is also presented for large variables with some numerical results. Author

N85-10010# National Aerospace Lab., Tokyo (Japan).
A STUDY OF AERODYNAMIC CHARACTERISTICS OF WING-BODY COMBINATIONS. PART 2: LOW-WING AIRPLANE
M. YANAGISAWA, K. KIKUCHI, and C. KOYAMA Jan. 1984 25 p refs In JAPANESE; ENGLISH summary
(NAL-TR-796; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

Experimental pressure distribution, lift, moment and drag coefficients on the wing-body combinations are measured. Data were obtained at angles of attack from -10 degree to 10 degree, a free stream velocity of 40 m/s and Reynolds numbers based upon wing chord lengths from 0.32 x 10 to the 6th power to 0.43 x 10 to the 6th power. The data obtained from these experiments are compared with data obtained from computations using a boundary element method which is a modification of Morino's theory. In order to confirm the starting points of the trailing vortex sheets on the body, observations of the flowfield by an oil flow technique are presented and the features of the oil film flow patterns are discussed. It is concluded that the present procedure may offer promise for practical engineering applications. Author

N85-10011# National Aerospace Lab., Tokyo (Japan).
OPTIMUM DESIGN OF NONPLANAR WINGS: MINIMUM INDUCED DRAG FOR A GIVEN LIFT AND WING ROOT BENDING MOMENT
K. ASAI Jan. 1984 23 p refs In JAPANESE; ENGLISH summary
(NAL-TR-797; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

The application of nonplanar wings such as Whitcomb's winglet to subsonic transport airplanes is discussed. A simple numerical method was developed to calculate the minimum induced drag for a wing of an arbitrary nonplanar configuration, using the Trefftz-plane (far-field) analysis and the Lagrangian multiplier technique. For a series of wing/winglet combinations and several more complex forms such as curved wings, the value of the induced drag efficiency parameter l/e is evaluated and compared with that of a conventional planar wing. When comparing the induced drag benefits, it is assumed that both wings have the same extended wing planform rather than the projected one. To take account of the trade-offs between wing aerodynamic efficiency and wing structural weight, the wing root bending moment as well as the wing total lift are kept constant. With these constraints, the drag performances for both wings could be compared without any ambiguity associated with wing structural weight and wing surface skin friction. M.G.

N85-10013# National Aerospace Lab., Tokyo (Japan).
SOME CONSIDERATIONS ON AEROELASTIC INSTABILITIES CAUSED BY COUPLING BETWEEN PROPELLER-TYPE ROTOR AND ITS SUPPORTING STRUCTURE
T. ICHIKAWA 1984 19 p refs In JAPANESE; ENGLISH summary
(NAL-TR-804; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

Aeroelastic instabilities caused by the coupling between a rigid rotor and a flexible tower of a horizontal axis wind turbine are considered. Equations of motion having periodic coefficients are derived with respect to the fixed frame of reference as well as the frame of reference moving with the rotor by assuming an aerodynamic force predicted by the quasi-steady blade element theory. The same equations can be applied to rotors of both downwind and upwind types. It is shown that the equations of motion with respect to an appropriate frame of reference have constant coefficients in cases where either the rotor or the tower stiffness is isotropic. Possible instabilities only in these cases are studied with the help of Routh's criterion. Three kinds of instabilities, that is, the whirl flutter and the divergences of the first and second kinds, are predicted. R.J.F.

N85-10014# National Aerospace Lab., Tokyo (Japan).
CHARACTERISTICS OF CONTROLLED-OSCILLATING ANNULAR CASCADE TEST FACILITY WITH FREON GAS
H. KOBAYASHI 1984 23 p refs In JAPANESE; ENGLISH summary
(NAL-TR-812; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

The trend towards ever greater mass flow or small diameter in turbomachines leads to high flow velocities and to slender blades. Therefore, it is likely that the problem of aeroelastic phenomena, namely flutter and forced vibration, will increase in significance in the fan stage of turbofan engines and the last stage of industrial turbines. To clarify aeroelastic phenomena of cascade blades, the annular test facility was designed and constructed at NAL, where all 16 blades in annular cascade can be harmonically oscillated by a mechanical oscillatory system in a torsional mode at frequencies up to 500 Hz with constant amplitude and interblade phase angle. Freon gas is used as a working fluid to simulate actual high Mach number and high reduced frequency in cascade flutter. By a series of experiments, it was made clear that this annular test facility satisfied the characteristics necessary for the study of aeroelasticity in turbomachinery at Mach numbers up to 1.4 and reduced frequencies up to 1.2. R.J.F.

N85-10015*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
INLET AND AIRFRAME COMPATIBILITY FOR A V/STOL FIGHTER/ATTACK AIRCRAFT WITH TOP-MOUNTED INLETS Final Report
D. A. DURSTON and D. B. SMELTZER Washington Jun. 1982 12 p refs
(NASA-TM-84252; A-8948; NAS 1.15:84252) Avail: NTIS HC A02/MF A01 CSCL 01A

Aerodynamic force and inlet pressure data are obtained for 9.5% force and pressure models of a V/STOL fighter/attack aircraft configuration with top mounted twin inlets. Data are presented from tests conducted in the Ames Unitary Wind Tunnels at Mach numbers of 0.6, 0.9, and 1.2 at angles of attack up to 27 deg. and angles of sideslip up to 12 deg. Trimmed aerodynamic characteristics and inlet performance are compared for three different leading edge extension (LEX) configurations. The effects of wing leading and trailing-edge flaps on the inlet are also determined. Maneuver performance is calculated form combined force and inlet pressure data. The largest of the three LEX sizes tested gives the best airplane maneuver performance. Wing flap deflections improved inlet recovery at all Mach numbers. M.A.C.

N85-10016# Oklahoma Univ., Norman. School of Aerospace Mechanical and Nuclear Engineering.
TURBULENT BOUNDARY LAYERS OVER ROUGH SURFACES HYPERSONIC FLOW Final Report, 1 May 1983 - 30 May 1984
J. M. RUSSELL 30 Jun. 1984 43 p
(Contract AF-AFOSR-0186-83)
(AD-A145040; AFOSR-84-0756TR) Avail: NTIS HC A03/MF A01 CSCL 20D

A method for predicting the downstream development of momentum thickness, skin friction, and heat transfer in a supersonic turbulent boundary layer over a rough flat plate based on ideas of Van Driest, Rotta, and Bradshaw is derived and discussed. Admissible thermal boundary conditions include the case of prescribed wall temperature and the case of an adiabatic wall. The velocity profiles for compressible nonadiabatic flow are expressed as transformations of the corresponding velocity profiles in incompressible adiabatic flow. Analytical curve fits to the experimentally determined law-of-the wall (including the sublayer region) are given, as are analytical representations of the effects of sand grain roughness based on the well known data of Nikuradse. A FORTRAN source code for implementing the method is included as are sample calculations of the momentum thickness, skin friction, and heat transfer for several roughness heights. Author (GRA)

N85-10017# Analytical Methods, Inc., Redmond, Wash.
PREDICTION OF AERODYNAMIC CHARACTERISTICS OF FIGHTER WINGS AT HIGH ANGLES OF ATTACK Final Technical Report, 15 Apr. 1982 - 31 Mar. 1984
B. MASKEW, T. S. VAIDYANATHAN, J. K. NATHMAN, and F. A. DVORAK Mar. 1984 133 p
(Contract N00014-82-C-0354)
(AD-A145107; AMI-8405) Avail: NTIS HC A07/MF A01 CSCL 20D

Potential modeling techniques for representing separated and vortical flows are investigated with the objective being the prediction of aerodynamic characteristics of fighter wings at high angles of attack. A low-order surface singularity panel method is coupled with iterative routines for locating the force free wake and for including viscous effects and edge vortices. The viscous effects are computed using integral boundary layer procedures and the displacement effect is represented in the panel method using the transpiration model. Regions of massive separation are enclosed in free vortex sheets which are included in the general wake configuration scheme of the panel method. Calculations show encouraging results in those cases where there is little cross flow inside the separated zone. The calculations were less successful when the separated zone became highly three-dimensional, as in the case of a vortex/surface interaction. The modeling technique promises to be a practical, cost effective approach to predicting the aerodynamic characteristics of fighter wings at high angle of attack; however, further development of the model is required for the highly three-dimensional separated zones involving strong vortical action. Author (GRA)

N85-10018# Notre Dame Univ., Ind. Aerodynamics Lab.
AERODYNAMICS OF AIRFOILS SUBJECT TO 3-DIMENSIONAL PERIODIC GUSTS Final Report
H. ATASSI 31 Aug. 1983 55 p
(Contract AF-AFOSR-0269-82)
(AD-A145149; REPT-1983-12; AFOSR-84-0757TR) Avail: NTIS HC A04/MF A01 CSCL 20D

A general analysis of periodic three-dimensional vortical disturbances of streaming motions around streamlined and bluff bodies is developed using a unified approach wherein the mathematical problem is reduced to solving a single inhomogeneous wave equation with non-constant coefficients. In the limit of vanishing Mach number, the problem is formulated in terms of an inhomogeneous Fredholm integral equation of the second kind. The analysis is first applied to study the unsteady aerodynamics of an airfoil of arbitrary shape moving at low Mach number in a three-dimensional periodic gust pattern. Because the homogeneous equation has a non-trivial solution, a special procedure was developed for its solution and uniqueness is obtained by applying the Kutta condition at the trailing edge. Results were compared with those obtained from a nonlinear two dimensional gust theory and linear oblique gust analyses. Comparison shows a very strong influence of the airfoil geometry and mean flow angle of attack and of the gust parameters on the unsteady lift and moment coefficients. In fact, depending on the conditions considered, the unsteady lift and moment coefficients can be several times larger or smaller than those obtained from linear theories. A superposition principal was derived whereby the unsteady lift and moment acting on a thin airfoil with small camber and small angle of attack and subject to a two-dimensional gust can be constructed by linear superposition to the Sears lift and moment of three independent components accounting separately for the effects of airfoil thickness, airfoil camber and non-zero angle of attack of the mean flow. GRA

N85-10019# Massachusetts Inst. of Tech., Cambridge. Computational Fluid Dynamics Lab.
COMPUTATIONAL METHODS FOR COMPLEX FLOWFIELDS Annual Report, 1 Jun. 1983 - 31 May 1984
E. M. MURMAN and J. R. BARON 22 Jun. 1984 67 p
(Contract AF-AFOSR-0136-82; AF PROJ. 2307)
(AD-A145219; AFOSR-84-0755TR) Avail: NTIS HC A04/MF A01 CSCL 12A

The development of solution algorithms for complex flowfields is the continuing objective of the research. Major focus is on use of coupled subdomains and descriptions which are either preselected or adapted to fit the physical events when necessary. The non-adaptive embedded mesh algorithm has completed airfoil solutions with an allowance for highly stretched meshes, alternate grids and reducing smoothing. A new algorithm is combining features from cell and nodal-centered methods to permit general embedded topology. Adaptive embedded mesh procedures have been extended to and carried out for two-dimensional Euler, subsonic, transonic and supersonic flows. An optimal distribution of local Courant numbers has been considered as a basis for accelerating the solution approach to a steady state.
Author (GRA)

N85-10020# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
EXPERIMENTAL DATA BASE FOR COMPUTERS PROGRAM ASSESSMENT. REPORT OF THE FLUID DYNAMICS PANEL WORKING GROUP 04: ADDENDUM
Loughton, England Jul. 1984 148 p refs
(AGARD-AR-138-ADD; ISBN-92-835-1475-0) Avail: NTIS HC A07/MF A01

Data sets for high and low aspect radio wings in wing-alone and wing-body combination are presented to provide data for computer program assessment.

N85-10023# Aircraft Research Association Ltd., Bedford (England).
PRESSURE DISTRIBUTIONS MEASURED ON RESEARCH WING M100 MOUNTED ON AN AXISYMMETRIC BODY
M. P. CARR and K. C. PALLISTER *In* AGARD Exptl. Data Base for Computer Program Assessment 36 p Jul. 1984 refs
Avail: NTIS HC A07/MF A01

Measurements of surface pressure distributions on a research wing in a transonic wind tunnel are presented. Tabulated data are given for an incidence range at constant Mach number and a Mach number range at approximately constant lift coefficient. Overall force measurements for the same test conditions as the presented pressures are also given. M.A.C.

N85-10024# Aircraft Research Association Ltd., Bedford (England).
PRESSURE DISTRIBUTIONS MEASURED ON RESEARCH WING M86 MOUNTED ON AN AXISYMMETRIC BODY
In AGARD Exptl. Data Base for Computers Program Assessment 25 p Jul. 1984 refs
Avail: NTIS HC A07/MF A01

Surface pressure distributions are measured on a research wind in a transonic wind tunnel. Tabulated data are given for seven conditions covering three Mach numbers. Force measurements for the same test conditions as the presented pressures are also given. M.A.C.

N85-10025# Aeronautical Research Inst. of Sweden, Bromma.
PRESSURE DISTRIBUTION ON A SWEPT WING AIRCRAFT IN FLIGHT
A. BERTELRUD *In* AGARD Exptl. Data Base for Computers Program Assessment 31 p Jul. 1984 refs
Avail: NTIS HC A07/MF A01

A comprehensive data base is developed for the flow on a swept wing aircraft under flight conditions. Four cases are presented. The data concerns pressure distributions, some skin friction information and very limited boundary layer results. The full data base contains several other types of data (including turbulence measurements), measurements taken under instationary conditions as well as particular investigations concerning drag reduction, junction flow, transition etc. The data structure obtained during a flight test differs from tunnel results in several respects. Ample and redundant data with elaborate checking of data validity and repeatability are required. Real life conditions, i.e., no wind tunnel walls, atmospheric turbulence (intensity and scale) vary with each flight and each altitude. For the present tests the following are observed: (1) natural transition, and (2) all data obtained are for trimmed conditions; i.e., the stabilizer/elevator has slightly different setting for each flight condition d-5. M.A.C.

N85-10911 Mississippi State Univ., Mississippi State.
EMBEDDED-GRID GENERATION WITH COMPLETE CONTINUITY ACROSS INTERFACES FOR MULTI-ELEMENT AIRFOILS Ph.D. Thesis
S. K. JAIN 1984 69 p
Avail: Univ. Microfilms Order No. DA8415732

An algorithm is developed to obtain embedded grid systems for multielement airfoils. The grid generating equations used are the elliptic equations developed by Thompson, et al., to generate boundary fitted curvilinear coordinate systems about an arbitrary two dimensional body. These equations are solved by a point SOR method. The physical region is divided into various simple or doubly connected subregions. An SOR iteration is performed first in the various subregions and then on the subregion's nonphysical boundaries. Thus a complete continuity of grid lines is maintained across these boundaries. The expression for the control functions at the boundaries are obtained by taking the projection of grid generating equations of the boundaries. These are further simplified by assuming the orthogonality condition and the zero curvature of the transverse grid line at each boundary point. The resulting expressions are evaluated using the point distribution along the boundary and the specified spacing of the first grid line of the boundary. Dissert. Abstr.

N85-10913*# California Univ., Los Angeles. Dept. of Mathematics.
SHOCK CAPTURING FINITE DIFFERENCE ALGORITHMS FOR SUPERSONIC FLOW PAST FIGHTER AND MISSILE TYPE CONFIGURATIONS Annual Status Report, 1 Mar. 1984 - 28 Feb. 1985
S. J. OSHER 1984 7 p refs
(Contract NAG1-270)
(NASA-CR-174051; NAS 1.26:174051) Avail: NTIS HC A02/MF A01

The construction of a reliable, shock capturing finite difference method to solve the Euler equations for inviscid, supersonic flow past fighter and missile type configurations is highly desirable. The numerical method must have a firm theoretical foundation and must be robust and efficient. It should be able to treat subsonic pockets in a predominantly supersonic flow. The method must also be easily applicable to the complex topologies of the aerodynamic configuration under consideration. The ongoing approach to this task is described and for steady supersonic flows is presented. This scheme is the basic numerical method. Results of work obtained during previous years are presented. B.W.

N85-10914*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRANSONIC FLOW ANALYSIS FOR ROTORS. PART 1: THREE-DIMENSIONAL QUASI-STEADY, FULL-POTENTIAL CALCULATION
I. C. CHANG Oct. 1984 87 p refs
(NASA-TP-2375; A-9721; NAS 1.60:2375) Avail: NTIS HC A05/MF A01 CSCL 01A

A new computer program is presented for calculating the quasi-steady transonic flow past a helicopter rotor blade in hover as well as in forward flight. The program is based on the full potential equations in a blade attached frame of reference and is capable of treating a very general class of rotor blade geometries. Computed results show good agreement with available experimental data for both straight and swept tip blade geometries. Author

N85-10915*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CHARACTERISTIC BOUNDARY CONDITIONS FOR THREE-DIMENSIONAL TRANSONIC UNSTEADY AERODYNAMICS
W. WHITLOW, JR. Oct. 1984 12 p refs
(NASA-TM-86292; NAS 1.15:86292) Avail: NTIS HC A02/MF A01 CSCL 01A

Characteristic far-field boundary conditions for the three-dimensional unsteady transonic small disturbance potential equation have been developed. The boundary conditions were implemented in the XTRAN3S finite difference code and tested for a flat plate rectangular wing with a pulse in angle of attack; the freestream Mach number was 0.85. The calculated force response shows that the characteristic boundary conditions reduce disturbances that are reflected from the computational boundaries. Author

N85-10916*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LIFTING SURFACE THEORY FOR A HELICOPTER ROTOR IN FORWARD FLIGHT
H. TAI and H. L. RUNYAN Sep. 1984 13 p refs Presented at the 2nd Decennial Specialists' Meeting on Rotorcraft Dyn., Moffett Field, Calif., 7-9 Nov. 1984
(NASA-TM-86315; NAS 1.15:86315) Avail: NTIS HC A02/MF A01 CSCL 01A

A lifting surface theory was developed for a helicopter rotor in forward flight for compressible and incompressible flow. The method utilizes the concept of the linearized acceleration potential and makes use of the vortex lattice procedure. Calculations demonstrating the application of the method are given in terms of the lift distribution on a single rotor, a two-bladed rotor, and a rotor with swept-forward and swept-back tips. In addition, the lift on a rotor which is vibrating in a pitching mode at 4/rev is given. Compressibility effects and interference effects for a two-bladed rotor are discussed. Author

N85-10917*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FITTING AERODYNAMIC FORCES IN THE LAPLACE DOMAIN: AN APPLICATION OF A NONLINEAR NONGRADIENT TECHNIQUE TO MULTILEVEL CONSTRAINED OPTIMIZATION
S. H. TIFFANY and W. M. ADAMS, JR. Oct. 1984 24 p refs
(NASA-TM-86317; NAS 1.15:86317) Avail: NTIS HC A02/MF A01 CSCL 01A

A technique which employs both linear and nonlinear methods in a multilevel optimization structure to best approximate generalized unsteady aerodynamic forces for arbitrary motion is described. Optimum selection of free parameters is made in a rational function approximation of the aerodynamic forces in the Laplace domain such that a best fit is obtained, in a least squares sense, to tabular data for purely oscillatory motion. The multilevel structure and the corresponding formulation of the objective models are presented which separate the reduction of the fit error into linear and nonlinear problems, thus enabling the use of linear methods where practical. Certain equality and inequality constraints that may be imposed are identified; a brief description of the nongradient, nonlinear optimizer which is used is given; and results which illustrate application of the method are presented. Author

N85-10918*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aero. Engineering.
FORCE AND MOMENT MEASUREMENTS ON A 74 DEG DELTA WING WITH AN APEX FLAP
T. A. BUTER and D. M. RAO (Vigyan Research Associates, Inc., Hampton, Va.) Hampton, Va. NASA. Langley Research Center Oct. 1984 23 p refs
(Contract NCC1-46)
(NASA-CR-166081; NAS 1.26:166081) Avail: NTIS HC A02/MF A01 CSCL 01A

Results are presented of a subsonic experimental investigation of an apex flap concept on a 74 deg swept delta wing with trailing-edge flaps. The apex flap comprised approximately 6 percent of the wing area forward of a transverse hinge, allowing for upward and downward deflection angles from +40 deg to -20 deg. Upward deflection forces leading-edge vortex formation on the apex flap, resulting in an increased lift component on the apex area. The associated nose-up moment balances the nose-down moment due to trailing-edge flaps, resulting in sizeable increase in the trimmed lift coefficient particularly at low angles of attack. Nose-down apex deflection may be used to augment the pitch control for rapid recovery from high-alpha maneuvers. This report presents the balance data without analysis. B.W.

N85-10919*# Ohio State Univ., Columbus.
DESIGN AND WIND TUNNEL EVALUATION OF A SYMMETRIC AIRFOIL SERIES FOR LARGE WIND TURBINE APPLICATIONS Final Report
G. M. GREGOREK May 1984 27 p refs
(Contract NAG3-330; DE-AI01-76ET-20320)
(NASA-CR-174764; DOE/NASA/0330-1; NAS 1.26:174764)
Avail: NTIS HC A03/MF A01 CSCL 01A

A family of symmetric airfoils with thickness to chord ratios of 0.21, 0.25, and 0.29 was designed for applications to large wind turbines using the Eppler analytic design methodology. The airfoil series, designed for Reynolds numbers above 4x1,000,000, has a contour that maintains its thickness to the 0.7 chord position, allowing use of a deep aft spar for structural integrity. Wind tunnel tests of the 21 percent thick airfoil conducted in the Ohio State University Airfoil Test Facilities at M = 0.25 and Re = 2, 4 and 8x1,000,000 showed good agreement with predicted surface pressures and lift and drag coefficients when the angle of attack was low and the Reynolds number was 8x1,000,000. At the lowest Reynolds number, both the measured lift curve slope and the maximum lift coefficient differ significantly from theory. In the post stall region, agreement with theory and experiment is poor, at all Reynolds numbers, verifying the need for improved analytic methods in this important flow regime. Author

N85-10920*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EXPERIMENTAL TRIM DRAG VALUES AND FLOW-FIELD MEASUREMENTS FOR A WIDE-BODY TRANSPORT MODEL WITH CONVENTIONAL AND SUPERCRITICAL WINGS
P. F. JACOBS Oct. 1982 142 p refs
(NASA-TP-2071; L-15315; NAS 1.60:2071) Avail: NTIS HC A07/MF A01 CSCL 01A

The purpose of this study was to determine if advanced supercritical wings incur higher trim drag values at cruise conditions than current wide body technology wings. Relative trim drag increments were measured in an experimental wind tunnel investigation conducted in the Langley 8 Foot Transonic Pressure Tunnel. The tests utilized a high aspect ratio supercritical wing and a wide body aircraft wing, in conjunction with five different horizontal tail configurations, mounted on a representative wide body fuselage. The three low tail and two T-tail configurations were designed to measure the effects of horizontal tail size, location, and camber on the trim drag increments for the two wings. Longitudinal force and moment data were taken at a Mach number of 0.82 and design cruise lift coefficients for the wide body and supercritical wings of 0.45 and 0.55, respectively. The data indicate that the supercritical wing does not have significantly higher trim drag than the wide body wing. A reduction in tail size, combined with relaxed static stability, produced trim drag reductions for both wings. The cambered tails had higher trim drag increments than the symmetrical tails for both wings, and the T-tail configurations had lower trim drag increments than the low tail configurations. Author

N85-10921*# Kansas Univ. Center for Research, Inc., Lawrence.
VORCOR: A COMPUTER PROGRAM FOR CALCULATING CHARACTERISTICS OF WINGS WITH EDGE VORTEX SEPARATION BY USING A VORTEX-FILAMENT AND-CORE MODEL
J. L. PAO, S. C. MEHROTRA (Vigyan Research Associates, Inc.), and C. E. LAN Apr. 1982 242 p
(Contract NAS1-16114; NCC1-18)
(NASA-CR-165902; NAS 1.26:165902) Avail: NTIS HC A11/MF A01 CSCL 01A

A computer code base on an improved vortex filament/vortex core method for predicting aerodynamic characteristics of slender wings with edge vortex separations is developed. The code is applicable to camber wings, straked wings or wings with leading edge vortex flaps at subsonic speeds. The prediction of lifting pressure distribution and the computer time are improved by using a pair of concentrated vortex cores above the wing surface. The main features of this computer program are: (1) arbitrary camber shape may be defined and an option for exactly defining leading edge flap geometry is also provided; (2) the side edge vortex system is incorporated. M.A.C.

N85-10922*# Boeing Military Airplane Development, Seattle, Wash.
PAN AIR: A COMPUTER PROGRAM FOR PREDICTING SUBSONIC OR SUPERSONIC LINEAR POTENTIAL FLOWS ABOUT ARBITRARY CONFIGURATIONS USING A HIGHER ORDER PANEL METHOD. VOLUME 3: CASE MANUAL (VERSION 1.0) Contractor Report, Jan. 1978 - Jun. 1981
R. T. MEDAN, ed., A. E. MAGNUS, K. W. SIDWELL, and M. A. EPTON Washington NASA Aug. 1981 237 p refs
Sponsored in part by AF and Navy
(Contract NAS2-9830)
(NASA-CR-3253; NAS 1.26:3253) Avail: NTIS HC A11/MF A01 CSCL 01A

Numerous applications of the PAN AIR computer program system are presented. PAN AIR is user-oriented tool for analyzing and/or designing aerodynamic configurations in subsonic or supersonic flow using a technique generally referred to as a higher order panel method. Problems solved include simple wings in subsonic and supersonic flow, a wing-body in supersonic flow, wing with deflected flap in subsonic flow, design of two-dimensional and three-dimensional wings, axisymmetric nacelle in supersonic flow, and wing-canard-tail-nacelle-fuselage combination in supersonic flow. Author

N85-10923# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
WIND TUNNEL CALIBRATION OF A HEMISPHERICAL HEAD ANGLE OF ATTACK AND ANGLE OF SIDESLIP INDICATOR
J. NORDSTROEM 29 Feb. 1984 55 p refs
(Contract FMV-FLYGFL-82223-78-003-21-001; FMV-FL-K-82223-80-001-21-001; FMV-FL-K-82223-80-181-21-001; FMV-FL-K-82223-81-158-25-001; FMV-FL-K-82260-83-053-25-001)
(FFA-TN-1984-11) Avail: NTIS HC A04/MF A01

A hemispherical head with 5 pressure taps at 45 deg in 2 planes was manufactured and calibrated at appropriate angles of incidence for actual Mach numbers, to indicate angle of attack and angle of sideslip in a flight test. Calibration results, direct test results and final calibration equations to be used in flight are given. Reynolds number dependence was explored and error analysis carried out. Author (ESA)

N85-11702# Joint Publications Research Service, Arlington, Va.
PROBLEM OF REDUCTION TO IDEAL WIND TUNNEL IN EXPERIMENTAL AERODYNAMICS Abstract Only
N. N. YANENKO, Y. Y. VOSKOBOYNIKOV, and N. G. PREOBRAZHENSKIY *In its* USSR Rept.: Phys. and Math. (JPRS-UPM-84-006) p 48 12 Sep. 1984 Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 274, no. 6, Feb. 1984 p 1309-1312
Avail: NTIS HC A08/MF A01

Reduction to an ideal wind tunnel is necessary in experimental aerodynamics for elimination of the instrument error which, in the case of a wind tunnel, results from distorting stochastic perturbations caused by the flow of air. A Volterra integral equation of the first kind is derived for the probability distribution densities in a way that makes it possible to separate and exclude the instrument function characterizing the wind tunnel. The experiment thus becomes reduced to one in an ideal wind tunnel without interference. The corresponding problem for this equation is mathematically ill-conditioned and is regularized before it is solved, preferably by numerical experiment. Finiteness of interference and noise probability distribution densities, differenceness of its kernel, and inaccuracy of both its kernel and right hand side are taken into account in the algorithm of its solution. The procedure is demonstrated on evaluation of the emplitude distribution density of fluctuations in a turbulent stream flowing through a wind tunnel. Author

03

AIR TRANSPORTATION AND SAFETY

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

A85-10653*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PROGRESS TOWARD THE DEVELOPMENT OF AN AIRCRAFT ICING ANALYSIS CAPABILITY
R. J. SHAW (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 36 p. Previously announced in STAR as N84-20490. refs
(AIAA PAPER 84-0105)

An overview of the NASA efforts to develop an aircraft icing analysis capability is presented. Discussions are included of the overall and long term objectives of the program as well as current capabilities and limitations of the various computer codes being developed. Descriptions are given of codes being developed to analyze two and three dimensional trajectories of water droplets, airfoil ice accretion, aerodynamic performance degradation of components and complete aircraft configurations, electrothermal deicer, and fluid freezing point depressant deicer. The need for bench mark and verification data to support the code development is also discussed. Author

A85-11822
A PARACHUTE THEORY ALLOWING FOR THE STRUCTURE OF THE CANOPY FABRIC [TEORIIA PARASHIUTA S UCHETOM STRUKTURY TKANI KUPOLA]
R. KHUDAIBERDIEV (Tashkentskii Politekhnicheskii Institut, Tashkent, Uzbek SSR) Problemy Prochnosti (ISSN 0556-171X), Sept. 1984, p. 90-94. In Russian. refs

A two-dimensional theory for an axisymmetric parachute is presented which allows for the anisotropy of the canopy material. The problem is reduced to that of solving Kepler-Rakhmatulin transcendental equations and a system of differential equations with linearly deviating arguments. This system is solved using the concepts of integral manifolds and structural development, with the shape of the parachute determined to a first approximation on the basis of Rakhmatulin's one-dimensional theory. V.L.

N85-10026 Department of the Air Force, Washington, D.C.
SIMPLE NONRESTRICTIVE ARM RESTRAINT SYSTEM Patent
L. J. SPECKER, T. J. JENNINGS, and M. P. CONNORS, inventors (to Air Force) 31 Jul. 1984 8 p Supersedes AD-D009950
(AD-D011216; US-PATENT-4,462,563;
US-PATENT-APPL-SN-433597; US-PATENT-CLASS-244-122)
Avail: US Patent and Trademark Office CSCL 01C

An improved arm restraint system for moving the arms of an ejection seat occupant to restrained positions along the sides of the occupant's torso upon initiation of emergency escape ejection of the seat and occupant from an aircraft includes a multistrap and guide ring arrangement wherein the elbow of the aircrewmen is drawn tightly against the torso side through a direct interconnection there between and concurrently his hands/wrists are drawn to the ejection control of the seat. GRA

N85-10027# National Transportation Safety Board, Washington, D. C. Bureau of Safety Programs.
REVIEW OF AIRCRAFT ACCIDENT DATA: US GENERAL AVIATION Annual Report, 1981
8 Jun. 1984 155 p
(PB84-230960; NTSB/ARG-84-02) Avail: NTIS HC A08/MF A01

This report presents a statistical compilation and review of general aviation accidents which occurred in 1981. The accidents reported are all those involving U.S. registered aircraft not conducting air carrier revenue operations under 14 CFR 121, 14 CFR 127, or 14 CFR 135. The report is divided into sections, each of which (except for the All Operations Section) presents a review of a subset of all general aviation accidents. Each subset represents aircraft of similar types of aircraft being operated for particular purposes. Several tables present accident parameters for 1981 only, and each section includes tabulations which present comparative statistics for 1981 and for the five year period 1976-1980. Author

N85-10028# Federal Aviation Agency, Atlantic City, N.J.
A STUDY OF BIRD INGESTIONS INTO LARGE HIGH BYPASS RATIO TURBINE AIRCRAFT ENGINES Final Report
G. FRINGS Sep. 1984 152 p refs
(DOT/FAA-CT-84-13) Avail: NTIS HC A08/MF A01

Bird ingestions into large high bypass ratio turbine aircraft engines were studied. The worldwide study covered over 2.7 million operations by 1,513 aircraft consisting of the DC8, DC10, B747, B767, A300, A310, and L1011. The numbers, weights, and species of birds which are ingested into these engines and resulting engine damage, were determined. E.A.K.

N85-10029# National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation.
PROCEEDINGS OF THE AVIATION ACCIDENT INVESTIGATION SYMPOSIUM
13 Jul. 1984 205 p Proc. held in Springfield, Va., 26-28 Apr. 1983
(PB84-917004; NTSB/RP-84-01) Avail: NTIS HC A10/MF A01

In April, 1983, the National Transportation Safety Board held an accident investigation symposium to discuss Safety Board programs and to receive industry input on Safety Board accident investigation policies and procedures. Over 280 participants from industry, government and the military participated in the symposium on panels to discuss issues, and in working groups. At the conclusion of the symposium, the four industry moderated working groups presented 57 recommendations to the Safety Board related to aviation accident investigation. Another 11 recommendations were submitted by participants after the close of the symposium. The recommendations and the Safety Board responses to the recommendations are given. Topics discussed are aircraft accident investigations, human factors engineering, aircraft safety, and human performance. R.J.F.

N85-10924# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REPORT. CENTRAL AIRLINES FLIGHT 27, HUGHES CHARTER AIR, GATES LEARJET MODEL 25 (N51CA) NEWARK INTERNATIONAL AIRPORT, NEWARK, NEW JERSEY, MARCH 30, 1983
7 Aug. 1984 31 p
(PB84-910411; NTSB-AAR-84-11) Avail: NTIS HC A03/MF A01 CSCL 01C

About 0514, eastern standard time, on March 30, 1983, Central Airlines Flight 27, a Gates Learjet model 25 (N51CA), with two pilots aboard crashed at Newark International Airport, Newark, New Jersey, during a landing attempt on runway 4 right. The airplane was destroyed by impact, and the two pilots died as a result of the accident. The airplane came to rest in a drainage ditch at the airport perimeter. A ground fire erupted near the latter portion of the impact area. The National Transportation Safety Board determines that the probable causes of this accident were: (1) loss of control following ground contact; (2) an unstabilized approach; and (3) impairment of the flightcrew's judgment, decision making, and flying abilities by a combination of physiological and psychological factors. Author

N85-10925# National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation.
AIRCRAFT ACCIDENT REPORT: FLYING TIGERS, INC., FLIGHT 2468, MCDONELL DOUGLAS DC8-63, N797FT, CHAMBERS FIELD, NAVAL AIR STATION, NORFOLK, VIRGINIA, OCTOBER 25, 1983
30 May 1984 53 p
(PB84-910408; NTSB-AAR-84-08) Avail: NTIS HC A04/MF A01 CSCL 01C

An accident involving a DC 8 aircraft is discussed in detail. Pilot decisions, air traffic control, airspeed, runway conditions, and weather conditions are among the aspects of the accident given consideration. Flight crew preparedness and training and damage to the aircraft are also mentioned. The probable causes of the mishap as determined by the National Transportation Safety Board are provided. R.S.F.

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A85-11024
ANOMALOUS INTERFERENCE IN OMEGA VLF WAVE PROPAGATION ON EAST-TO-WEST EQUATORIAL PATHS
T. KIKUCHI (Ministry of Posts and Telecommunications, Radio Research Laboratories, Koganei, Tokyo, Japan) and A. OHTANI (Inubo Radio Wave Observatory, Choshi, Chiba, Japan) Journal of Atmospheric and Terrestrial Physics (ISSN 0021-9169), vol. 46, Aug. 1984, p. 697-703. refs

On-board ship measurements of anomalous phase variation of Omega waves at 10.2 and 13.6 kHz on EW equatorial paths are examined. Periodic phase fluctuations and phase cycle slips occur when observations are made around the geomagnetic equator. These propagation anomalies indicate a wave interference pattern with a spacing distance half of the transmitting wave's wavelength. It is suggested that the wave interference is caused between the wave propagated directly from the transmitter and a wave propagated in the WE direction on the long path. It is concluded that the attenuation of the first-order mode is anomalously large on the EW equatorial path, in good agreement with theoretical calculations from an anisotropic waveguide model. C.D.

A85-11078

AIRCRAFT IDENTIFICATION BASED ON PATTERN RECOGNITION OF FM EMISSION SPECTRA

S. F. RASHBA (Bradley University, Peoria, IL) IN: Modeling and simulation. Volume 14 - Proceedings of the Fourteenth Annual Pittsburgh Conference, Pittsburgh, PA, April 21, 22, 1983. Parts 1-2 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 277-286. refs

The purpose of this paper is to present a method for identifying aircraft type. Radar returns from propeller blades are analyzed for signature features. Two new algorithms for identification are presented: (1) the m/N algorithm which requires that m-out-of-N features match a known 'catalogued' pattern; and (2) the beta-recursion algorithm which estimates an aircraft-identifying parameter. Curves of probability of error are given for both algorithms. The m/N algorithm provides probabilities of error in the range: 0.1 to 0.001 for low signal-to-noise conditions; 0.001 to 0.000001 for medium conditions; and 10 to the -6th to 10 to the -10th for high signal-to-noise conditions. The beta-recursion algorithm provides probability of error in the range of 0.25 to 0.017 depending on signal-to-noise conditions and the amount of data available. Author

A85-12080

FAA'S NEW TERMINAL RADAR, THE ASR-9 INCORPORATES A SEPARATE WEATHER CHANNEL

C. PRIMEGGIA (FAA, Washington, DC) and C. PHILLIPS (Westinghouse Electric Corp., Baltimore, MD) (International Federation of Air Traffic Controllers' Associations, Annual Conference, 23rd, Estoril, Portugal, Mar. 26-30, 1984) The Controller (ISSN 0010-8073), vol. 23, 3rd Quarter, 1984, p. 14, 15, 18.

The independent weather channel of the FAA ASR-9 airport surveillance radar is characterized and illustrated with a block diagram. It is pointed out that an independent weather channel with calibrated levels of weather and elimination of ground clutter is needed to supplement the advanced ATC radar capability of the ASR-9, since its sophisticated signal-processing electronics limit its usefulness in providing weather information. The AR-9 system is a receive-only channel employing a magic-tee adapter to recover weather information at the ASR-9 target-channel polarizer output, Doppler filtering optimized using a site-dependent stored map, and smoothing over six 4.8-sec scans for transmission over a dedicated modem link at 9.6 kbit/s to the Surveillance and Communication Interface Processor at the ASR-9 remote ATC installation, where it is converted to analog form and displayed on a separate screen with two selectable weather levels. T.K.

A85-12081

THE AUTOMATIC SSR TAXIWAY TEST FACILITY

D. J. BROCKLEBANK (Cossor Electronics, Ltd., Harlow, Essex, England) (International Federation of Air Traffic Controllers' Associations, Annual Conference, 23rd, Estoril, Portugal, Mar. 26-30, 1984) The Controller (ISSN 0010-8073), vol. 23, 3rd Quarter, 1984, p. 22-25.

The test facility designed for the UK National Air Traffic Services to evaluate the mode A and C reply integrity, sidelobe suppression capability, and radiated power of SSR transponders on incoming aircraft on the airport taxiway is characterized and illustrated with diagrams and maps. The facility comprises a transponder ramp test set, cross-site cables, visual display, and activation system (acoustic, pressure-pad, IR-beam, radiotelephone, manual, or continuous-interrogation/range-limited). In preliminary trials conducted at Gatwick airport during May, 1981, about 17 percent of installations were found to be defective, indicating both the effectiveness of the test facility and the need for more careful transponder maintenance. T.K.

A85-12353#

SCENE MATCHING AND ITS APPLICATION TO AEROSPACE ELECTRONIC SYSTEMS

Z. SUN (Changsha Institute of Technology, Changsha, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 118-131. In Chinese, with abstract in English. refs

The principles and implementation of scene matching in position location systems are described. Several essential problems in scene matching technique are reviewed, measures of similarity are outlined, and fast search methods aea introduced. The probability of acquisition is given for the maximum or minimum algorithm, and the preprocessing of signals is addressed. Geometrical distortion and its effects are analyzed and methods for overcoming such effects are presented. Feature matching and correlation tracking, two important techniques for the homing seeker, are considered. Method of extracting scene matching features such as invariant moments, edges, lines, planes, and vertices are introduced. Feature selection, update, and replacement in terminal target homing are stressed. Block diagrams of a combined optimum aided-navigation system and a homing seeker using correlation tracking are presented. C.D.

A85-12533#

DATA COMMUNICATIONS AND TELEPROCESSING SYSTEMS ON GROUND AND ON BOARD OF AIRCRAFT

F. POLLONI (Alitalia - Linee Aeree Italiane, Rome, Italy) IN: International Scientific Congress on Electronics, 30th, Rome, Italy, March 22, 23, 1983, Proceedings . Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1984, p. 341-350. In Italian.

Message attributes possible for the proposed automatic communications addressing and reporting system (ACARS) on-board commercial aircraft are described. The digital ACARS system will transmit both voice and data. Techniques are needed for formatting messages, codes, sets, terminal and control codes, and standards are required for data processing. Protocols and data processing hierarchies are described for message exchange between ACARS without requiring one system to be internally compatible with any other ACARS system or protocols. M.S.K.

N85-10926# Engineering and Economics Research, Inc., Vienna, Va.

NATIONAL AIRSPACE REVIEW Interim Report

Jun. 1984 101 p

Avail: NTIS HC A06/MF A01

Background information is given concerning the evolution of a program to review airspace allocations and air traffic control procedures in order to enable the FAA to identify and implement changes which can promote greater efficiency of all airspace users and simplify the system. The processes developed to undertake three distinct phases of the project are outlined and the activities that are being performed to accomplish the group's objectives are described. Accomplishments to date are identified and the phasing of system enhancements is defined based on Agency processing requirements and system needs. Recommendations for the terminal, en route, and flight services systems are advanced, as well as those for the airspace system structure and regulations and standards. A.R.H.

N85-10927*# Analytical Mechanics Associates, Inc., Mountain View, Calif.

ENHANCED TCAS 2/CDTI TRAFFIC SENSOR DIGITAL SIMULATION MODEL AND PROGRAM DESCRIPTION Final Report

T. GOKA Oct. 1984 175 p refs

(Contract NAS1-16135)

(NASA-CR-172445; NAS 1.26:172445) Avail: NTIS HC A08/MF A01 CSCL 17G

Digital simulation models of enhanced TCAS 2/CDTI traffic sensors are developed, based on actual or projected operational and performance characteristics. Two enhanced Traffic (or Threat) Alert and Collision Avoidance Systems are considered. A digital simulation program is developed in FORTRAN. The program contains an executive with a semireal time batch processing capability. The simulation program can be interfaced with other modules with a minimum requirement. Both the traffic sensor and CAS logic modules are validated by means of extensive simulation runs. Selected validation cases are discussed in detail, and capabilities and limitations of the actual and simulated systems are noted. The TCAS systems are not specifically intended for Cockpit Display of Traffic Information (CDTI) applications. These systems are sufficiently general to allow implementation of CDTI functions within the real systems' constraints. M.A.C.

N85-10929# Martin Marietta Aerospace, Washington, D.C. Air Traffic Control Div.
SYSTEM ENGINEERING AND INTEGRATION CONTRACT FOR IMPLEMENTATION OF THE NATIONAL AIRSPACE SYSTEM PLAN. VOLUME 2: SECTION 5.0 NAS Plan Audit Report
Aug. 1984 211 p
(Contract DTFA01-84-C-00017)
(AD-A145710; ATC-84-0026-VOL-2) Avail: NTIS HC A10/MF A01 CSCL 17G

This section provides the detailed audit findings for each of the NAS Plan F&E projects. The individual sections are arranged to follow the sequence and order of the technical program chapters in the NAS Plan. The text on each project is formatted to describe: (1) Project role in the National Airspace System. (2) The products that will be produced by the project. (3) The status of the project. (4) The major audit findings broken into technical, schedule, and cost if appropriate. (5) Recommendations to help achieve a successful project on schedule. GRA

N85-10930# Standard Elektrik Lorenz A.G., Stuttgart (West Germany). Entwicklung Navigation.
USE OF MICROPROCESSOR TECHNIQUES AND NEW ANTENNA SYSTEMS TO IMPROVE THE NAVIGATION AIDS VERY HIGH FREQUENCY OMNIDIRECTIONAL RADAR (VOR), DOPPLER VOR AND INSTRUMENT LANDING SYSTEM (ILS) Final Report, Dec. 1982
H. KLEIBER Bonn Bundesministerium fuer Forschung und Technologie Jul. 1984 99 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-W-84-026; ISSN-0170-1339) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 21

Prototypes of Very High Frequency Omnidirectional Range (VOR), Doppler-VOR (DVOR), and Instrument Landing System (ILS) equipments are described. Digital signal processing with a 16-bit microprocessor was used for signal generation of sinusoidal modulation wave forms. Generated and radiated signals were monitored by application of time discrete systems and digital filtering. Increased efficiency and simplified maintenance are outlined. The antenna system comprises a VOR antenna with reduced cone of silence, a DVOR antenna with switch gear for 50 side-band antennas according to the double sideband principle, and a modular heading antenna. Author (ESA)

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A85-10872*# Columbia Univ., New York.
THEORETICAL DESIGN OF ACOUSTIC TREATMENT FOR CABIN NOISE CONTROL OF A LIGHT AIRCRAFT
R. VAICAITIS (Columbia University, New York, NY) and J. S. MIXSON (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 14 p. refs
(Contract NSG-1450; NAS1-16117)
(AIAA PAPER 84-2328)

An analytical procedure has been used to design an acoustic treatment for cabin noise control of a light aircraft. Using this approach acoustic add-on treatments capable of reducing the average noise levels in the cabin by about 17 dB from the untreated condition are developed. The added weight of the noise control package is about 2 percent of the total gross take-off weight of the aircraft. The analytical model uses modal solutions wherein the structural modes of the sidewall and the acoustic modes of the receiving space are accounted for. The additional noise losses due to add-on treatments are calculated by the impedance transfer method. The input noise spectral levels are selected utilizing experimental flight data. The add-on treatments considered for cabin noise control include aluminum honeycomb panels, constrained layer damping tape, porous acoustic materials, noise barriers and limp trim panels. To reduce the noise transmitted through the double wall aircraft windows to acceptable levels, changes in the design of the aircraft window are recommended. Author

A85-10874*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LABORATORY TESTS ON AN AIRCRAFT FUSELAGE TO DETERMINE THE INSERTION LOSS OF VARIOUS ACOUSTIC ADD-ON TREATMENTS
K. E. HEITMAN (NASA, Langley Research Center; U.S. Army, Structures Laboratory, Hampton, VA) and J. S. MIXSON (NASA, Langley Research Center, Structural Acoustics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 9 p. refs
(AIAA PAPER 84-2330)

This paper describes a laboratory study of add-on acoustic treatments for a propeller-driven light aircraft fuselage. The treatments included: no treatment (i.e., baseline fuselage); a production-type double-wall interior; and various amounts of high density fiberglass added to the baseline fuselage. The sound source was a pneumatic-driver with attached exponential horn, supplied with a broadband signal. Data were acquired at the approximate head positions of the six passenger seats. The results were analyzed on space-averaged narrowband, one-third octave band and overall insertion loss basis. In addition, insertion loss results for the different configurations at specific frequencies representing propeller tone spectra are presented. The propeller tone data includes not only the space-averaged insertion loss, but also the variation of insertion loss at these particular frequencies across the six microphone positions. Author

A85-10875*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFECTS OF ACOUSTIC TREATMENT ON THE INTERIOR NOISE LEVELS OF A TWIN-ENGINE PROPELLER AIRCRAFT - EXPERIMENTAL FLIGHT RESULTS AND THEORETICAL PREDICTIONS

T. B. BEYER, C. A. POWELL, E. F. DANIELS, and L. D. POPE (NASA, Langley Research Center, Structural Acoustics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 8 p. refs

(AIAA PAPER 84-2331)

In-flight noise level measurements were made within two cabin configurations of a general aviation business aircraft. The Fairchild Merlin IVC twin-engine aircraft was tested with bare walls and fiberglass insulation and in an executive trim configuration. Narrow-band and octave format data were subjected to analyses which permitted identification of the blade passage harmonics (BPH). Cabin noise level reductions (insertion losses) due to added insulation varied with position in the cabin, the BPH number, cabin pressure, and engine torque. The measurements were closely predicted using the propeller aircraft interior noise (PAIN) mode. M.S.K.

A85-10885*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

REVIEW OF RECENT RESEARCH OF INTERIOR NOISE OF PROPELLER AIRCRAFT

J. S. MIXSON and C. A. POWELL (NASA, Langley Research Center, Structural Acoustics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 28 p. refs

(AIAA PAPER 84-2349)

Publications on the topics of propeller source noise, airborne noise transmission, and passenger comfort response to noise and vibration are reviewed. Of the 187 publications referenced, 140 have appeared since 1978. Examples of research accomplishments are presented to illustrate the state of the art. Emphasis is on comparisons of theoretical and measured results, but the description of the theories is left to the references. This review shows that substantial progress has been made in understanding the characteristics of propeller noise, airborne noise, and passenger response, and in the development of prediction methods. Application of the technology to cabin noise control and possible future research directions are discussed. Author

A85-10897#

PROPELLER NOISE MEASUREMENTS IN DNW ON THE FUSELAGE OF A TWIN ENGINE AIRCRAFT MODEL

T. ZANDBERGEN (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands), S. L. SARIN (Fokker, Schiphol, Netherlands), and R. P. DONNELLY (Dowty Rotol, Ltd., Gloucester, England) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs

(AIAA PAPER 84-2367)

Results of sound pressure measurements on the fuselage wall on a twin engine propeller driven model are presented. The tests were carried out in the German-Dutch low speed wind tunnel DNW in the Netherlands. The model was equipped with either metallic propeller blades or composite blades. The propeller diameter was 0.762 m. Six microphones were installed in the area of minimum propeller tip clearance. The experimental data obtained at several wind speeds, angles of attack and propeller rotational speeds show encouraging comparisons with free field and installed noise predictions derived using theoretical and/or empirical methods. Author

A85-10898*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

NOISE CONTROL CHARACTERISTICS OF SYNCHROPHASING - AN ANALYTICAL INVESTIGATION

C. R. FULLER (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 10 p. refs

(Contract NAG1-390)

(AIAA PAPER 84-2369)

In this paper the noise control characteristics of synchrophasing are investigated using a simplified model of an aircraft fuselage. The analysis presented here includes directivity effects of the noise sources and solves in closed form the coupled motion between the interior and exterior acoustic fields and the shell vibrational response. The variation in sound pressure level at various locations inside the shell is studied for various synchrophase angles as well as the shell vibrational response and input power flow in order to uncover the principal mechanisms behind the transmission phenomena. Author

A85-10899*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

NOISE CONTROL CHARACTERISTICS OF SYNCHROPHASING - AN EXPERIMENTAL INVESTIGATION

J. D. JONES and C. R. FULLER (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 9 p. refs

(Contract NAG1-390)

(AIAA PAPER 84-2370)

A simplified cylindrical model of an aircraft fuselage is used to investigate the mechanisms of interior noise suppression of the synchrophasing technique. This investigation allows isolation of important parameters to define the characteristics of synchrophasing. The optimum synchrophase angle for maximum noise reduction is found for several interior microphone positions with pure tone source conditions. Noise reductions of up to 30dB are shown for some microphone positions, however, overall reductions are less. A computer algorithm is developed to decompose the modal composition of the cylinder vibration over a wide range of synchrophase angles. The circumferential modal response of the shell vibration is shown to govern the transmission of sound into the cylinder rather than localized transmission. Author

A85-10900#

ALTERNATE APPROACH TO AIRCRAFT INTERIOR NOISE CONTROL. I DAMPED TRIM PANELS

C. I. HOLMER (Cabot Corp., E.A.R. Div., Indianapolis, IN) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 10 p. refs

(AIAA PAPER 84-2371)

The attenuation mechanisms for interior trim panel systems are reviewed. The significance of structureborne transmission through trim attachments is emphasized. The significant factors for high frequency performance include: density of attachments, panel critical frequency, and panel damping. The need for sufficient damping below and maximal damping above trim panel critical frequency is described. Two experimental flight demonstrations are described which emphasize the role of trim panel damping. One program involves new interior system design for a large business jet. Utilization of portions of the weight budget in the form of structural damping treatments permitted a 40 + percent weight savings in acoustical materials with no significant increase in cabin noise levels. Significant reductions in noise levels were achieved in the cockpit, galley and lav. A second program involved a commercial twin engine jet, with a design objective of significant reduction in noise with minimal weight increase. A reduction of 5 dBA and 5 dB SIL in cabin average noise was achieved with only a 0.7 percent incrase in Maximum Gross Takeoff Weight. Only simple add-on skin, trim, and bulkhead damping treatments were used. Author

A85-10901#
ALTERNATE APPROACH TO AIRCRAFT INTERIOR NOISE CONTROL. II SELF-SUPPORTING DAMPED INTERIOR SHELL
C. I. HOLMER (Cabot Corp., E.A.R. Div., Indianapolis, IN) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 8 p. refs
(AIAA PAPER 84-2372)
The companion paper presents theoretical and experimental data identifying the significance of panel critical frequency and structural damping in controlling trim panel dynamic response from excitation at attachment points. This paper explores a logical extension to the trim panel system. The shell presents several desirable non-acoustic properties which may offer design or construction economies. Of concern here are the design considerations which can turn potential acoustic problems into significant advantages. The high stiffness, necessary to make the shell self supporting, may provide improved low frequency performance in the vicinity of the double wall resonance. The low critical frequency, usually implied by this stiffness, may be controlled through design of the panel dynamic properties, judicious location of attachment points, and effective vibration isolation. Quantitative approaches to each of these issues are explored. A successful installation in one aircraft is described. Author

A85-11249
HELICOPTER STABILITY [PROCHNOST' VERTOLETOV]
R. A. MIKHEEV Moscow, Izdatel'stvo Mashinostroenie, 1984, 280 p. In Russian. refs
A handbook describing a number of technical problems associated with helicopter stability is presented. Attention is given to several mathematical methods for analyzing the destabilizing effects of rotor oscillation, vibration, flutter, ground resonance, and flight loads. Several experimental methods for improving helicopter stability are identified, and the theoretical basis for stability control systems is discussed in detail. Graphic illustrations of the important structural components used for stability control in rotary wing aircraft are provided. I.H.

A85-11473
HELICOPTER GROUND RESONANCE - A SPATIAL MODEL ANALYSIS
M. N. NAHAS (King Abdulaziz University, Jeddah, Saudi Arabia) Aeronautical Journal (ISSN 0001-9240), vol. 88, Aug.-Sept. 1984, p. 299-308. refs
Classic theory of helicopter ground resonance studies the phenomenon on a planar model obtained by reducing the dynamic parameters of the full helicopter into the plane of rotation. In this paper the phenomenon is studied on a spatial helicopter model of six degrees of body freedom. It is found that in general there exist six regions of instability, whereas the planar theory of Coleman determines only one region. The theoretical results obtained here are verified by experiments conducted on a dynamic model of helicopter. In addition, this paper reviews all the existing analyses which have studied the problem. Author

A85-11475
THE PREDICTION OF BUFFETING RESPONSE IN FLIGHT FROM WIND-TUNNEL MEASUREMENTS ON MODELS OF CONVENTIONAL CONSTRUCTION
G. F. BUTLER and J. G. JONES (Royal Aircraft Establishment, Flight Systems Dept., Farnborough, Hants., England) Aeronautical Journal (ISSN 0001-9240), vol. 88, Aug.-Sept. 1984, p. 317-325. refs
A technique for the prediction of buffeting response in flight from wind-tunnel tests on models of conventional construction is described and assessed. Results are presented from tests on models of a Gnat T Mk 2 trainer aircrft, and predictions are compared with flight measurements of buffeting made during high incidence maneuvers. Flight/tunnel comparisons of buffeting response measurements on the TACT F-111 and SAAB 105 aircraft are also discussed. In general, good agreement is demonstrated between measured and predicted responses. Some remarks are also made on the determination of damping ratios from accelerometer or strain gauge readings recorded under buffeting conditions. Author

A85-11983#
WING DESIGN FOR MINIMUM DRAG WITH PRACTICAL CONSTRAINTS
T. MCGEER (Simon Fraser University, Burnaby, British Columbia, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 879-886. refs
General design characteristics of wings that offer minimum drag while satisfying a variety of practical constraints are sought, including primarily a constraint upon structural weight. The essential elements of aerodynamics and structures, when combined with analytical optimization, lead to a series of solutions for lift, chord, and thickness distributions across the span. Although the optimized wings do not differ radically from current practice in these distributions, they can offer significantly lower drag. For high subsonic wings of given structural weight, elasticity, and maximum load factor, forward rather than aft sweep promises a reduction in cruise induced drag of about 10 percent. Wings whose weight is a large fraction of the total lift, as in sailplanes, may realize larger reductions. Author

A85-11986#
MEASUREMENT OF TRANSONIC DIPS IN THE FLUTTER BOUNDARIES OF A SUPERCRITICAL WING IN A WIND TUNNEL
A. J. PERSOON, J. J. HORSTEN, and J. J. MEIJER (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 2, p. 664-675) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 906-912. Research supported by the Nederlands Institut voor Vliegtuigontwikkeling en Ruimtevaart. Previously cited in issue 12, p. 1703, Accession no. A83-29878. refs

A85-11988#
DIVERGENCE SPEED DEGRADATION OF FORWARD-SWEPT WINGS WITH DAMAGED COMPOSITE SKIN
F. E. EASTEP (Dayton, University, Dayton, OH), V. B. VENKAYYA, and V. A. TISHLER (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 921-923. refs
A computation scheme is proposed for the prediction of the effects of damage to the composite skin of a forward swept wing. The wing selected for investigation is swept forward through 30 degrees and is constructed from graphite-epoxy composites. The wing structure is represented by a finite element model and incompressible aerodynamic strip theory is used to generate the aerodynamic loading for the divergence condition. Results are obtained from the integration of the model for only one preselected damage location. A description is offered of the damage in 17 different cases in the form of a table. The method is considered to be rapid enough to permit damage analysis from a number of different locations without a complete divergence analysis. I.H.

A85-12175
HUGHES' NEW ATTACKERS
M. GAINES Flight International (ISSN 0015-3710), vol. 126, Oct. 6, 1984, p. 875-879.
Attention is given to the design features and performance characteristics of the 530MG 'Defender' light attack helicopter, and to the 'Sea Apache' variant of the AH-64 helicopter that has been proposed for use by the U.S. Navy and Marine Corps. The primary weapons of the 530MG are four TOW antitank missiles, together with two 0.5-in. machine gun pods. The primary flight instrument is a multifunction CRT display which presents navigation, power management, communications, TOW missile guidance data and caution warnings in an integrated fashion. The proposed Sea Apache helicopter will carry Harpoon antiship missiles, Sidewinder air-to-air missiles, and a 30-mm chain gun. Both antishipping and ground support (Marine) roles will be undertaken by this design. O.C.

A85-12351#
STATE-OF-ART AND FUTURE OF AICRAFT STRUCTURE DESIGN AND STRENGTH ANALYSIS
Y. HUANG and D. ZHU (Northwestern Polytechnical University, Xian, Shaanxi, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 103-111. In Chinese, with abstract in English. refs

The state of the art and future prospects of design and strength analysis of aircraft structures are briefly reviewed. The subjects discussed include: modern procedures in aircraft structure design, the finite element method and structural analysis programming, mode active control technology and analytical method, the application of fatigue and fracture, advanced composite structures, serious environmental conditions, and reliability analysis for structures. Author

A85-12357#
DETERMINATION OF THE AXIS AND THE ANGLE OF ROTATION FOR A RETRACTABLE LANDING GEAR
Q. ZHANG (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 157-162. In Chinese, with abstract in English. refs

The analytical determination of the axis and angle of rotation for a retractable landing gear is considered. The rotation matrix about a skew axis is used to obtain the one point of three on a rigid body before and after rotation about an axis, when the two other points are given. An improvement on the calculation of the axis and the angle of rotation is given and a numerical landing gear problem is solved. The results may also be applied to the design of retractable mechanisms for antennas and sensors on spacecraft. C.D.

N85-10021# Lockheed-Georgia Co., Marietta.
TRANSONIC WING AND FAR FIELD TEST DATA ON A HIGH ASPECT RATIO TRANSPORT WING FOR THREE DIMENSIONAL COMPUTATIONAL METHOD EVALUATION
K. P. BURDGES and B. L. HINSON *In* AGARD Exptl. Data Base for Computers Program Assessment p Jul. 1984 refs
Avail: NTIS HC A07/MF A01

Force and pressure data were obtained on a moderate aspect ratio transport wing that is representative of high performance supercritical technology. The pressure distributions on this wing exhibit recompression of the local supersonic flow over the front part of the wing, terminating the supersonic region with a moderate strength, swept shock wave. Far field boundary conditions were measured to provide a rigorous test case for theoretical models and eliminate uncertainties about wind tunnel wall effects. Tables show pressure coefficients with m=0.62, 0.80, 0.82, and 0.84 for the upper and lower surfaces and the far field. Lift, pitching moments, and drag data are summarized in graphs. A.R.H.

N85-10032*# United Technologies Research Center, East Hartford, Conn.
HELICOPTER ROTOR BLADE DESIGN FOR MINIMUM VIBRATION Final Report
R. B. TAYLOR Washington NASA Oct. 1984 144 p refs
(Contract NAS2-11025)
(NASA-CR-3825; NAS 1.26:3825; AVSCOM-TR-84-A-2; R33-915783-27) Avail: NTIS HC A07/MF A01 CSCL 01C

The importance of blade design parameters in rotor vibratory response and the design of a minimum vibration blade based upon this understanding are examined. Various design approaches are examined for a 4 bladed articulated rotor operating at a high speed flight condition. Blade modal shaping, frequency placement, structural and aerodynamic coupling, and intermodal cancellation are investigated to systematically identify and evaluate blade design parameters that influence blade airloads, blade modal response, hub loads, and fuselage vibration. The relative contributions of the various components of blade force excitation and response to the vibratory hub loads transmitted to the fuselage are determined in order to isolate primary candidates for vibration alleviation. A blade design is achieved which reduces the predicted fuselage vibration from the baseline blade by approximately one half. Blade designs are developed that offer significant reductions in vibration (and fatigue stresses) without resorting to special vibration alleviation devices, radical blade geometries, or weight penalties. M.A.C.

N85-10033*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A MATHEMATICAL SIMULATION MODEL OF THE CH-47B HELICOPTER, VOLUME 1
J. M. WEBER, T. Y. LIU (Computer Sciences Corp.), and W. CHUNG (Computer Sciences Corp.) Aug. 1984 137 p refs 2 Vol.
(NASA-TM-84351-VOL-1; A-9303-VOL-1; NAS 1.15:84351-VOL-1)
Avail: NTIS HC A07/MF A01 CSCL 01C

A nonlinear simulation model of the CH-47B helicopter was adapted for use in the NASA Ames Research Center (ARC) simulation facility. The model represents the specific configuration of the ARC variable stability CH-47B helicopter and will be used in ground simulation research and to expedite and verify flight experiment design. Modeling of the helicopter uses a total force approach in six rigid body degrees of freedom. Rotor dynamics are simulated using the Wheatlely-Bailey equations including steady-state flapping dynamics. Also included in the model is the option for simulation of external suspension, slung-load equations of motion. Author

N85-10034*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
ROTOR SYSTEMS RESEARCH AIRCRAFT AIRPLANE CONFIGURATION FLIGHT-TEST RESULTS Final Report
W. D. PAINTER and R. E. ERICKSON (NASA. Ames Research Center) Oct. 1984 13 p refs Presented at the AIAA Aircraft Design Systems and Operations Meeting, San Diego, Calif., 31 Oct. - 2 Nov. 1984
(NASA-TM-85911; H-1263; NAS 1.15:85911; AIAA-84-2465)
Avail: NTIS HC A02/MF A01 CSCL 01C

The rotor systems research aircraft (RSRA) has undergone ground and flight tests, primarily as a compound aircraft. The purpose was to train pilots and to check out and develop the design flight envelope. The preparation and flight test of the RSRA in the airplane, or fixed-wind, configuration are reviewed and the test results are discussed. E.A.K.

N85-10035*# National Aeronautics and Space Administration, Washington, D. C.
DFVLR ROTORCRAFT: CONSTRUCTION AND ENGINEERING
H. J. LANGER Aug. 1984 64 p Transl. into ENGLISH of "DFVLR-rotorversuchsstand-konstruktion und entwicklung" rept. Brunswick, 1984 60 p Transl. by Scientific Translation Service, Santa Barbara, Calif. Original doc. prep. by Inst. fuer Flugmechanik, DFVLR, Brunswick
(Contract NASW-3542)
(NASA-TM-77740; NAS 1.15:77740) Avail: NTIS HC A04/MF A01 CSCL 01C

A helicopter rotor test stand is described. Full scale helicopter components can be tested such as hingeless fiberglass rotors and two blade rotor with flapping hinge, or a hybrid system. The facility is used to test stability, rotor components and downwind components. M.A.C.

N85-10036*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
APPLICATIONS OF NUMERICAL OPTIMIZATION METHODS TO HELICOPTER DESIGN PROBLEMS: A SURVEY
H. MIURA Oct. 1984 24 p refs
(NASA-TM-86010; A-9856; NAS 1.15:86010) Avail: NTIS HC A02/MF A01 CSCL 01C

A survey of applications of mathematical programming methods is used to improve the design of helicopters and their components. Applications of multivariable search techniques in the finite dimensional space are considered. Five categories of helicopter design problems are considered: (1) conceptual and preliminary design, (2) rotor-system design, (3) airframe structures design, (4) control system design, and (5) flight trajectory planning. Key technical progress in numerical optimization methods relevant to rotorcraft applications are summarized. M.A.C.

N85-10037*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.
DESIGN OF A DIGITAL RIDE QUALITY AUGMENTATION SYSTEM FOR COMMUTER AIRCRAFT Final Report
T. A. HAMMOND, S. P. AMIN, J. D. PADUANO, and D. R. DOWNING Oct. 1984 366 p refs
(Contract NAG1-345)
(NASA-CR-172419; NAS 1.26:172419) Avail: NTIS HC A16/MF A01 CSCL 01C

Commuter aircraft typically have low wing loadings, and fly at low altitudes, and so they are susceptible to undesirable accelerations caused by random atmospheric turbulence. Larger commercial aircraft typically have higher wing loadings and fly at altitudes where the turbulence level is lower, and so they provide smoother rides. This project was initiated based on the goal of making the ride of the commuter aircraft as smooth as the ride experienced on the major commercial airliners. The objectives of this project were to design a digital, longitudinal mode ride quality augmentation system (RQAS) for a commuter aircraft, and to investigate the effect of selected parameters on those designs. Author

N85-10038# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
AIRWORTHINESS AND FLIGHT CHARACTERISTICS TEST OF THE JOH-6A LIGHT COMBAT HELICOPTER CONFIGURED WITH A WIRE STRIKE PROTECTION SYSTEM Final Report, 30 Aug. - 2 Sep. 1983
J. L. WEBRE, R. WORATSCHEK, E. L. MITCHELL, and R. S. ADLER Nov. 1983 52 p
(AD-A144880) Avail: NTIS HC A04/MF A01 CSCL 01C

A limited airworthiness and flight characteristics test on the JOH-6A Light Combat helicopter (LCH) configured with a wire strike protection system (WSPS) was conducted to substantiate the airworthiness. Tests were conducted at Edwards in four flights totaling 4.1 productive flight hours. The insufficient ground clearance of the lower cutter allows contact with the ground and is a deficiency. The handling qualities of the JOH-6A LCH with WSPS installed are essentially unchanged from the JOH-6A LCH without WSPS. GRA

N85-10039# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
AIRWORTHINESS AND FLIGHT CHARACTERISTICS (A AND FC) TEST OF THE EH - 1X/EH - 1H HELICOPTER CONFIGURATIONS Final Report, 26 Jul. - 19 Sep. 1983
G. T. DOWNS, J. M. ADKINS, J. I. NAGATA, J. L. KIMBERLY, and J. L. LINEHAN Jan. 1984 74 p
(AD-A144881) Avail: NTIS HC A04/MF A01 CSCL 01C

Level flight performance tests were conducted on five EH-1X/EH-1H helicopter configurations to determine the change in drag characteristics with the addition of external mission equipment to the standard UH-1H helicopter configuration. Comparison of data from a baseline test configuration with previously published UH-1H and YUH-1H data indicated approximately 8.0 increase in equivalent flat plate area which was attributed to the external mission antennas, low reflective infrared/optical paint, and heat suppression kit with vertical exhaust ejector. Installation of the M-130 chaff/flare dispensers resulted in a further increase in equivalent flat plate area of 5.0 sq ft. Replacing the vertical exhaust ejector with the hot metal plus plume infrared suppressor, including the ALQ-144 countermeasures jammer resulted in a reduction in equivalent flat plate area of 1.5 sq ft. Installation of the direction finding antennas resulted in no measurable increase in drag. Addition of all external mission equipment and the hot metal plus plume exhaust resulted in a total increased equivalent flat plate area of approximately 11.5 sq ft. from the standard UH-1H helicopter. GRA

N85-10040# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
THE INFLUENCE OF LARGE SCALE COMPUTING ON AIRCRAFT STRUCTURAL DESIGN
Loughton, England Aug. 1984 55 p refs Meeting held in Sienna, Italy, 2-6 Apr. 1984
(AGARD-R-706; ISBN-92-835-0364-3) Avail: NTIS HC A04/MF A01

Advances in large scale computing capacity and how they affect aeronautical design are reported. The use of vector processing to solve aircraft structural problems, the influence of new computing systems on computational mechanisms, and use of artificial intelligence in design processing is discussed. The role of AGARD and its response to the challenge is examined.

N85-10042*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
IMPACT OF NEW COMPUTING SYSTEMS ON COMPUTATIONAL MECHANICS AND FLIGHT-VEHICLE STRUCTURES TECHNOLOGY
A. K. NOOR, O. O. STORAASLI, and R. E. FULTON *In* AGARD The Influence of Large Scale Computing on Aircraft Struct. Design 29 p Aug. 1984 refs
Avail: NTIS HC A04/MF A01 CSCL 01C

Advances in computer technology which may have an impact on computational mechanics and flight vehicle structures technology were reviewed. The characteristics of supersystems, highly parallel systems, and small systems are summarized. The interrelations of numerical algorithms and software with parallel architectures are discussed. A scenario for future hardware/software environment and engineering analysis systems is presented. Research areas with potential for improving the effectiveness of analysis methods in the new environment are identified. E.A.K.

N85-10043# Cranfield Inst. of Tech., Bedford (England). College of Aeronautics.
LARGE SCALE COMPUTING IN AERONAUTICAL DESIGN
A. J. MORRIS *In* AGARD The Influence of Large Scale Computing on Aircraft Struct. Design 4 p Aug. 1984
Avail: NTIS HC A04/MF A01

The use of new advances in large scale computing and software techniques and how they create comprehensive design programs is outlined. The role of artificial intelligence in making large design programs accessible to the single user is emphasized. The AGARD response to the challenge posed by the new a situation is discussed and a series of tasks is proposed. E.A.K.

N85-10399*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
CRASHWORTHINESS OF LIGHT AIRCRAFT FUSELAGE STRUCTURES: A NUMERICAL AND EXPERIMENTAL INVESTIGATION
A. P. NANYARO, R. C. TENNYSON, and J. S. HANSEN *In* NASA. Langley Research Center Res. in Struct. and Dyn., 1984 p 325-346 Oct. 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01C

The dynamic behavior of aircraft fuselage structures subject to various impact conditions was investigated. An analytical model was developed based on a self-consistent finite element (CFE) formulation utilizing shell, curved beam, and stringer type elements. Equations of motion were formulated and linearized (i.e., for small displacements), although material nonlinearity was retained to treat local plastic deformation. The equations were solved using the implicit Newmark-Beta method with a frontal solver routine. Stiffened aluminum fuselage models were also tested in free flight using the UTIAS pendulum crash test facility. Data were obtained on dynamic strains, g-loads, and transient deformations (using high speed photography in the latter case) during the impact process. Correlations between tests and predicted results are presented, together with computer graphics, based on the CFE model. These results include level and oblique angle impacts as well as the free-flight crash test. Comparisons with a hybrid, lumped mass finite element computer model demonstrate that the CFE formulation provides the test overall agreement with impact test data for comparable computing costs. A.R.H.

N85-10400*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ANALYSIS OF A TRANSPORT FUSELAGE SECTION DROP TEST
E. L. FASANELLA (Kentron International, Inc., Hampton, Va.), R. J. HAYDUK, M. P. ROBINSON, and E. WIDMAYER (Boeing Commercial Airplane Co., Seattle) *In its* Res. in Struct. and Dyn., 1984 p 347-368 Oct. 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01C

Transport fuselage section drop tests provided useful information about the crash behavior of metal aircraft in preparation for a full-scale Boeing 720 controlled impact demonstration (CID). The fuselage sections have also provided an operational test environment for the data acquisition system designed for the CID test, and data for analysis and correlation with the DYCAST nonlinear finite-element program. The correlation of the DYCAST section model predictions was quite good for the total fuselage crushing deflection (22 to 24 inches predicted versus 24 to 26 inches measured), floor deformation, and accelerations for the floor and fuselage. The DYCAST seat and occupant model was adequate to approximate dynamic loading to the floor, but a more sophisticated model would be required for good correlation with dummy accelerations. Although a full-section model using only finite elements for the subfloor was desirable, constraints of time and computer resources limited the finite-element subfloor model to a two-frame model. Results from the two-frame model indicate that DYCAST can provide excellent correlation with experimental crash behavior of fuselage structure with a minimum of empirical force-deflection data representing structure in the analytical model. A.R.H.

N85-10931 Virginia Polytechnic Inst. and State Univ., Blacksburg.
ON-BOARD NEAR-OPTIMAL CLIMB-DASH ENERGY MANAGEMENT Ph.D. Thesis
A. WESTON 1983 125 p
Avail: Univ. Microfilms Order No. DA8415977

A method suitable for an onboard guidance system is presented which makes use of the ideas that the energy determines the optimal attitude and path angle, and trajectories which do not initially lie on the optimal schedule rapidly fair into it. (The optimal schedule is an Euler solution to the two point boundary value problem, found by a multiple shooting technique). This transition which occurs instantaneously in the energy model, is approximated by the use of a feedback control law. The gains are determined by numerical differentiation about the nominal optimal path. Once the nominal path and the feedback gains have been found as functions of energy, they are represented using cubic splines for real time implementation, requiring minimal onboard computational and storage capabilities. The problem which was studied was to maximize range in symmetric flight with fuel open. Some computational results are presented comparing the paths generated by the feedback law to Euler solutions from the same point. Dissert. Abstr.

N85-10932*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ROLE OF RESEARCH AIRCRAFT IN TECHNOLOGY DEVELOPMENT Final Report
K. J. SZALAI 1984 30 p refs Presented at the AIAA/AHS/ASEE Aircraft Design Systems and Operation Meeting, 31 Oct. - 2 Nov. 1984, San Diego, Calif.
(NASA-TM-85913; H-1265; NAS 1.15:85913; AIAA-PAPER-A84-2473) Avail: NTIS HC A03/MF A01 CSCL 01C

The United States's aeronautical research program has been rich in the use of research aircraft to explore new flight regimes, develop individual aeronautical concepts, and investigate new vehicle classes and configurations. This paper reviews the NASA supercritical wing, digital fly-by-wire, HiMAT, and AD-1 oblique-wing flight research programs, and draws from these examples general conclusions regarding the role and impact of research aircraft in technology development. The impact of a flight program on spinoff technology is also addressed. The secondary, serendipitous results are often highly significant. Finally, future research aircraft programs are examined for technology trends and expected results. Author

N85-10933*# Boeing Commercial Airplane Co., Seattle, Wash. Preliminary Design Dept.
HYBRID LAMINAR FLOW CONTROL STUDY Final Technical Report
Oct. 1982 166 p refs
(Contract NAS1-15325)
(NASA-CR-165930; NAS 1.26:165930; D6-49359) Avail: NTIS HC A08/MF A01 CSCL 01C

Hybrid laminar flow control (HLFC) in which leading edge suction is used in conjunction with wing pressure distribution tailoring to postpone boundary layer transition and reduce friction drag was examined. Airfoil design characteristics required for laminar flow control (LFC) were determined. The aerodynamic design of the HLFC wing for a 178 passenger commercial turbofan transport was developed, and a drag was estimated. Systems changes required to install HLFC were defined, and weights and fuel economy were estimated. The potential for 9% fuel reduction for a 3926-km (2120-nmi) mission is identified. E.A.K.

N85-10934*# Boeing Commercial Airplane Co., Seattle, Wash.
ADVANCED COMPOSITE STABILIZER FOR BOEING 737 AIRCRAFT Quarterly Technical Progress Report, 19 Jul. 1978 - 18 Oct. 1978
1978 28 p refs
(Contract NAS1-15025)
(NASA-CR-168451; NAS 1.26:168451; DRL-018; QTPR-5) Avail: NTIS HC A03/MF A01 CSCL 01C

Activities related to development of an advanced composites stabilizer for the Boeing 737 commercial transport are reported. Activities include discussion of the design and weight status, stiffness requirements, the finite element model, test programs, quality assurance, and manufacturing producibility studies. Design details of the graphite/epoxy components are virtually complete. Emphasis is placed on the metal and fiberglass trailing edge components. The bending and torsional stiffness properties are satisfactory for both stability/control and for flutter requirements. The finite element model input geometry is revised to reflect the latest changes to production drawings. M.A.C.

N85-10935*# Boeing Commercial Airplane Co., Seattle, Wash. Preliminary Design Dept.
AIRCRAFT SURFACE COATINGS Final Summary Report, Aug. 1977 - Feb. 1982
Washington NASA Jan. 1983 34 p refs
(Contract NAS1-14742; NAS1-15325)
(NASA-CR-3661; NAS 1.26:3661; D6-51151) Avail: NTIS HC A03/MF A01 CSCL 01C

A series of studies in which films and liquid spray-on materials were evaluated in the laboratory for transport aircraft external surface coatings are summarized. Elastomeric polyurethanes were found to best meet requirements. Two commercially available products, CAAPCO B-274 and Chemglaze M313, were subjected to further laboratory testing, airline service evaluations, and drag-measurement flight tests. It was found that these coatings were compatible with the severe operating environment of airlines and that coatings reduced airplane drag. An economic analysis indicated significant dollar benefits to airlines from application of the coatings. R.J.F.

N85-10936*# Douglas Aircraft Co., Inc., Long Beach, Calif.
RESULTS OF WINGLET DEVELOPMENT STUDIES FOR DC-10 DERIVATIVES Final Report
C. A. SHOLLENBERGER, J. W. HUMPHREYS, F. S. HEIBERGER, and R. M. PEARSON Washington NASA Mar. 1983 164 p refs
(Contract NAS1-15327)
(NASA-CR-3677; NAS 1.26:3677; ACEE-17-FR-1682) Avail: NTIS HC A08/MF A01 CSCL 01C

The results of investigations into the application of winglets to the DC-10 aircraft are presented. The DC-10 winglet configuration was developed and its cruise performance determined in a previous investigation. This study included high speed and low speed wind tunnel tests to evaluate aerodynamic characteristics, and a subsonic flutter wind tunnel test with accompanying analysis and evaluation of results. Additionally, a configuration integration study employed the results of the wind tunnel studies to determine the overall impact of the installation of winglets on the DC-10 aircraft. Conclusions derived from the high speed and low speed tests indicate that the winglets had no significant effects on the DC-10 stability characteristics or high speed buffet. It was determined that winglets had a minimal effect on aircraft lift characteristics and improved the low speed aircraft drag under high lift conditions. The winglets affected the DC-10 flutter characteristics by reducing the flutter speed of the basic critical mode and introducing a new critical mode involving outer wing torsion and longitudinal bending. The overall impact of winglets was determined to be of sufficient benefit to merit flight evaluation. Author

N85-10937# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
PRELIMINARY AIRWORTHINESS EVALUATION OF THE RUTAN AIRCRAFT FACTORY (RAF), INC. LONG-EZ AIRPLANE WITH EXTERNAL SIGHT Final Report, 12 Mar. - 10 Apr. 1984
D. L. UNDERWOOD, G. M. YAMAKAWA, T. L. REYNOLDS, and W. F. CARMONA May 1984 108 p
(AD-A145381; USAAEFA-84-04) Avail: NTIS HC A06/MF A01 CSCL 01C

The US Army Aviation Engineering Flight Activity conducted a Preliminary Airworthiness Evaluation of the LONG-EZ airplane with an external sensor (Combat Surveillance Airborne Test Bed (CSATB) configuration). During the test program 13 flights were conducted for a total of 15.3 hours, of which 11.6 were productive. The objectives of the evaluation were to assess the performance and handling qualities of the LONG-EZ so that the US Army Aviation systems Command could issue an airworthiness release to allow the 9th Infantry Division to conduct a mission evaluation of the CSATB configured aircraft. All tests were performed at an average gross weight of 1335 pounds and nominal mission longitudinal center of gravity (cg). Test results were compared with basic data obtained during previous testing and evaluated against military specification MIL-F-8785C. The performance was degraded considerably by the installation of the external sensor with handling qualities at the mid cg essentially identical to those obtained near the aft cg limit, FS 104.0, for the basic aircraft. The performance capabilities and handling qualities, however, are adequate for the CSATB evaluation including night operations. GRA

N85-10938# Federal Aviation Agency, Atlantic City, N.J.
QUASI-STEADY ANALYSIS OF AIRCRAFT PANEL FLAMMABILITY Final Report, Apr. 1983 - Apr. 1984
T. I. EKLUND Jun. 1984 32 p
(AD-A145461; DOT/FAA/CT-84/14) Avail: NTIS HC A03/MF A01 CSCL 01C

The purpose of this analysis is the development of a model that relates polymeric material properties to ignitability. The model is developed for an idealized fire test for ignitability of large-scale aircraft honeycomb panels in a vertical orientation. Transport relations for radiative heat transmission and turbulent mass and energy transfer are applied to an idealized piloted ignition of a vertical aircraft panel. The incident radiative energy required for panel ignition is related to thermal decomposition temperatures from thermogravimetric analysis. Effects of pyrolysis energy requirements and temperature dependence of flammability lean limits are incorporated in the analysis. The analysis is quasi-steady, in that transient effects are ignored and a slow ramp heating of the panel is assumed. State-of-the-art panel materials are dominated by radiative effects at the point of ignition. The analysis demonstrates that higher polymer degradation temperatures result in improved fireworthiness, that surface emissivities and reflectivities are the dominant factors controlling the incident radiation needed for ignition, and that the heat of pyrolysis becomes less significant in the energy balance as the polymer degradation temperature is raised. GRA

N85-10939# General Accounting Office, Washington, D. C. National Security and International Affairs Div.
PERFORMANCE CAPABILITIES OF THE C-5 AND C-17 CARGO AIRCRAFT
9 Jul. 1984 21 p
(AD-A145518; GAO/NSIAD-84-119) Avail: NTIS HC A02/MF A01 CSCL 01C

This report discusses Air Force and contractor information on the feasibility of using the C-5A/B and C-17 cargo aircraft in small, austere airfield operations. It also discusses other general characteristics and performance capabilities of both aircraft. Although the manufacturer disagrees, the Air Force, based on its 13 years of C-5A experience, believes that neither the C-5A nor the C-5B can routinely and safely land or takeoff from small, austere airfields. The Air Force further advised us that the C-5A/B is not suited for small airfield ground operations because of its large size and lack of maneuverability. For these reasons, the Air Force states it will continue to restrict routine operations C-17 advantages in the small, austere airfield environment include its smaller size, better maneuverability using its backup capability, and its combat offload capability. The Military Airlift Command states that the C-17 will be able to perform any type of mission currently assigned to the Command, including tactical airlift missions currently performed by the C-130. GRA

N85-10940# Lufthansa G.m.b.H., Hamburg (West Germany).
INSIGHT. BACKGROUND INFORMATION FOR MULTIPURPOSE PILOTS: FLIGHT PHENOMENA [INSIGHT. HINTERGRUND-INFORMATIONEN FUER VIELFLIEGER]
1984 23 p In GERMAN Original contains color illustrations
Avail: NTIS HC A02/MF A01

A flight between Frankfurt and Cairo aboard an Airbus 310 is described. Takeoff, cruise, approach, landing, and braking procedures are summarized and a brief description of the cockpit is included. Author (ESA)

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A85-10628
THE APPROACH TO OPTICAL SYSTEM DESIGNS FOR AIRCRAFT HEAD UP DISPLAYS
C. H. VALLANCE (Marconi Avionics, Ltd., Rochester, Kent, England) IN: Optical system design, analysis, and production; Proceedings of the Meeting, Geneva, Switzerland, April 19-22, 1983 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p. 15-25.

HUD optics configurations departing from the conventional refractive system have been developed with high performance by folding and bending optical systems and by the introduction of holographic elements, enabling reflective system configurations to be realized. Refractive and reflective HUD configurations are examined, and the reflective HUD performance is discussed in terms of fields of view, aberrational performance, display brightness, combiner transmissivity, head motion box-exit pupil, and the outside world obscuration-birdstrike requirement. The Lantirn HUD configured for the A-10 aircraft is examined. B.J.

N85-10044*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
PERIPHERAL VISION HORIZON DISPLAY (PVHD)
Apr. 1984 131 p refs Conf. held at Edwards, Calif., 15-16 Mar. 1983
(NASA-CP-2306; H-1232; NAS 1.55:2306) Avail: NTIS HC A07/MF A01 CSCL 01D

A Canadian invention, the peripheral vision horizon display (PVHD), shows promise in alleviating vertigo or disorientation in pilots flying under instrument conditions and easing the piloting task when flying in weather or other conditions requiring close attention to aircraft attitude instruments. A diversity of research and applied work was being done to investigate and validate the benefits of the PVHD during the years immediately preceding this conference. Organizers of the conference were able to assemble a group of outstanding presenters representing academic, industrial, and military. The theoretical foundation and applied use of the PVHD are discussed, and results from operational tests are presented.

N85-10046*# Maltech Research Corp., Oakville (Ontario).
THE MALCOLM HORIZON: HISTORY AND FUTURE
R. MALCOLM *In* NASA. Dryden Flight Research Center Peripheral Vision Horizon Display (PVHD) p 11-40 Apr. 1984 refs
Avail: NTIS HC A07/MF A01 CSCL 01D

The development of the Malcolm Horizon, a peripheral vision horizon used in flight simulation, is discussed. A history of the horizon display is presented as well as a brief overview of vision physiology, and the role balance plays is spatial orientation. Avenues of continued research in subconscious cockpit instrumentation are examined. M.A.C.

N85-10051*# School of Aerospace Medicine, Brooks AFB, Tex. Crew Technology Div.
EVALUATION OF THE MALCOLM HORIZON IN A MOVING-BASE FLIGHT SIMULATOR
K. K. GILLINGHAM *In* NASA. Dryden Flight Research Center Peripheral Vision Horizon Display (PVHD) p 71-80 Apr. 1984 refs
Avail: NTIS HC A07/MF A01 CSCL 01D

The efficacy of the Malcolm Horizon (MH) in a controlled, simulated, instrument flight environment was examined. Eight flight parameters were used to compare performance under experimental and control conditions. The parameters studied were pitch attitude, roll attitude, turn rate, airspeed, vertical velocity, heading, altitude, and course deviation. Testing of a commercial realization of the MH concept in a flight simulator revealed strengths and weaknesses of the currently available MH hardware. E.R.

N85-10053*# Air Force Flight Test Center, Edwards AFB, Calif.
PERIPHERAL VISION HORIZON DISPLAY ON THE SINGLE SEAT NIGHT ATTACK A-10
D. F. NIMS *In* NASA. Dryden Flight Research Center Peripheral Vision Horizon Display (PVHD) p 89-96 Apr. 1984
Avail: NTIS HC A07/MF A01 CSCL 01D

The concept of the peripheral vision horizon display (PVHD) held promise for significant reduction in workload for the single seat night attack pilot. For this reason it was incorporated in the single seat night attack (SSNA) A-10. The implementation and results of the PVHD on the SSNA A-10 are discussed as well as the SSNA program. The part the PVHD played in the test and the results and conclusions of that effort are also considered. Author

N85-10054*# Air Force Test Pilot School, Edwards AFB, Calif.
PERIPHERAL VISION HORIZON DISPLAY TESTING IN RF-4C AIRCRAFT
L. B. HAMMOND, JR. *In* NASA. Dryden Flight Research Center Peripheral Vision Horizon Display (PVHD) p 97-102 Apr. 1984
Avail: NTIS HC A07/MF A01 CSCL 01D

A test program to assess the capability of the peripheral vision horizon display (PVHD) to provide peripheral attitude cues to the pilot is described. The system was installed in the rear cockpit of a RF-4C aircraft, selected because its poor instrument crosscheck conditions. The PVHD test plan was designed to assess three primary areas: (1) ability of the system to reduce spatial disorientation; (2) ability of the system to aid the pilot in recovering from unusual attitudes; and (3) improvement in pilot performance during instrument landing system (ILS) approaches. Results of preliminary test flights are summarized. The major problem areas concern the distinction of the display itself and the capability of the display to provide pitch motion cues. M.G.

N85-10055*# Calspan Corp., Buffalo, N. Y. Flight Research Dept.
EXTRACTS FROM THE TEST PLAN FOR IN-FLIGHT EVALUATION OF THE NT-33A PERIPHERAL VISION DISPLAY
L. KNOTTS *In* NASA. Dryden Flight Research Center Peripheral Vision Horizon Display (PVHD) p 103-110 Apr. 1984 refs
Avail: NTIS HC A07/MF A01 CSCL 01D

The Peripheral Vision Display (PVD) which presents the pilot with a gyro stabilized artificial horizon projected onto his instrument panel by a laser light source is outlined. During instrument flight conditions, such a display allows the pilot to gain attitude awareness by sensing the horizon line through his peripheral vision. The pilot can detect changes to aircraft attitude without continuously referring back to his flight instruments. A second generation PVD unit was installed in the USAF/Calspan NT-33A during late 1982. An NT-33A flight evaluation of the display provides a unique opportunity to utilize a Workload Assessment Device (WAD) to obtain quantitative data regarding the utility of the PVD in reducing pilot workload. The experimental design and procedures for a two phase NT-33 PVD flight evaluation program is described. Author

N85-10056*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
NASA AMES-DRYDEN T-37 DEMONSTRATION COMMENTS
In its Peripheral Vision Horizon Display (PVHD) p 111-112 Apr. 1984 Prepared in cooperation with NASA. Ames Research Center
Avail: NTIS HC A07/MF A01 CSCL 01D

A homemade peripheral vision horizon device (PVHD) made from an eight-ball attitude indicator, with a slit cut at the equator of the eight ball, and a light source at its center that was used on a I-37 for several years is discussed. The instrument produced a sharp white line about one-fourth of an inch that extended completely across the cockpit from about the left to the right quarterpanels. The line remained parallel to the real horizon during all maneuvers. Its brightness and vertical distance from the horizon were adjustable in flight, as was the lateral center-of-rotation in later flights. Flight demonstrations were done on visual flight rules (VFR) moonless nights and over terrain with few lights. Pilot responses were mostly favorable to enthusiastic, with no negative reactions. Problem areas noted were the upright-inverted ambiguity; one pilot recovered inverted following an unusual attitude exercise and a general deterioration in the naturalness of cuing at bank angles greater than 60 deg or pitch attitudes greater than 30 deg. R.J.F.

N85-10057*# Air Force Flight Test Center, Edwards AFB, Calif.
EARLY AIR FORCE FLIGHT TEST CENTER (AFFTC) EXPERIENCE WITH PERIPHERAL VISION HORIZON DISPLAYS (PVHD)
B. L. SCHOFIELD *In* NASA. Dryden Flight Research Center Peripheral Vision Horizon Display (PVHD) p 113-115 Apr. 1984 refs
Avail: NTIS HC A07/MF A01 CSCL 01D

Three separate Air Force Flight Test Center (AFFTC) tests were conducted in 1980 and 1981 on two models of the peripheral vision horizon displays (PVHD) (Malcolm Horizon). A fixed base simulator test was conducted with twenty test pilot subjects using the Flight Simulator Demonstration Model which incorporated a Helium Neon laser as the light bar medium. Two separate flight tests were conducted by the Test Pilot School classes 80A and 80B in a Twin Otter commuter aircraft using the Stage A Model PVHD. The Xenon lighted A Model was tested in its original configuration by class 80A. Class 80B used a modified configuration which incorporated an AFFTC designed and manufactured hood. With the hood, the PVHD projected a thinner, distinct light bar. Only a few general remarks concerning the tests and unrestricted, overall conclusions reached by the author are presented. The conclusions of all three AFFTC evaluations of the PVHD concept were that it has not yet been adequately evaluated. There seems to be a significant learning curve associated with the PVHD and the project pilots for Test Pilot School Class 80B only got a good start on the learning curve. A lengthy learning curve for the PVHD should be anticipated in view of the training period required for the attitude display indicator (ADI). This does seem to point out that the PVHD, in its present form, is simply not as compelling as the natural horizon. It can also be concluded that any attempt at a valid evaluation of the PVHD concept can be done only under instrument meteorological conditions (IMC) or validly simulated IMC conditions. The knee in the learning curve, however, may be reached without full IMC, although it may take much longer to reach. R.J.F.

N85-10058*# Garrett Mfg. Ltd., Rexdale (Ontario).
PERIPHERAL VISION DISPLAYS: THE FUTURE
H. M. ASSENHEIN *In* NASA. Dryden Flight Research Center Peripheral Vision Horizon Display (PVHD) p 117-124 Apr. 1984
Avail: NTIS HC A07/MF A01 CSCL 01D

Several areas of research relating to peripheral vision displays used by aircraft pilots are outlined: fiber optics, display color, and holography. Various capacities and specifications of gas and solid state lasers are enumerated. These lasers are potential sources of green light for the peripheral vision displays. The relative radiance required for rod and cone vision at different wavelengths is presented graphically. Calculated and measured retinal sensitivities (foveal and peripheral) are given for wavelength produced by various lasers. R.S.L.

N85-10059*# Garrett Mfg. Ltd., Rexdale (Ontario).
A PRODUCTION PERIPHERAL VISION DISPLAY SYSTEM
B. HEINMILLER *In* NASA. Dryden Flight Research Center Peripheral Vision Horizon Display (PVHD) p 125-128 Apr. 1984
Avail: NTIS HC A07/MF A01 CSCL 01D

A small number of peripheral vision display systems in three significantly different configurations were evaluated in various aircraft and simulator situations. The use of these development systems enabled the gathering of much subjective and quantitative data regarding this concept of flight deck instrumentation. However, much was also learned about the limitations of this equipment which needs to be addressed prior to wide spread use. A program at Garrett Manufacturing Limited in which the peripheral vision display system is redesigned and transformed into a viable production avionics system is discussed. Modular design, interchangeable units, optical attenuators, and system fault detection are considered with respect to peripheral vision display systems. R.S.F.

N85-10060# Calspan Advanced Technology Center, Buffalo, N.Y.
A PRELIMINARY FLIGHT EVALUATION OF THE PERIPHERAL VISION DISPLAY USING THE NT-33A AIRCRAFT Final Report, Oct. 1982 - Dec. 1983
L. KNOTTS and V. GAWRON Wright-Patterson AFB, Ohio AFWAL Mar. 1984 43 p
(Contract F33615-79-C-3618)
(AD-A145123; CALSPAN-6645-F-13; AFWAL-TR-84-3020) Avail: NTIS HC A03/MF A01 CSCL 01D

The Malcolm Horizon, a Peripheral Vision Display (PVD), was installed in the NT-33A variable stability research aircraft. The display provided the evaluation pilot with a gyro stabilized horizon line of red laser light. An experiment was conducted to determine the effect of the PVD on pilot workload. Workload was inferred from performance on a secondary task, in this case, the Sternberg task generated by the Workload Assessment Device (WAD). The primary piloting task required maintenance of airspeed, altitude, and angle of bank during instrument flight conditions. Nine NT-33A flights were flown by two evaluation pilots. Presence of the PVD reduced the WAD reaction times of one of the pilots. The reaction times of the other pilot showed mixed results. In-flight data and the pilots subjective comments about the display are discussed. Author (GRA)

N85-10061# Boeing Aerospace Co., Seattle, Wash.
LED MULTIFUNCTION KEYBOARD ENGINEERING STUDY Final Technical Report, 25 Sep. 1981 - 30 Sep. 1982
R. J. SPIGER and M. H. TONKIN Wright-Patterson AFB, Ohio AFWAL Jan. 1984 172 p
(Contract F33615-81-C-3624; AF PROJ. 2403)
(AD-A145199; AFWAL-TR-83-3065) Avail: NTIS HC A08/MF A01 CSCL 09B

The purpose of this report is to describe the background system definition which formed the basis for the multifunction keyboard engineering study and to describe the procedures employed and results obtained in conducting the study. The study objectives were: (1) the evaluation of the performance of a sunlight readable multifunction switch using an x-y dot matrix light emitting diode (LED) array and incorporating tactile feedback and (2) definition and evaluation of a multifunction keyboard architecture to use the multifunction switch. The procedures and results obtained in the course of this study were specifically directed toward the evaluation of the performance of a LED programmable pushbutton switch (PPS), developed both as an individual unit and as a component of a multifunction keyboard (MFK). While the PPS display is limited to a single 16 x 35 LED array size, the procedures employed in the evaluation are applicable to LED switch displays in general. Similarly, the procedures and results obtained using the PPS units as a four switch MFK module are illustrative of the operation of larger keyboard matrices up to a maximum of 28 switches. This study is divided into three general areas of effort. First was the establishment of requirements for the switch function and MFK architecture and capabilities. The second covers the evaluation of the PPS switch/display module. Incorporated in this work are measurements of display parameters, electrical and mechanical characteristics, and environmental testing. The third area of effort involved the incorporation of the PPS units and their associated logic and refresh control unit (LRCU) into a MFK system. GRA

N85-10941# Battelle Columbus Labs., Ohio.
AVIONICS INTEGRITY PROGRAM (AVIP). VOLUME 4: FORCE MANAGEMENT. ECONOMIC LIFE CONSIDERATIONS Final Report, Sep. 1983 - Mar. 1984
M. BRIDGMAN, S. R. MCINERNEY, and D. ELDRIDGE Mar. 1984 40 p
(Contract F33657-83-C-0229)
(AD-A145592; ASD-TR-84-5012) Avail: NTIS HC A03/MF A01 CSCL 01C

The study assesses the qualities that defined the economic life of avionic hardware. Economic life is the term often used to refer to the period of time during which financial consideration justify the continued use of an existing system. The study addresses the strategies of logistic support. Terminology of the development of one economic life model computer program is included in the appendix. It is incomplete. It provides a baseline for future work for evaluating the timeframe limits for determining whether continued use of or replacement of a existing system would be more cost effective. Originator assigned keywords include: Life cycle cost; Stockpiling of components; Technological obsolescence; Economic life modeling parameters; and Cost effective. GRA

N85-10942# Gould, Inc., El Monte, Calif. Navcom Systems Div.
AVIONICS INTEGRITY PROGRAM (AVIP). VOLUME 3: PROGRAM COST ASSESSMENT - ENVIRONMENTAL STRESS SCREENING AND DIAGNOSTIC TECHNIQUES Final Report, Sep. 1983 - Mar. 1984
J. L. CAPITANO and D. ELDRIDGE, ed. (Battelle Memorial Inst., Columbus, Ohio) Mar. 1984 56 p Revised
(Contract F33657-83-C-0229)
(AD-A145644; ASD-TR-84-5009) Avail: NTIS HC A04/MF A01 CSCL 01C

This report covers Gould Inc.'s methodology of work with respect to Environmental Stress Screening (ESS) and represents an approach that can be demonstrated to result in increased integrity in the fielded product. It addresses the use of ESS as a concept whose effectiveness is achieved by exposing product to environments harsher than experienced in the field while not shortening its life. The pitfalls of the present procurement philosophy are exposed with major revisions recommended including that some of the funding that is currently in logistics support be spent as part of the initial contract budget to cause these failures to be removed. The total system savings to the Government by accepting a new method of work such as Environmental Stress Screening to reduce a logistics support budget are discussed. Additional topics discussed include: Latent defect removal, Failure diagnosis, Design-for-forgiveness, Quality feedback, Vendor control, Part screens, Corrective action, Combined environmental reliability testing (CERT), and Cost tradeoffs. GRA

N85-10943# Battelle Columbus Labs., Ohio.
AVIONICS INTEGRITY PROGRAM (AVIP). VOLUME 1: PROCUREMENT PHASE ISSUES: DESIGN, MANUFACTURING, AND INTEGRATION Final Report, Sep. 1983 - Mar. 1984
D. ELDRIDGE, E. F. HITT, R. K. THATCHER, and L. D. SCURLOCK Mar. 1984 229 p
(Contract F33657-83-C-0229)
(AD-A145651; ASD-TR-84-5010-VOL-1) Avail: NTIS HC A11/MF A01 CSCL 05A

This report addresses program phases of design, manufacturing and integration. It includes assessments of methodologies of work which can be used to develop a proven, tolerant product capable of withstanding the use environment. The goal of the process described is to eliminate defective piece parts, processes and final product, prior to delivery to the purchasing activity. A tolerable systems engineering process, dealing with activities that are known to take place during each phase can be developed through use of the material provided. GRA

N85-10944# Battelle Columbus Labs., Ohio.
AVIONICS INTEGRITY PROGRAM (AVIP). VOLUME 2: HARDWARE CASE STUDIES Final Report, Sep. 1983 - Mar. 1984
E. F. HITT and D. ELDRIDGE Mar. 1984 27 p 4 Vol.
(Contract F33657-83-C-0229)
(AD-A145689; ASD-TR-84-5011) Avail: NTIS HC A03/MF A01 CSCL 05A

The report presents a review of the efforts that several avionic manufacturers and systems integrators are using to eliminate defective parts and processes in hardware prior to delivery to a procuring activity. Time phasing for the major efforts vary among manufacturers depending on what is perceived to be best within their own realm of manufacturing operations. The resultant data identified areas of concern especially: (1) feedback from the field on the nature and types of errors that are being encountered, (2) the utility of built-in-test/fault-isolation-test, and (3) the specific nature and utilization of test equipment and establishment of data base information obtained from the test equipment. The case studies should be expanded to include data from the various users as well as from the base or depot level repair stations. The data from these organizations, if properly used, could improve the integrity of the product, especially for the next generation avionics systems. GRA

N85-10945# General Accounting Office, Washington, D. C. National Security and International Affairs Div.
INCREASED JOINT AVIONICS STANDARDIZATION COULD RESULT IN MAJOR ECONOMIES AND OPERATIONAL BENEFITS
10 Jul. 1984 32 p
(AD-A145730; AD-F300467; GAO/NSIAD-84-127) Avail: NTIS HC A03/MF A01 CSCL 01D

This report discusses the Department of Defense's efforts to standardize tactical avionics subsystems and the need to provide better support for these activities. The objective was to look at the progress made in standardizing core avionics subsystems by the Joint Services Review Committee for Avionics Components and Subsystems. Top management commitment must be enhanced and funds must be allocated to projects expected to provide major cost-saving and operational benefits. The GAO recommends to: establish a management structure for standardization that includes a high-level sponsor accountable for supporting the JSRC programs through the budget process, determine whether funds for fiscal year 1984 and subsequent years should be reprogrammed to ensure that joint standard avionics systems sponsored by JSRC are developed and available when needed to meet candidate aircraft installation schedules, and establish a dedicated budget line item for joint avionics programs. The DOD agrees with the first two recommendations but does not agree with the last one. GRA

07

AIRCRAFT PROPULSION AND POWER

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

A85-10840#
FAR-FIELD MEASUREMENT AND MODE ANALYSIS OF THE EFFECTS OF VANE/BLADE RATIO ON FAN NOISE
P. J. G. SCHWALLER, A. B. PARRY, M. J. OLIVER (Rolls-Royce, Ltd., Derby, England), and A. ECCLESTON (Rolls-Royce, Inc., Seattle, WA; Rolls-Royce Ltd., Derby, England) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs
(AIAA PAPER 84-2280)

Forward and rearward arc tests on a model fan with various blade/vane ratios are reported. In-duct modal analysis has been used to explain the observed far-field trends in sound power level with both blade/vane ratio and speed. This analysis showed that rotor/vane interactions produce the modes predicted by Tyler and Sofrin and that mode cut-off and its direction of rotation relative to the rotor have significant effects in both forward and rearward arcs. Low vane number designs show benefits over conventional designs at high frequencies for both tonal and broadband noise, but there is a large penalty in both the forward and rear arc for cutting on the blade passing frequency. Author

A85-10841#

ENGINE NOISE MEASUREMENT WITH ACOUSTIC SHIELD WALL

Y. NAKAMURA, T. TAMAKI (Ishikawajima-Harima Heavy Industries Co., Ltd., R&D Dept., Tokyo, Japan), and M. ITOH (JAEC, Tokyo, Japan) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 9 p.

(AIAA PAPER 84-2283)

The real engine noise was measured with acoustic shield wall to separate front radiation from intake duct and rear radiation from exhaust nozzle. Good shielding effect and then the useful noise data for the improvement of prediction scheme or for the noise control design were obtained. Exhaust shield data were compared with model fan noise test results and generally good coincidence was shown proving the validity of both shield test and model test. Author

A85-10878#

APPLICATION AND TEST VERIFICATION OF FINITE ELEMENT ANALYSIS FOR GAS TURBINE EXTENDED REACTION EXHAUST MUFFLER SYSTEMS

D. F. ROSS and C. A. LYON (Garrett Turbine Engine Co., Phoenix, AZ) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 13 p. Research sponsored by the Lockheed-Georgia Co. refs

(AIAA PAPER 84-2334)

Effective suppression of small gas turbine exhaust noise dictates muffler designs utilizing extended reaction resonators to obtain the necessary broadband tuning within a small radial envelope. This paper describes a design procedure for folded-cavity and coupled resonator muffler configurations capable of providing significant broadband attenuation. The analysis technique is based on a Lagrangian finite element method suitable for the complex geometry and boundary conditions encountered in these exhaust systems. An interactive graphics system is incorporated for the preparation of finite element input mesh parameters and the subsequent investigation of the predicted pressure distribution inside the suppressor. To validate the finite element analysis design procedure, a series of exhaust system mufflers was evaluated experimentally on a small gas turbine engine. The results of these comprehensive measurements indicate that significant broadband attenuation is obtained with the folded-cavity mufflers and that the finite element analysis is sufficiently accurate for design purposes. Author

A85-10974#

A STUDY ON CONFIGURATIONS OF CASING TREATMENT FOR AXIAL FLOW COMPRESSORS

H. FUJITA and H. TAKATA (Tokyo, University, Tokyo, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 27, Aug. 1984, p. 1675-1681.

A number of casing treatment configurations have been tested with a view to selecting configurations that would provide the largest stall margin improvement with the smallest loss in compressor efficiency. For all the configurations tested, the relation between the stall margin and the compressor efficiency is described by a smooth curve, i.e., none of the treatment configurations is found to be superior to others. A certain loss in efficiency is inevitable in order to obtain the required improvement in the stall margin. The relationship between the effect of the casing treatment and that of the rotor tip clearance is examined. A comparison is also made between the effects of the casing treatment in the case of an isolated rotor and in the case of a single-stage compressor equipped with the same rotor. V.L.

A85-11617#

A BIAXIAL FATIGUE TEST FOR DOVETAIL JOINTS

P. H. B. BODDINGTON and C. RUIZ (Oxford University, Oxford, England) IN: International Conference on Advances in Life Prediction Methods, Albany, NY, April 18-20, 1983, Proceedings . New York, American Society of Mechanical Engineers, 1983, p. 277-283. Research supported by the Ministry of Defence (Procurement Executive). refs

A small-scale system for reproducing the failure found at the dovetail blade root fixing in turbojets is described. The system consists of a single-blade and a three-blade test specimen, both constructed from epoxy sheets. Dovetails and matching blades were machined using a numerically-controlled milling machine in order to minimize residual contact stresses. The results of initial tests with the system indicate that sheet load is as important a parameter as the circumferential stress in dovetail blade root failure, and that the opening of the dovetail promotes wear over a wide band, accelerating the process of crack initiation. Several photographs and drawings of the experimental setup are provided, and the results are presented in graphic form. I.H.

A85-11821

RESONANCE VIBRATIONS OF SKELETON MODELS OF TURBINE BLADES WITH A COMPOSITE FIR-TREE ROOT [REZONANSNYE KOLEBANIIA STERZHNEVYKH MODELEI TURBINNYKH LOPATOK S SOSTAVNYM ELOCHNYM KHVOSTOVIKOM]

A. P. ZINKOVSKII, M. V. SMERTIUK, V. V. MATVEEV, I. G. TOKAR, and A. IA. ADAMENKO (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), Sept. 1984, p. 85-89. In Russian. refs

A computational model for paired blades with a joint composite root is presented which allows for the elastic-dissipative coupling of the blades through a lock joint. Model computations show that antiphase vibrations may be excited in the blades, in addition to synphase vibrations, when the blades have different natural frequencies. This leads to a significant increase in the vibrational stress of the blades. The results of the calculations are verified experimentally. V.L.

A85-11839

ENERGY CHARACTERISTICS OF THE COMBUSTION CHAMBERS OF AN AIRCRAFT ENGINE WHEN OPERATING ON NATURAL GAS [ENERGETICHESKIE POKAZATELI KAMER SGORANIIA V SOSTAVE AVIADVIGATELIA PRI RABOTE IKH NA PRIRODNOM GAZE]

V. A. KHRISTICH, G. N. LIUBCHIK, V. I. DIDENKO, A. M. SHEVCHENKO, and V. A. ILCHENKO (Kievskii Politekhnicheskii Institut, Kiev, Ukrainian SSR) Energetika (ISSN 0579-2983), Sept. 1984, p. 72-77. In Russian. refs

A method is proposed for estimating the energy efficiency of the combustion chambers of gas turbine engines, and results are presented for seven types of combustion chambers operating on natural gas. It is shown that the combustion process can be optimized by varying the air velocity at the inlet. For a combustion chamber using natural gas, it is calculated that optimum inlet air velocity is 95-100 m/s, which is practically equal to the velocity adopted in the case of kerosene fuel. V.L.

A85-11984#

FUEL EFFECTS ON GAS TURBINE COMBUSTION-LINER TEMPERATURE, PATTERN FACTOR, AND POLLUTANT EMISSIONS

A. H. LEFEBVRE (Purdue University, West Lafayette, IN) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 887-898. USAF-supported research. Previously cited in issue 16, p. 2285, Accession no. A84-35235. refs

A85-12365#
AN EXPERIMENTAL INVESTIGATION ON RESPONSE OF TURBOJET ENGINE TO THE TURBULENCE-TYPE OF DYNAMIC INLET DISTORTION
F. CHEN, W. LI, Z. WANG, M. CONG, B. LU, and L. ZHENG (Northwestern Polytechnical University, Xian, Shaanxi, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 225-232. In Chinese, with abstract in English. refs

The response of a turbojet engine to turbulence-type dynamic inlet total pressure distortion is discussed. The distortion is generated by a blockage plate with 180 deg circumferential extent and 50 percent blockage ratio in the blade-tip and blade-hub region of the inlet section. Strong pressure fluctuation regions are set up at the tip or hub of the blade whose amplitude probability density approximately follows a normal distribution. The distortion causes a drift-mode surge at 100 percent engine speed and at 90 percent when the first stage turbine nozzle area is 12 percent smaller. The inlet distortion generated by the screen produces a classical mode or deep mode surge. The degree of inlet distortion by the screen can change the surge mode, as can a decrease in the turbine nozzle area. The engine speed can affect the unstable behavior of the compressor. C.D.

N85-10062 Department of the Air Force, Washington, D.C.
STALL ELIMINATION AND RESTART ENHANCEMENT DEVICE Patent
F. D. STEPHENS, inventor (to Air Force) 24 Jul. 1984 4 p Supersedes AD-D009929
(AD-D011217; US-PATENT-4,461,145; US-PATENT-APPL-SN-433561; US-PATENT-CLASS-60-226.3)
Avail: US Patent and Trademark Office CSCL 21E

Stall elimination means in a jet turbofan engine includes a plurality of pairs of generally parallel case struts arranged in an annular row in an annular fan bypass duct of the engine, and a series of freely-rotatable vanes, each vane disposed between a pair of the struts and movable between open and closed positions. In its open position, air flow in the duct, while in its closed position it extends generally across the duct and blocks most reverse air flow in the duct. The vane automatically rotates to the closed position in response to the onset of an adverse pressure gradient in the duct. GRA

N85-10063 Department of the Air Force, Washington, D.C.
VARIABLE INLET VANE ASSEMBLY FOR A GAS TURBINE COMBUSTION Patent
C. MARSHALL, inventor (to Air Force) 17 Jul. 1984 7 p Supersedes AD-D009408
(AD-D011220; US-PATENT-4,459,803; US-PATENT-APPL-SN-350493; US-PATENT-CLASS-60-39.23)
Avail: US Patent and Trademark Office CSCL 21E

This patent discloses a variable inlet vane assembly for use within the inlet area of a combustor, the vane assembly having a plurality of rotatable vanes situated within an annular-shaped opening in the inlet area of the combustor. Each vane is operated by the rotation of a crank assembly and actuator. The actuator meshes with the crank assembly through a sliding interface in order to accommodate axial and/or radial growth of the combustor with no loss in the precision of the control of air entering the combustor during rotation of the vanes. Such as arrangement substantially enhances the relight capability of the combustor. GRA

N85-10064*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMBUSTION GAS PROPERTIES I-ASTM JET A FUEL AND DRY AIR
R. E. JONES, A. M. TROUT, J. D. WEAR, and B. J. MCBRIDE Oct. 1984 12 p refs Document incl. microfiche supplement
(NASA-TP-2359; NAS 1.60:2359) Avail: NTIS HC E03/MF A01 CSCL 21E

A series of computations was made to produce the equilibrium temperature and gas composition for ASTM jet A fuel and dry air. The computed tables and figures provide combustion gas property data for pressures from 0.5 to 50 atmospheres and equivalence ratios from 0 to 2.0. S.B.

N85-10066# Pratt and Whitney Aircraft, East Hartford, Conn. Engineering Div.
DEVELOPMENT TRENDS AND REQUIREMENTS OF PROPULSION SYSTEM TECHNOLOGY FOR CIVIL AIRCRAFT
W. A. KERR 1984 19 p Presented at German Soc. of Aeron., Hamburg, 1-3 Oct. 1984
Avail: NTIS HC A02/MF A01

The major technology features in the PW0237 engine are discussed and the certification/flight test program is summarized. M.A.C.

N85-10067*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF COMBINED PRESSURE AND TEMPERATURE DISTORTION ORIENTATION ON HIGH-BYPASS-RATIO TURBOFAN ENGINE STABILITY
R. H. SOEDER and C. M. MEHALIC Washington Oct. 1984 37 p refs
(NASA-TM-83771; E-2262; NAS 1.15:83771) Avail: NTIS HC A03/MF A01 CSCL 21E

Total-temperature, static-pressure and total-pressure distributions were measured in the inlet duct upstream of the engine inlet and within the fan and compressor of a YTF34 turbofan engine. Free-stream and boundary layer yaw angle variations were measured between a rotable screen assembly and the engine inlet. Total pressure distortions were generated using three 180 deg extent screens and total temperature distortions were generated using a rotatable hydrogen burner. Reynolds number index upstream of the rotatable screen assembly was maintained at 0.5 (based on the undistorted sectors at station 1, the inlet flow measuring station). The engine mechanical fan speed at sea level condition was rated at 7005 rpm. The engine was tested at a corrected fan speed of 90 percent of rated condition. Yaw angle increased between the rotatable screen assembly and the engine inlet. The largest variation in free-stream and boundary layer yaw angle occurs when the combined distortions are 180 deg out-of-phase. Static-pressure distortion increased exponentially as flow approached the engine. Total-pressure distortions were attenuated between the engine inlet and the compressor exit. Total-temperature distortion persisted through the compressor for all four combined distortions investigated. Author

N85-10069*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPUTATIONAL THERMO-FLUID DYNAMICS CONTRIBUTIONS TO ADVANCED GAS TURBINE ENGINE DESIGN
R. W. GRAHAM, J. J. ADAMCZYK, and H. E. ROHLIK Washington 1984 13 p refs Proposed for presentation at the 23d Aerospace Sciences Meeting, Reno, Nev., 14-17 Jan. 1985; sponsored by AIAA
(NASA-TM-86865; E-2194; NAS 1.15:86865) Avail: NTIS HC A02/MF A01 CSCL 21E

The design practices for the gas turbine are traced throughout history with particular emphasis on the calculational or analytical methods. Three principal components of the gas turbine engine will be considered: namely, the compressor, the combustor and the turbine. B.W.

N85-10070# Massachusetts Inst. of Tech., Cambridge. Dept. of Ocean Engineering.
PRELIMINARY MECHANICAL REDESIGN OF AN EXISTING GAS-TURBINE ENGINE TO INCORPORATE A HIGH-EFFICIENCY, LOW-PRESSURE-RATIO, HIGHLY REGENERATIVE CYCLE FOR MARINE APPLICATIONS M.S. Thesis
P. K. POOLE and L. D. OWENS, JR. Jun. 1984 89 p
(Contract N66314-70-A-0073)
(AD-A144808) Avail: NTIS HC A05/MF A01 CSCL 21E

The low-pressure-ratio, highly-regenerative, gas-turbine engine has been proposed as an efficient alternative to other current small-scale marine propulsion systems. This thesis provides a preliminary mechanical redesign of an existing gas-turbine engine to lower the compressor pressure ratio and incorporate a regenerator. One basic design is presented with several alternative turbine modifications. The redesign includes elimination of the second stage of the original two-stage centrifugal compressor, increasing the liner flow area of the existing annular combustor, elimination of the first stage of the three-stage axial turbine, reblading the last two turbine stages, sizing an appropriate regenerator, and designing annular inlet and outlet scrolls to direct gas flow to the regenerator. Due to the simplicity of the original engine and its operating environment (high-altitude turboprop), modification to a regenerative system for marine use appears feasible and attractive. The redesigned engine has a maximum design-point thermal efficiency of 49% with a reduction in power output from the original engine of only 12.5%. The extend of the modifications to the original engine could be reduced somewhat to enhance economic attractiveness at the expense of reduced efficiency or power output. GRA

N85-10947*# United Technologies Corp., East Hartford, Conn. Engineering Div.
ENERGY EFFICIENT ENGINE FLIGHT PROPULSION SYSTEM PRELIMINARY ANALYSIS AND DESIGN REPORT Final Update Report
J. W. BISSET and D. C. HOWE Sep. 1983 166 p refs
(Contract NAS3-20646)
(NASA-CR-174701; NAS 1.26:174701; PWA-5594-248) Avail: NTIS HC A08/MF A01 CSCL 21E

The final design and analysis of the flight propulsion system is presented. This system is the conceptual study engine defined to meet the performance, economic and environmental goals established for the Energy Efficient Engine Program. The design effort included a final definition of the engine, major components, internal subsystems, and nacelle. Various analytical representations and results from component technology programs are used to verify aerodynamic and structural design concepts and to predict performance. Specific design goals and specifications, reflecting future commercial aircraft propulsion system requirements for the mid-1980's, are detailed by NASA and used as guidelines during engine definition. Information is also included which details salient results from a separate study to define a turbofan propulsion system, known as the maximum efficiency engine, which reoptimized the advanced fuel saving technologies for improved fuel economy and direct operating costs relative to the flight propulsion system. M.A.C.

N85-10950*# United Technologies Corp., East Hartford, Conn.
ENERGY EFFICIENT ENGINE COMBUSTOR TEST HARDWARE DETAILED DESIGN REPORT
M. H. ZEISSER, W. GREENE, and D. J. DUBIEL Mar. 1982 105 p refs
(Contract NAS3-20646)
(NASA-CR-167945; NAS 1.26:167945; PWA-5594-197) Avail: NTIS HC A06/MF A01 CSCL 21E

The combustor for the Energy Efficient Engine is an annular, two-zone component. As designed, it either meets or exceeds all program goals for performance, safety, durability, and emissions, with the exception of oxides of nitrogen. When compared to the configuration investigated under the NASA-sponsored Experimental Clean Combustor Program, which was used as a basis for design, the Energy Efficient Engine combustor component has several technology advancements. The prediffuser section is designed with short, strutless, curved-walls to provide a uniform inlet airflow profile. Emissions control is achieved by a two-zone combustor that utilizes two types of fuel injectors to improve fuel atomization for more complete combustion. The combustor liners are a segmented configuration to meet the durability requirements at the high combustor operating pressures and temperatures. Liner cooling is accomplished with a counter-parallel FINWALL technique, which provides more effective heat transfer with less coolant. Author

N85-10951*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TURBINE ENGINE HOT SECTION TECHNOLOGY (HOST)
Washington Oct. 1982 356 p refs Workshop held in Cleveland, 19-20 Oct. 1982
(NASA-TM-83022; E-1458; NAS 1.15:83022) Avail: NTIS HC A16/MF A01 CSCL 21E

Research and plans concerning aircraft gas turbine engine hot section durability problems were discussed. Under the topics of structural analysis, fatigue and fracture, surface protective coatings, combustion, turbine heat transfer, and instrumentation specific points addressed were the thermal and fluid environment around liners, blades, and vanes, material coatings, constitutive behavior, stress-strain response, and life prediction methods for the three components.

N85-10952*# General Electric Co., Cincinnati, Ohio.
EQUIVALENT DAMAGE: A CRITICAL ASSESSMENT
J. H. LAFLEN and T. S. COOK *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 11-23 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The overall goal of achieving improved life cycle management of aircraft engine, gas turbine components is a major industry thrust. Low cycle fatigue (LCF) crack initiation prediction, an important element of life cycle management as traditionally applied, may be overly conservative in estimating total cyclic life capability. Consequently, there is increasing pressure to improve predictive methods both for crack initiation and for subsequent crack propagation. The utility of equivalent damage concepts for application to hot section components of aircraft engines was studied. Specifically, the topics examined were mean stress, cumulative damage, and multiaxiality. Other factors inherently linked to this study were the basic formulation of damage parameters at elevated temperatures and the fact that hot section components experience severe temperature fluctuations throughout their service lifetime. R.S.F.

N85-10953*# General Electric Co., Cincinnati, Ohio.
BENCHMARK NOTCH TEST FOR LIFE PREDICTION
P. A. DOMAS, J. YAU, W. N. SHARPE (Louisiana State Univ., Baton Rouge), and M. WARD (Louisiana State Univ., Baton Rouge) *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 25-37 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

Aircraft gas turbine engine components are subjected to severe stress, temperature, and environmental conditions. Economic and reliabilty demands have prompted inordinate effort in development of analytic methods to predict stresses and strains in aircraft engines. There remains, however, the need to check or verify these analytical methodologies against actual experimental data measurements. The laser interferometric strain displacement gage was recognized as having the potential to accomplish this task and was employed in this program. The actual strains incurred at the root of a discontinuity in cyclically loaded test samples subjected to inelastic deformation at high temperature where creep deformation readily occur were measured. The steady-state, cyclic stress-strain response at the root of the discontinuity in the tested samples was analyzed for comparison with the measured results. A comprehensive set of local notch root strain measurements for a variety of load patterns in an Inconel 718 notch specimen at

649 C (1200 F) was obtained and documented using the laser interferometric strain displacement gage. R.S.F.

N85-10954*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NONLINEAR STRUCTURAL AND LIFE ANALYSES OF A TURBINE BLADE
A. KAUFMAN *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 39-44 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The most critical structural requirements that aircraft gas turbine engines must meet result from the diversity of extreme environmental conditions in the turbine section components. Accurate life assessment of the components under these conditions requires sound analytical tools and techniques. The utility of advanced structural analysis techniques and advanced life prediction techniques in the life assessment of hot-section components was evaluated. The extend to which a three-dimensional cyclic isoparametric finite element analysis of a hot-section component would improve the accuracy of component life predictions was assessed. At the same time, high temperature life prediction theories such as strainrange partitioning and the frequency modified approaches were applied and their efficiency judged. A stress analysis was performed on a commercial air-cooled turbine blade. The evaluation of the life prediction methods indicated that none of those studied were satisfactory. R.S.F.

N85-10955*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NONLINEAR STRUCTURAL AND LIFE ANALYSES OF A COMBUSTOR LINER
A. KAUFMAN *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 45-53 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

Three-dimensional, nonlinear, finite element structural analyses were performed for a simulated aircraft combustor liner specimen in order to assess the capability of nonlinear analyses using classical inelastic material models to represent the thermoplastic-creep response of the component. In addition, the computed stress-strain history at the critical location was input into life prediction methods in order to evaluate the ability of these procedures to predict crack initiation life. It is concluded that: (1) elastic analysis is adequate for obtaining strain range and critical location; (2) inelastic analyses did not accurately represent cyclic behavior of materials; and (3) none of the crack initiation life prediction methods were satisfactory. R.S.F.

N85-10956*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRE-HOST HIGH TEMPERATURE CRACK PROPAGATION
T. W. ORANGE *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 55-63 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The highlights of NASA contract CR-167896, Fracture Mechanics Criteria for Turbine Engine Hot Section Components, are presented. The five technical tasks of the program are reviewed. Results of several tasks are presented. R.S.F.

N85-10957*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HOST INSTRUMENTATION R AND D PROGRAM OVERVIEW
N. C. WENGER *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 65-68 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The turbine hot-section technology (HOST) Instrumentation R&D program focuses on two main classes of instrumentation: (1) those that characterizes the environment around the turbine engine components, which include gas flows measurement, gas temperatures, and heat fluxes; (2) to characterize the effect of the environment on the turbine engine components, which include strain measurements and an optical system to structural responses such as cracking, buckling, spalling, carbon buildup. The HOST Instrumentation R&D program concentrates on the critical measurements that can not be made by commercially available instruments or with instruments that are already in development. The measurements of strain and gas flow are emphasized, these measurements are extremely critical to the success of the HOST program and the HOST requirements differ from the current state of the art by a considerable margin. E.A.K.

N85-10958*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Government Products Div.
DYNAMIC GAS TEMPERATURE MEASUREMENT SYSTEM
D. ELMORE *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 75-82 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The development of an advanced measuring system which measures the rapidly varying gas temperature at the exit of an aircraft jet engine combustor during ground based testing of hot section components was identified. Sensor guidelines, technical approach/program schedule, and the accomplishments are reviewed. The environment of a present generation combustor is shown. The method uses two beadless junctions type-B thermocouples to measure heat transfer coefficient in situ. Heat conduction effects are shown by a finite element model of the thermocouple. Author

N85-10959*# United Technologies Research Center, East Hartford, Conn.
HIGH TEMPERATURE STATIC STRAIN SENSOR DEVELOPMENT PROGRAM
C. HULSE, F. LEMKEY, R. BAILEY, and H. GRANT *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 83-91 Oct. 1982
(Contract NAS3-23169)
Avail: NTIS HC A16/MF A01 CSCL 21E

The development of resistance strain gages which are useful for static strain measurements on nickel or cobalt superalloy parts inside a gas turbine engine on a test stand were examined. These measurements of a strain gage alloy development program which to be followed by an optional investigation of complete strain gage systems which will use the best of the alloys developed together with other system improvements is reviewed. The specific goal for the complete system is to make measurements to 2,000 micro epsilon with error of only + or - 10% over a 50 hour period. In addition to simple survival and stability, attaining a low thermal coefficient to resistivity, of order 100 ppm/K or less, is also a major goal. The first task was to select candidate alloys or alloy systems using a search of the literature and the available metallurgical theory. Alloy candidates were evaluated and compared by a grading system. Equipment and techniques were developed which are suitable for iterative studies of a variety of compositions. Many compositions were examined and significantly improved alloys were identified. E.A.K.

N85-10960*# United Technologies Research Center, East Hartford, Conn.
LASER SPECKLE TECHNIQUE FOR BURNER LINER STRAIN MEASUREMENTS
K. A. STETSON *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 93-99 Oct. 1982 refs
Avail: NTIS HC A16/MF A01 CSCL 21E

Thermal and mechanical strains were measured on samples of a common material used in jet engine burner liners, which were heated from room temperature to 870 C and cooled back to 220 C, in a laboratory furnance. The physical geometry of the sample surface was recorded at selected temperatures by a set of 12 single exposure speckle-grams. Sequential pairs of specklegrams were compared in a heterodyne interferometer which give high precision measurement of differential displacements. Good speckle correlation between the first and last specklegrams is noted which allows a check on accumulate errors. E.A.K.

N85-10962*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HOT SECTION LASER ANEMOMETRY
W. C. NIEBERDING *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 109-112 Oct. 1982 refs
Avail: NTIS HC A16/MF A01 CSCL 21E

The objectives and problems faced in the development of a laser anemometry system for hot section applications was discussed. The goal was to map the flow profiles through and between the vanes and between the rotating blades of a turbine. A laser anemometer system was developed which measures the Doppler shift directly along the optical axis. Some testing is being conducted in a small bench top combustor facility. The cost involved in this testing was also discussed. E.R.

N85-10963*# Case Western Reserve Univ., Cleveland, Ohio. Dept. of Chemical Engineering.
LASER ANEMOMETER OPTIMIZATION
R. V. EDWARDS *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 113-118 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The design, construction, and testing of laser anemometer configurations for hot section velocity measurements is discussed. The optimization of the laser anemometer systems include the data processing algorithms used. Some relevant hot section properties considered are high temperature with a large background radiation, difficulty of optical access, large flow velocity variations, the presence of solid surfaces that generate reflections and low seed particle density. E.R.

N85-10964*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TURBINE HEAT TRANSFER
J. E. ROHDE *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 119-136 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

Objectives and approaches to research in turbine heat transfer are discussed. Generally, improvements in the method of determining the hot gas flow through the turbine passage is one area of concern, as is the cooling air flow inside the airfoil, and the methods of predicting the heat transfer rates on the hot gas side and on the coolant side of the airfoil. More specific areas of research are: (1) local hot gas recovery temperatures along the airfoil surfaces; (2) local airfoil wall temperature; (3) local hot gas side heat transfer coefficients on the airfoil surfaces; (4) local coolant side heat transfer coefficients inside the airfoils; (5) local hot gas flow velocities and secondary flows at real engine conditions; and (6) local delta strain range of the airfoil walls. E.R.

N85-10965*# Detroit Diesel Allison, Indianapolis, Ind.
GAS SIDE HEAT TRANSFER: 2-D FLOW
R. YORK *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 137-147 Oct. 1982 refs
Avail: NTIS HC A16/MF A01 CSCL 21E

Significant progress was made in advancing the idea of establishing a unified approach for predicting airfoil heat transfer for a wide range of operating conditions and geometries. Preliminary results are encouraging and further mixing length (ml) turbulence modeling ideas will be explored, concentrating on transition behavior. The capability of available modeling techniques to predict airfoil surface heat transfer distributions in a two-dimensional flow field was assessed, experimental data as required for model verification were acquired, and improvements in the analytic models was made and verified. B.G.

N85-10967*# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
JET ARRAY IMPINGEMENT FLOW DISTRIBUTIONS AND HEAT TRANSFER CHARACTERISTICS: EFFECTS OF INITIAL CROSSFLOW AND NONUNIFORM ARRAY GEOMETRY
L. W. FLORSCHUETZ and D. E. METZGER *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 161-173 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

Flow distributions and heat transfer characteristics for two-dimensional arrays of circular air jets impinging on a surface parallel to the jet orifice plate were determined. The configurations considered were intended to model those of interest in current and contemplated gas turbine airfoil midchord cooling applications. The geometry of the airfoil applications considered dictates that all of the jet flow, after impingement, exit in the chordwise (i.e., streamwise) direction toward the trailing edge. Experimental results for the effect of an initial crossflow on both flow distributions and heat transfer characteristics for a number of the prior uniform array geometries. The effects of nonuniform array geometries on flow distributions and heat transfer characteristics for noninitial crossflow configurations are discussed. B.G.

N85-10969*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STRUCTURAL ANALYSIS
R. H. JOHNS *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 181-184 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

Hot section components of aircraft gas turbine engines are subjected to severe thermal-structural loading conditions, especially during the start-up and take-off portions of the engine cycle. The most severe and damaging stresses and strains are those induced by the steep thermal gradients induced during the start-up transient. These transient stresses and strains are also the most difficult to predict, in part because the temperature gradients and distributions are not well known or predictable, and also because the cyclic elasto-viscoplastic behavior of the materials at these extremes of temperature and strain are not well known or predictable. One element of the structures program will develop improved time-varying thermal-mechanical load models for the entire engine mission cycle from start-up to shutdown. The thermal model refinements will be consistent with those required by the structural code including considerations of mesh-point density, strain concentrations, and thermal gradients. Models will be developed for the burner liner, turbine vane and turbine blade. B.G.

N85-10970*# General Electric Co., Cincinnati, Ohio. Aircraft Engineering Business Group.
BURNER LINER THERMAL/STRUCTURAL LOAD MODELLING
R. J. MAFFEO *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 185-196 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The objective of this program is to develop a thermal data transfer computer program module for the Burner Liner Thermal-Structural Load Modelling Program. This will be accomplished by reviewing existing methodologies for thermal data transfer and selecting three heat transfer codes for application in this program, evaluating the selected codes to establish criteria for developing a computer program module to transfer thermal data from the heat transfer codes to selected stress analysis codes, developing the automated thermal load transfer module, and verifying and documenting the module. The overall objectives of this thermal transfer module are that it handle independent mesh configurations, perform the transfer in an accurate and efficient fashion and that the total system be flexible for future improvements. R.J.F.

N85-10971*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPONENT-SPECIFIC MODELING
M. S. HIRSCHBEIN *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 197-202 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The ability to accurately structurally analyze engine components to assure that they can survive for their designed lifetime in an increasingly harsh environment is discussed. Under the HOST (HOt Section Technology) program, advanced component-specific modeling methods, with built-in analysis capability, will be developed separately for burner liners, turbine blades and vanes. These modeling methods will make maximum use of, but will not rely solely on, existing analysis methods and techniques, to analyze the three identified components. Nor will the complete structural analysis of a component necessarily be performed as a single analysis. The approach to be taken will develop complete software analysis packages with internal, component-specific, self-adaptive solution strategies. Each package will contain a set of modeling and analysis tools. The selection and order of specific methods and techniques within the set to be applied will depend on the specific-component, the current thermo-mechanical loading, and the current state of the component. All modeling and analysis decisions will be made internally based on developed decision criteria within the solution strategies; minimal user intervention will be required. B.W.

N85-10972*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE 3-D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS: BRIEF DESCRIPTION
C. C. CHAMIS *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 203-208 Oct. 1982
Avail: NTIS HC A16/MF A01

Advanced 3-D inelastic structural/stress analysis methods and solution strategies for more accurate yet more cost-effective analysis of components subjected to severe thermal gradients and loads in the presence of mechanical loads, with steep stress and strain gradients are being developed. Anisotropy, time and temperature dependent plasticity and creep effects are also addressed. The approach is to develop four different theories, one linear and three higher order theories (polynomial function, special function, general function). The theories are progressively more complex from linear to general function in order to provide streamlined analysis capability with increasing accuracy for each hot section component and for different parts of the same component according to the severity of the local stress, strain and temperature gradients associated with hot spots, cooling holes and surface coating cracks. To further enhance the computational effectiveness, the higher order theories will have embedded singularities (cooling passages, for example) in the generic modeling region. Each of the four theories consists of three formulation models derivable from independent theoretical formulations. These formulation models are based on: (1) mechanics of materials; (2) special finite elements; and (3) an advanced formulation to be recommended by the contractor. B.W.

N85-10973*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LIFE PREDICTION AND CONSTITUTIVE BEHAVIOR: OVERVIEW
G. R. HALFORD *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 209-212 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The evolution of programs to investigate high temperature consititutive behavior and develop cyclic life prediction methods is reviewed. Contracts granted for developing and verifying workable engineering methods for the calculation, in advance of service, of the local stress-strain response at the critical life governing location in typical hot section components as well as the resultant cyclic crack initiation and crack growth lifetimes are listed. The Langley fatigue facility is being upgraded to include: (1) a servocontrolled testing machine for high temperature crack growth; (2) three servocontrolled tension/torsion machines for biaxial studies; (3) a HOST/satellite computer for data acquisition, processing, storage, and retrieval; and (4) HCV/LCF machines for cumulative damage studies. A.R.H.

N85-10974*# Pratt and Whitney Aircraft, East Hartford, Conn. Commercial Engineering.
CREEP-FATIGUE LIFE PREDICTION FOR ENGINE HOT SECTION MATERIALS (ISOTROPIC)
V. MORENO *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 213-214 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The objectives of this program are the investigation of fundamental approaches to high temperature crack initiation life prediction, identification of specific modeling strategies and the development of specific models for component relevant loading conditions. A survey of the hot section material/coating systems used throughout the gas turbine industry is included. Two material/coating systems will be identified for the program. The material/coating system designated as the base system shall be used throughout Tasks 1-12. The alternate material/coating system will be used only in Task 12 for further evaluation of the models developed on the base material. In Task II, candidate life prediction approaches will be screened based on a set of criteria that includes experience of the approaches within the literature, correlation with isothermal data generated on the base material, and judgements relative to the applicability of the approach for the complex cycles to be considered in the option program. The two most promising approaches will be identified. Task 3 further evaluates the best approach using additional base material fatigue testing including verification tests. Task 4 consists of technical, schedular, financial and all other reporting requirements in accordance with the Reports of Work clause. R.J.F.

N85-10975*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CONSTITUTIVE MODEL DEVELOPMENT FOR ISOTROPIC MATERIALS
A. KAUFMAN *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 215-221 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The objective is to develop a unified constitutive model for finite-element structural analysis of turbine engine hot section components. This effort constitutes a different approach for nonlinear finite-element computer codes which were heretofore based on classical inelastic methods. A unified constitutive theory will avoid the simplifying assumptions of classical theory and should more accurately represent the behavior of superalloy materials under cyclic loading conditions and high temperature environments. Model development will be directed toward isotropic, cast nickel-base alloys used for aircooled turbine blades and vanes. The contractor will select a base material for model development and an alternate material for verification purposes from a list of three alloys specified by NASA. The candidate alloys represent a cross-section of turbine blade and vane materials of interest to both large and small size engine manufacturers. Material stock for the base and alternate materials will be supplied to the Contractor by the government. R.J.F.

N85-10976*# Army Research and Technology Labs., Cleveland, Ohio. Propulsion Lab.
LIFE PREDICTION AND CONSTITUTIVE MODELS FOR ANISOTROPIC MATERIALS
R. C. BILL *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 223-226 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The intent of this program is to develop a basic understanding of cyclic creep-fatigue deformation mechanisms and damage accumulation, a capability for reliable life prediction, and the ability to model the constitutive behavior of anisotropic single crystal (SC) and directionally solidified or recrystallized (DSR) comprise the program, and the work breakdown for each option reflects a distinct concern for two classes of anisotropic materials, SC and DSR materials, at temperatures encountered in the primary gas path (airfoil temperatures), and at temperatures typical of the blade root attachment and shank area. Work directed toward the higher temperature area of concern in the primary gas path includes effects of coatings on the behavior and properties of the materials of interest. The blade root attachment work areas will address the effects of stress concentrations associated with attachment features. R.J.F.

N85-10978*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SURFACE PROTECTION OVERVIEW
S. R. LEVINE *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 231-239 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

A first-cut integrated environmental attack life prediction methodology for hot section components is addressed. The HOST program is concerned with oxidation and hot corrosion attack of metallic coatings as well as their degradation by interdiffusion with the substrate. The effects of the environment and coatings on creep/fatigue behavior are being addressed through a joint effort with the Fatigue sub-project. An initial effort will attempt to scope the problem of thermal barrier coating life prediction. Verification of models will be carried out through benchmark rig tests including a 4 atm. replaceable blade turbine and a 50 atm. pressurized burner rig. B.W.

N85-10979*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIRFOIL DEPOSITION MODEL
F. J. KOHL *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 241-257 Oct. 1982 refs
Avail: NTIS HC A16/MF A01 CSCL 21E

The methodology to predict deposit evolution (deposition rate and subsequent flow of liquid deposits) as a function of fuel and air impurity content and relevant aerodynamic parameters for turbine airfoils is developed in this research. The spectrum of deposition conditions encountered in gas turbine operations includes the mechanisms of vapor deposition, small particle deposition with thermophoresis, and larger particle deposition with inertial effects. The focus is on using a simplified version of the comprehensive multicomponent vapor diffusion formalism to make deposition predictions for: (1) simple geometry collectors; and (2) gas turbine blade shapes, including both developing laminar and turbulent boundary layers. For the gas turbine blade the insights developed in previous programs are being combined with heat and mass transfer coefficient calculations using the STAN 5 boundary layer code to predict vapor deposition rates and corresponding liquid layer thicknesses on turbine blades. A computer program is being written which utilizes the local values of the calculated deposition rate and skin friction to calculate the increment in liquid condensate layer growth along a collector surface. B.W.

N85-10980*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECTS OF SURFACE CHEMISTRY ON HOT CORROSION LIFE: OVERVIEW
J. MERUTKA *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 263-267 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

This program concentrates on analyzing a limited number of hot corroded components from the field and the carrying out of a series of controlled laboratory experiments to establish the effects of oxide scale and coating chemistry on hot corrosion life. This is to be determined principally from the length of the incubation period, the investigation of the mechanisms of hot corrosion attack, and the fitting of the data generated from the test exposure experiments to an empirical life prediction model. Author

N85-10981*# Army Research and Technology Labs., Cleveland, Ohio. Propulsion Lab.
COMBUSTION HOT SECTION TECHNOLOGY
D. B. ERCEGOVIC *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 269-281 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The Turbine Engine Hot Section Technology Combustion Program is briefly described. The overall objective of the project is to develop and verify improved and more accurate analysis methods for increasing the ability to design with confidence the combustion system for advanced aircraft turbine engines. The approach is to first assess and evaluate existing combustor aerothermal analysis models by means of a contracted effort initiated during FY-82. The program also includes both analytical and experimental research efforts in the areas of aerothermal modeling and liner cyclic life. It is expected that the combustor model development effort will generate improved understanding in the areas of high pressure flame radiation characteristics, model numerical methods and solution schemes, complex geometrical boundary conditions, fuel spray - flow field interactions, combustion kinetics, flow and mixing of dilution jets, turbulence and heat transfer, and soot and carbon formation. M.G.

N85-10982*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Engineering.
AEROTHERMAL MODELING
G. J. STURGESS *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 283-299 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

The objectives, approach, and status of a program to develop the computational fluid dynamics tools needed to improve combustor design and analysis are outlined. The calculation procedure selected consists of a finite difference solution of the time averaged, steady state, primitive variable, elliptic form of the Reynolds equations. Standard TEACH type numerics are used to solve the resulting equations. These include hybrid differencing, SIMPLE algorithm for the pressure field, line by line iterative solution using the ADI method and the tridiagonal matrix algorithm (TDMA). Convergence is facilitated by using under relaxation. The physical processes are modeled by a two equation eddy viscosity model for turbulence; combustion is represented by a simple, irreversible, one step chemical reaction whose rate is influenced only by the time scale of the turbulence. The model evaluation procedure is also described. M.G.

N85-10983*# General Electric Co., Evendale, Ohio.
AEROTHERMAL MODELING PROGRAM
M. KENWORTHY *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 301-306 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

Some significant features of the approach adopted for the combustor aerothermal modeling program are described. The individual computerized models utilized in the aero design approach are characterized. The preliminary design module provides the overall envelope definition of the burner. The diffuser module provides the detailed contours of the diffuser and combustor cowl region, as well as the pressure loss characteristics into each of the individual flow passages into the dome and around the combustor. The flow distribution module provides the air entry quantities through each of the aperatures and the overall pressure drop. The heat transfer module provides detailed metal temperature distribution throughout the metal structure as input to stress and life analysis that are not part of the aerothermo design effort. Finally, the internal flow module, INTFLOW, is described and the approach for model evaluation using laboratory data is discussed. M.G.

N85-10984*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DILUTION ZONE MIXING STUDIES
J. D. HOLDEMAN *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 307-314 Oct. 1982 refs
Avail: NTIS HC A16/MF A01 CSCL 21E

The objectives and status of a project to investigate various aspects of the jet in a confined cross flow problem are outlined. The experiments performed thus far dealt primarily with a single row of jets mixing into an isothermal flow in a constant cross section duct. Variations in the mixing were observed as a function of jet to mainstream momentum ratio, orifice size, and spacing. The current experiments examine perturbations of this problem characteristic to gas turbine combustion chambers, namely: flow area convergence, nonisothermal mainstream flow, and opposed in line and staggered injection. An empirical model was developed to describe the observed temperature distributions. The current interactive code provides a 3-D pictorial representation of the temperature, as given by these correlations, for any user specified downstream location, flow, and orifice parameters. M.G.

N85-10985*# Garrett Turbine Engine Co., Phoenix, Ariz.
DILUTION JET MIXING
S. SRINIVASAN *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 315-329 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

Schematics are given for test section configurations, orifice configurations, and the dilution jet mixing test rig used to collect a data base on mixing a single sided and a two sided row of jets with a confined cross flow. Parameters investigated include momentum ratio; nonuniform cross stream temperature and velocity profiles; cold/hot injection, and cross stream flow area convergence. Graphs show measured theta momentum distributions for: (1) in line and staggered orifice configurations; and (2) the profiled mainstream; and (3) flow area convergence.
A.R.H.

N85-10986*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMBUSTION SYSTEM FOR RADIATION INVESTIGATIONS
J. D. WEAR *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 331-334 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

An inlet interface flange, inlet diffuser, fuel struts and nozzles, combustor liner, liner housing and exhaust flange comprise a system to be installed in an existing test facility. The system was designed for operation at 40 atmospheres inlet pressure, 900 K inlet temperature, and air flow to 80 kg/sec. Six penetrations are provided in the outer pressure housing. Adapters at the penetrations, permit use of various types of radiation instrumentation. Five total radiation radiometers and two heat flux gases were installed. Rotating exhaust instrumentation can also be used to determine combustor performance. Data are presented showing total radiation at three axial positions of the combustor, and comparison of total radiation with data from a heat flux gage.
A.R.H.

N85-10987*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
VALIDATION OF STRUCTURAL ANALYSIS METHODS USING THE IN-HOUSE LINER CYCLIC RIGS
R. L. THOMPSON *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 335-344 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

Test conditions and variables to be considered in each of the test rigs and test configurations, and also used in the validation of the structural predictive theories and tools, include: thermal and mechanical load histories (simulating an engine mission cycle; different boundary conditions; specimens and components of different dimensions and geometries; different materials; various cooling schemes and cooling hole configurations; several advanced burner liner structural design concepts; and the simulation of hot streaks. Based on these test conditions and test variables, the test matrices for each rig and configurations can be established to verify the predictive tools over as wide a range of test conditions as possible using the simplest possible tests. A flow chart for the thermal/structural analysis of a burner liner and how the analysis relates to the tests is shown schematically. The chart shows that several nonlinear constitutive theories are to be evaluated.
A.R.H.

N85-10988*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HOST LINER CYCLIC FACILITIES: FACILITY DESCRIPTION
D. SCHULTZ *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 345-360 Oct. 1982
Avail: NTIS HC A16/MF A01 CSCL 21E

A quartz lamp box, a quartz lamp annular rig, and a low pressure liner cyclic can rig planned for liner cyclic tests are described. Special test instrumentation includes an IR-TV camera system for measuring liner cold side temperatures, thin film thermocouples for measuring liner hot side temperatures, and laser and high temperature strain gages for obtaining local strain measurements. A plate temperature of 2,000 F was obtained in an initial test of an apparatus with three quartz lamps. Lamp life, however, appeared to be limited for the standard commercial quartz lamps available. The design of vitiated and nonvitiated preheaters required for the quartz lamp annular rig and the cyclic can test rigs is underway.
A.R.H.

N85-10989*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
ENERGY EFFICIENT ENGINE COMPONENT DEVELOPMENT AND INTEGRATION PROGRAM Semiannual Report, 1 Oct. 1981 - 31 Mar. 1982
Apr. 1982 346 p
(Contract NAS3-20643)
(NASA-CR-169496; NAS 1.26:169496; R82AEB285; SAR-8)
Avail: NTIS HC A15/MF A01 CSCL 21E

The development of the technology to improve energy efficiency of propulsion systems for subsonic commercial aircrafts was examined. Goals established include: (1) fuel consumption, reduction in flight propulsion system; (2) direct operation cost; (3) noise, with provision for engine growth corresponding to future engine application; and (4) emissions, EPA new engine standards.
E.A.K.

N85-10990*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
ENERGY EFFICIENT ENGINE COMPONENT DEVELOPMENT AND INTEGRATION PROGRAM Semiannual Report, 1 Apr. - 30 Sep. 1981
30 Oct. 1981 338 p
(Contract NAS3-20643)
(NASA-CR-170034; NAS 1.26:170034; R81AEG709; SAR-7)
Avail: NTIS HC A15/MF A01 CSCL 21E

Accomplishments in the Energy Efficient Engine Component Development and Integration program during the period of April 1, 1981 through September 30, 1981 are discussed. The major topics considered are: (1) propulsion system analysis, design, and integration; (2) engine component analysis, design, and development; (3) core engine tests; and (4) integrated core/low spool testing. R.S.F.

N85-10991*# TRW, Inc., Cleveland, Ohio. Materials Technology.
ENERGY EFFICIENT ENGINE. VOLUME 2. APPENDIX A: COMPONENT DEVELOPMENT AND INTEGRATION PROGRAM Final Semiannual Status Report, 1 Apr. - 30 Sep. 1981
D. J. MORACZ and C. R. COOK East Hartford, Conn. Pratt and Whitney Aircraft 30 Oct. 1981 200 p refs Prepared for Pratt and Whitney Aircraft, East Hartford, Conn. 2 Vol.
(Contract NAS3-20646)
(NASA-CR-173085; NAS 1.26:173085; PWA-5594-179-VOL-2-APP-A; ER-8050-F-VOL-2-APP-A; SASR-7-VOL-2-APP-A) Avail: NTIS HC A09/MF A01 CSCL 21E

The large size and the requirement for precise lightening cavities in a considerable portion of the titanium fan blades necessitated the development of a new manufacturing method. The approach which was selected for development incorporated several technologies including HIP diffusion bonding of titanium sheet laminates containing removable cores and isothermal forging of the blade form. The technology bases established in HIP/DB for composite blades and in isothermal forging for fan blades were applicable for development of the manufacturing process. The process techniques and parameters for producing and inspecting the cored diffusion bonded titanium laminate blade preform were established. The method was demonstrated with the production of twelve hollow simulated blade shapes for evaluation. Evaluations of the critical experiments conducted to establish procedures to produce hollow structures by a laminate/core/diffusion bonding approach are included. In addition the transfer of this technology to produce a hollow fan blade is discussed. B.G.

N85-10992*# Pratt and Whitney Aircraft, East Hartford, Conn. Commercial Products Div.
ENERGY EFFICIENT ENGINE. VOLUME 1: COMPONENT DEVELOPMENT AND INTEGRATION PROGRAM Semiannual Status Report, 1 Apr. - 30 Sep. 1981
30 Oct. 1981 228 p 2 Vol.
(Contract NAS3-20646)
(NASA-CR-173084; NAS 1.26:173084; PWA-5594-179-VOL-1; SASR-7-VOL-1) Avail: NTIS HC A11/MF A01 CSCL 21E

Technology for achieving lower installed fuel consumption and lower operating costs in future commercial turbofan engines are developed, evaluated, and demonstrated. The four program objectives are: (1) propulsion system analysis; (2) component analysis, design, and development; (3) core design, fabrication, and test; and (4) integrated core/low spoon design, fabrication, and test. B.G.

N85-10993*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
ENERGY EFFICIENT ENGINE ICLS NACELLE DETAIL DESIGN REPORT
R. R. ESKRIDGE, A. P. KUCHAR, and C. L. STOTLER Jul. 1982 125 p refs
(Contract NAS3-20643)
(NASA-CR-167870; NAS 1.26:167870; R81AEG700) Avail: NTIS HC A06/MF A01 CSCL 21E

The results of the detail design of the Nacelle for the General Electric Energy Efficient Engine (E3) Integrated Core Low Spool (ICLS) test vehicles are presented. A slave nacelle is designed for the ICLS test. Cost and reliability are the important factors considered. The slave nacelle simulates the internal flow lines of the actual Flight Propulsion System (FPS) but has no external fairing. The aerodynamic differences between the ICLS and FPS nacelles are presented, followed by the structural description and analysis of the various nacelle components. M.A.C.

N85-10994*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
ENERGY EFFICIENT ENGINE. LOW PRESSURE TURBINE TEST HARDWARE DETAILED DESIGN REPORT
D. G. CHERRY, C. H. GAY, and D. T. LENAHAN Aug. 1982 186 p
(Contract NAS3-20643)
(NASA-CR-167956; NAS 1.26:167956; R81AEG597) Avail: NTIS HC A09/MF A01 CSCL 21E

The low pressure turbine for the energy efficient engine is a five-stage configuration with moderate aerodynamic loading incorporating advanced features of decambered airfoils and extended blade overlaps at platforms and shrouds. Mechanical integrity of 18,000 hours on flowpath components and 36,000 hours on all other components is achieved along with no aeromechanical instabilities within the steady-state operating range. Selection of a large number (156) of stage 4 blades, together with an increased stage 4 vane-to-blade gap, assists in achieving FAR 36 acoustic goals. Active clearance control (ACC) of gaps at blade tips and interstage seals is achieved by fan air cooling judiciously applied at responsive locations on the casing. This ACC system is a major improvement in preventing deterioration of the 0.0381 cm (0.015 in.) clearances required to meet the integrated-core/low-spool turbine efficiency goal of 91.1% and the light propulsion system efficiency goal of 91.7%. Author

N85-10995*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
ENERGY EFFICIENT ENGINE HIGH PRESSURE TURBINE TEST HARDWARE DETAILED DESIGN REPORT
E. E. HALILA, D. T. LENAHAN, and T. T. THOMAS Jun. 1982 194 p refs
(Contract NAS3-20643)
(NASA-CR-167955; NAS 1.26:167955; R81AEG284) Avail: NTIS HC A09/MF A01 CSCL 21E

The high pressure turbine configuration for the Energy Efficient Engine is built around a two-stage design system. Moderate aerodynamic loading for both stages is used to achieve the high level of turbine efficiency. Flowpath components are designed for 18,000 hours of life, while the static and rotating structures are designed for 36,000 hours of engine operation. Both stages of turbine blades and vanes are air-cooled incorporating advanced state of the art in cooling technology. Direct solidification (DS) alloys are used for blades and one stage of vanes, and an oxide dispersion system (ODS) alloy is used for the Stage 1 nozzle airfoils. Ceramic shrouds are used as the material composition for the Stage 1 shroud. An active clearance control (ACC) system is used to control the blade tip to shroud clearances for both stages. Fan air is used to impinge on the shroud casing support rings, thereby controlling the growth rate of the shroud. This procedure allows close clearance control while minimizing blade tip to shroud rubs. Author

N85-10997*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
ENERGY EFFICIENT ENGINE ICLS ENGINE BEARINGS, DRIVES AND CONFIGURATION: DETAIL DESIGN REPORT
C. L. BROMAN Jun. 1982 76 p refs
(Contract NAS3-20643)
(NASA-CR-167871; NAS 1.26:167871; R81AEG821) Avail: NTIS HC A05/MF A01 CSCL 21E

The detailed design of the forward and aft sumps, the accessory drive system, the lubrication system, and the piping/manifold configuration to be employed in the ICLS engine test of the Energy Efficient Engine is addressed in the report. The design goals for the above components were established based on the requirements of the test cell engine. Author

N85-10998*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
ENERGY EFFICIENT ENGINE. HIGH PRESSURE COMPRESSOR DETAIL DESIGN REPORT
P. R. HOLLOWAY, C. C. KOCH, G. L. KNIGHT, and S. L. SHAFFER May 1982 168 p refs
(Contract NAS3-20643)
(NASA-CR-165558; NAS 1.26:165558; R81AEG710) Avail: NTIS HC A08/MF A01 CSCL 21E

A compressor optimization study defined a 10-stage configuration with a 22.6:1 pressure ratio, and adiabatic efficiency goal of 86.1%, and a polytropic efficiency of 90.6%; the corrected airflow is 53.5 kg/sec. Subsequent component testing included three full-scale tests: a six-stage rig test, and another 10-stage rig test completed in the second quarter of 1982. Information from these tests is being used to select the configuration for a core engine test scheduled for July 1982 and an integrated core/low spool test slated for early 1983. The test results will also provide data base for the flight propulsion system. Author

08

AIRCRAFT STABILITY AND CONTROL

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

A85-10451
MODEL PROBLEM CONCERNING THE CONTROL OF THE LATERAL MOTION OF AN AIRCRAFT DURING LANDING [MODEL'NAIA ZADACHA OB UPRAVLENII BOKOVYM DVIZHENIEM SAMOLETA NA POSADKE]
N. D. BOTKIN, V. M. KEVIN, and V. S. PATSKO Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 48, July-Aug. 1984, p. 560-567. In Russian. refs

The problem of controlling the lateral motion of an aircraft at the final stage of landing under significant wind loading is examined in the linear approximation. The problem is formalized as an antagonistic positional differential game of two players with a fixed ending and a convex cost function. Numerical-simulation results are presented. B.J.

A85-10470
INVESTIGATION OF THE SEMIAUTOMATIC CONTROL OF AN AIRCRAFT USING TIMER REDUNDANCY IN ONBOARD DIGITAL COMPUTERS OF THE FLIGHT-PATH CONTROL SYSTEM [ISSLEDOVANIE PROTSESSOV POLUAVTOMATICHESKOGO UPRAVLENIIA SAMOLETOM PRI ISPOL'ZOVANII VREMENNOI IZBYTOCHNOSTI V BORTOVYKH TSIFROVYKH VYCHISLITELIAKH SISTEMY TRAEKTORNOGO UPRAVLENIIA]
S. M. FEDOROV, N. N. SUKHIKH, and M. IU. SMUROV (Akademiia Grazhdanskoi Aviatsii, Leningrad, USSR) Priborostroenie (ISSN 0021-3454), vol. 27, Aug. 1984, p. 20-24. In Russian. refs

Aircraft semiautomatic control processes are analyzed with allowance for the failure and recovery of the onboard computers using timer-redundancy methods. The admissible time of computer recovery is estimated, and results of semifull-scale simulation of the digital system are presented for different values of the discreteness period. B.J.

A85-11981*# Tennessee Univ., Tullahoma.
WIND SHEAR TERMS IN THE EQUATIONS OF AIRCRAFT MOTION
W. FROST (Tennessee, University; FWG Associates, Inc., Tullahoma, TN) and R. L. BOWLES (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 866-872. Research supported by the National Center for Atmospheric Research and NASA. Previously cited in issue 08, p. 1041, Accession no. A84-21860. refs

A85-12356#
ROOT LOCUS METHOD AND AUTOMATIC IDENTIFICATION OF MODES IN FLUTTER ANALYSIS
X. YANG (Aeronautical Computation Techniques Institute, People's Republic of China) and G. LI (Aircraft Structural Mechanics Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 149-156. In Chinese, with abstract in English. refs

A flutter analysis based on the root locus method which can be applied to a wing equipped with an active flutter suppression system is programmed. An automatic identification method for flutter modes is proposed which is highly efficient in computation, has brief algorithms, and offers simplicity in programming. Numerical examples are presented which show that the method is feasible. C.D.

A85-12360#
MULTI-RATE DIGITAL FLIGHT CONTROL SYSTEMS
S. GUO (Nanjing Aeronautical Institute, Nanjing, People's Republic of China) *Acta Aeronautica et Astronautica Sinica*, vol. 5, June 1984, p. 178-185. In Chinese, with abstract in English.

The equivalent transformation approach and its conversion into an equivalent single-rate system for multirate digital flight control systems is analyzed. The method of decomposing sampling signals in the frequency domain may be used in the equivalent transformation. The implementation and timing on a computer is simplified by considering the ratio of the sampling rate as an integer. Then, the equivalent single-rate system can be represented by a transfer function with several parallel paths. The behavior of a multirate system is discussed and illustrated with a simple system. Approaches to the design of multirate digital flight control systems are briefly described. C.D.

A85-12361#
A RECONFIGURABLE REDUNDANCY MANAGEMENT STRATEGY FOR A TRIPLEX DFBW SYSTEM
L. LI (Institute of Automatic Flight Control System, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 186-192. In Chinese, with abstract in English.

A reconfigurable redundancy management strategy for a triplex DFBW flight control system is discussed. The strategy consists of redundancy and control law reconfiguration after 1st, 2nd, and 3rd failures, Every part of the system uses both the comparison-monitored and the self-tested schemes, which permits the functional range of reconfigurable strategy to be expanded and high system reliability to be achieved. Computer verification results for the strategy are presented along with the architecture and interfaces of software designed for the reconfigurable management. It is shown that the data transmissions rate, in particular the across-channel data transmission rate, is the key factor for the feasibility of the strategy. C.D.

A85-12593* Lockheed-California Co., Burbank.
DEMONSTRATION OF RELAXED STATIC STABILITY ON A COMMERCIAL TRANSPORT
J. J. RISING, W. J. DAVIS, C. S. WILLEY, and R. C. COKELEY (Lockheed-California Co., Burbank, CA) Lockheed Horizons, no. 16, 1984, p. 44-64.
(Contract NAS1-15326)

Increasing jet aircraft fuel costs from 25 percent to nearly 60 percent of the aircraft direct operating costs have led to a heavy emphasis on the development of transport aircraft with significantly improved aerodynamic performance. The application of the concept of relaxed static stability (RSS) and the utilization of an active control stability augmentation system make it possible to design an aircraft with reduced aerodynamic trim drag due to a farther-aft cg balance. Reduced aerodynamic parasite drag and lower structural weight due to a smaller horizontal tail surface can also be obtained. The application of RSS has been studied under a NASA-sponsored program to determine ways of improving the energy efficiency in current and future transport aircraft. Attention is given to a near-term pitch active control system, an advanced pitch active control system, and an operational overview. G.R.

N85-10071*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ACTIVE CONTROL TECHNOLOGY EXPERIENCE WITH THE SPACE SHUTTLE IN THE LANDING REGIME Final Report
B. G. POWERS Oct. 1984 12 p refs Presented at the AGARD Flight Mech. Panel Symp. on Active Control Systems, Toronto, 15-18 Oct. 1984
(NASA-TM-85910; H-1260; NAS 1.15:85910) Avail: NTIS HC A02/MF A01 CSCL 01C

The shuttle program took on the challenge of providing a manual landing capability for an operational vehicle returning from orbit. Some complex challenges were encountered in developing the longitudinal flying qualities required to land the orbiter manually in an operational environmental. Approach and landing test flights indicated a tendency for pilot-induced oscillation near landing. Changes in the operational procedures reduced the difficulty of the landing task, and an adaptive stick filter was incorporated to reduce the severity of any pilot-induced oscillatory motions. Fixed-base, moving-base, and in-flight simulations were used for the evaluations, and in general, flight simulation was the only reliable means of assessing the low-speed longitudinal flying qualities problems. Overall, the orbiter control system and operational procedures have produced a good capability for routinely performing precise landings in a large, unpowered vehicle with a low lift-to-drag ratio. Author

N85-11000 Wichita State Univ., Kans.
MODEL SIMPLIFICATION OF FLIGHT CONTROL SYSTEMS Ph.D. Thesis
M. T. TRAN 1983 128 p
Avail: Univ. Microfilms Order No. DA8412645

Large scale linear shift invariant discrete time systems satisfying the two time scale property are considered. Design techniques based on complete separation of slow and fast subsystems are developed. The slow and fast subsystem performances are obtained and compared to those of the original system. Subsystem regulator design problems are investigated and the controllability and observability properties of the system are studied based on the corresponding properties of the subsystems. Stabilizing controller design methods are developed based on the separability of the slow and fast controllers. Subsystem outputs are compared to those of the original system by using output feedback design. In the case where these systems are controlled by more than one decision maker with direct conflict, the zero sum Nash strategies are employed to derive near optimal solutions based on the slow and fast subsystems separately. The composite performance is analytically compared to the optimal performance. Quadratic performance indices are used for this purpose.
Dissert. Abstr.

N85-11002*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SIMULATOR STUDY OF FLIGHT CHARACTERISTICS OF SEVERAL LARGE, DISSIMILAR, CARGO TRANSPORT AIRPLANES DURING APPROACH AND LANDING
W. D. GRANTHAM, P. M. SMITH (Kentron International, Inc.), P. L. DEAL (Air Force Systems Command), and W. R. NEELY, JR. Nov. 1984 88 p refs
(NASA-TP-2357; L-15805; NAS 1.60:2357) Avail: NTIS HC A05/MF A01 CSCL 01C

A six-degree-of-freedom, ground based simulator study is conducted to evaluate the low-speed flight characteristics of four dissimilar cargo transport airplanes. These characteristics are compared with those of a large, present-day (reference) transport configuration similar to the Lockheed C-5A airplane. The four very large transport concepts evaluated consist of single-fuselage, twin-fuselage, triple-fuselage, and span-loader configurations. The primary piloting task is the approach and landing operation. The results of his study indicate that all four concepts evaluated have unsatisfactory longitudinal and lateral directional low speed flight characteristics and that considerable stability and control augmentation would be required to improve these characteristics (handling qualities) to a satisfactory level. Through the use of rate command/attitude hold augmentation in the pitch and roll axes, and the use of several turn-coordination features, the handling qualities of all four large transports simulated are improved appreciably. M.A.C.

N85-11003*# Purdue Univ., Lafayette, Ind. School of Aeronautics and Astronautics.
INTERACTIVE AIRCRAFT FLIGHT CONTROL AND AEROELASTIC STABILIZATION Semiannual Report, 1 May - 31 Oct. 1984
T. A. WEISSHAAR Nov. 1984 19 p
(Contract NAG1-157)
(NASA-CR-174025; NAS 1.26:174025) Avail: NTIS HC A02/MF A01 CSCL 01C

An analytical model has been used to study the problem of integrated control system/structural dynamic design. This model utilizes the traditional typical section lifting surface with a control surface attached in 2-D unsteady incompressible flow. The studies have as their purpose the examination of the use of the location of the elastic axis of the airfoil as a design variable in the search for an actively controlled configuration that has a specified flutter margin. Items of interest include the determination of flutter speed and divergence speed as functions of a nondimensional parameter, a sub c, that measures the location (in semi-chords) of the elastic axis with respect to the airfoil midchord. All other parameters are fixed. The behavior of velocity root locus curves with changes in a sub c is illustrated. Also shown is an example of the use of sensitivity derivatives to reposition poles of the open loop system. The behavior of the actively controlled or closed loop system is also discussed. A set of examples are presented to indicate how the shear center parameter, a sub c, affects the design of the controlled system. B.W.

N85-11004*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AIRCREW-AIRCRAFT INTEGRATION: A SUMMARY OF US ARMY RESEARCH PROGRAMS AND PLANS
D. L. KEY and E. W. AIKEN Oct. 1984 24 p refs
(NASA-TM-85991; A-8853; NAS 1.15:85991; USAAVSCOM-TR-84-A-4) Avail: NTIS HC A02/MF A01 CSCL 01C

A review of selected programs which illustrate the research efforts of the U.S. Army Aeromechanics Laboratory in the area of aircrew-aircraft integration is presented. Plans for research programs to support the development of future military rotorcraft are also described. The crew of a combat helicopter must, in general, perform two major functions during the conduct of a particular mission: flightpath control and mission management. Accordingly, the research programs described are being conducted in the same two major categories: (1) flightpath control, which encompasses the areas of handling qualities, stability and control, and displays for the pilot's control of the rotorcraft's flightpath, and (2) mission management, which includes human factors and cockpit integration research topics related to performance of navigation, communication, and aircraft systems management tasks. Author

N85-11005*# Boeing Commercial Airplane Co., Seattle, Wash. Preliminary Design Dept.
INTEGRATED APPLICATION OF ACTIVE CONTROLS (IAAC) TECHNOLOGY TO AN ADVANCED SUBSONIC TRANSPORT PROJECT-LONGITUDINAL HANDLING QUALITIES STUDY OF A RELAXED-STABILITY AIRPLANE Final Contractor Report, Feb. - Dec. 1981
Washington NASA Jan. 1983 59 p refs
(Contract NAS1-15325)
(NASA-CR-3660; NAS 1.26:3660; D6-51147) Avail: NTIS HC A04/MF A01 CSCL 01C

The results of a piloted simulation of longitudinal handling qualities of an airplane with relaxed static stability are described. This task was performed under the Integrated Application of Active Controls (IAAC) Technology Project within the NASA Energy Efficient Transport Program. A representative medium range transport airplane, the Boeing Model 757, was simulated. Evaluations were made of the unaugmented airplane and of the airplane with an Essential Pitch Augmented Stability (PAS) System and with a Primary PAS System at various center of gravity (cg) conditions. Level 2 pilot ratings were attained with cg locations aft to about 57% mean aerodynamic chord (MAC) or 6% aft of the neutral point for unaugmented landing approach. For Mach = 0.80, unaugmented cruise Level 2 ratings were attained to 47% MAC or 5% forward of the maneuver point. The augmented airplane model provided handling qualities close to or within the Level 1 boundary at all cg locations for both Essential and Primary PAS. Analyses of the test conditions when compared with existing handling qualities criteria based on classical unaugmented airplane characteristics agreed well with the pilot ratings. The unaugmented results are comparable to those reported by both the Douglas Aircraft Company and Lockheed California Company from simulation investigations of transport configurations with roughly similar dimensional and mass characteristics. B.W.

N85-11006*# Lockheed-California Co., Burbank.
DEVELOPMENT AND FLIGHT EVALUATION OF AN AUGMENTED STABILITY ACTIVE CONTROLS CONCEPT: EXECUTIVE SUMMARY Contractor Report, Dec. 1978 - Apr. 1982
W. A. GUINN 19 Nov. 1982 22 p
(Contract NAS1-15326)
(NASA-CR-166009; NAS 1.26:166009; LR-30208-1) Avail: NTIS HC A02/MF A01 CSCL 01C

A pitch active control system (PACS) was developed and flight tested on a wide body jet transport (L-1011) with a flying horizontal stabilizer. Two dual channel digital computers and the associated software provide command signals to a dual channel series servo which controls the stabilizer power actuators. Input sensor signals to the computer are pitch rate, column trim position, and dynamic pressure. Control laws are given for the PACS and the system architecture is defined. Discussions are given regarding piloted flight simulation and vehicle system simulation and vehicle system simulation tests that are performed to verify control laws and system operation prior to installation on the aircraft. Modifications to the basic aircraft included installation of the PACS, addition of a c.g. management system to provide a c.g. range from 25 to 39% mac, and downrigging of the geared elevator to provide the required nose down control authority for aft c.g. flight test conditions. Three pilots used the Cooper-Harper Rating Scale to judge flying qualities of the aircraft with PACS on and off. The handling qualities with the c.g. at 39% mac (41% stability margin) and PACS operating were judged to be as good as the handling qualities with the c.g. at 25% mac (+15% stability margin) and PACS off. B.W.

N85-11007# McDonnell Aircraft Co., St. Louis, Mo.
DEFINITION OF ACCEPTABLE LEVELS OF MISMATCH FOR EQUIVALENT SYSTEMS OF AUGMENTED CTOL (CONVENTIONAL TAKE-OFF AND LANDING) AIRCRAFT
J. R. WOOD and J. HODGKINSON 19 Dec. 1980 74 p
(AD-A145619; MDC-A6792) Avail: NTIS HC A04/MF A01 CSCL 01D

High order pitch rate frequency responses of augmented aircraft can be broken down into the response of a low order equivalent system, and the mismatch between the response of the actual high order system and the low order equivalent. This study used variable stability NT-33 in-flight data to define frequency response envelopes of acceptable levels of mismatch. The envelopes were narrowest in a region believed to coincide with the piloted crossover region. The computer program for obtaining the equivalent system was then modified to weight the match in the crossover region. Equivalent system summaries for the LAHOS and Neal-Smith data sets are included. 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.

A85-10408
PENETRATION OF AIRCRAFT NOISE INTO AN OPEN CONFIGURATION AIRPORT TERMINAL BUILDING
K. W. YEOW (University of Malaya, Kuala Lumpur, Malaysia) Journal of Sound and Vibration (ISSN 0022-460X), vol. 95, July 22, 1984, p. 291-294.

It is pointed out that the noise from parked or taxiing aircraft in close proximity to the building is a major consideration in the design of a modern airport terminal building. Problems can arise in the case of buildings of the open type, which are sometimes found in tropical climates. The present investigation has the objective to show that approximate methods based on geometrial acoustics can be used to obtain estimates of the degree of penetration of aircraft noise into a typical modern open configuration airport terminal building. The employed approach is also suitable for other situations, such as those involving the intrusion of traffic noise into a building with openings outside. Attention is given to details regarding the considered approach and an illustration of its application in an application example. G.R.

N85-10073# Systems Control, Inc., West Palm Beach, Fla.
HELIPORT SNOW AND ICE CONTROL METHODS AND GUIDELINES Final Report
J. B. MCKINLEY and R. B. NEWMAN Aug. 1984 61 p refs
(Contract DTFA01-80-C-10080)
(DOT/FAA-PM-84-22) Avail: NTIS HC A04/MF A01

Guidelines for snow and ice control on heliports are presented for the purpose of both enhancing the operational utility of heliports, and employing the unique capabilities of the rotorcraft to the maximum extent. These guidelines consider manual methods of snow and ice control such as plowing and chemical application, and automated methods through pavement heating systems. Cost and design considerations are provided for each system. Benefit/cost decision guidelines are provided with estimated annual operating cost data for 32 U.S. cities, and six snow and ice control methods. In addition, selection guidelines provide a methodology to assist heliport planners and designers with the selection of the most appropriate snow and ice control system. Author

N85-10074*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
YO-3A ACOUSTICS RESEARCH AIRCRAFT SYSTEMS MANUAL
J. L. CROSS Jul. 1984 38 p
(NASA-TM-85968; A-9776; NAS 1.15:85968) Avail: NTIS HC A03/MF A01 CSCL 14B

The flight testing techniques, equipment, and procedures employed during air-to-air acoustic testing of helicopters using the NASA YO-3A Acoustic Research Aircraft are discussed. The research aircraft instrumentation system is described as well as hardware installation on the test aircraft and techniques used during the tests. Emphasis is placed on formation flying, position locations, test matrices, and test procedures. M.A.C.

N85-10075# National Aerospace Lab., Tokyo (Japan).
THE DATA PROCESSING SYSTEM OF THE NAL 2M X 2M TRANSONIC WIND TUNNEL
S. NAKAMURA, K. SUZUKI, M. SHIRAI, A. KOIKE, and T. FUJITA 1984 90 p
(NAL-TR-811; ISSN-0389-4010) Avail: NTIS HC A05/MF A01

The current data processing system of the NAL 2m x 2m Transonic Wind Tunnel is described. The system is based on dual ECLIPSE S/140 processors with a core memory of 128 KW x 2 at 16 bits/word. An outline of the main processing stages through which the test data cascade is first given, and then a description is given of the way in which force and moment data as well as pressure and temperature data are collected, processed, stored and displayed at each processing stage. Part of the hardware system used for the test data acquisition is also described when thought helpful in delineating the process of data reduction. Author

N85-10076# Naval Civil Engineering Lab., Port Hueneme, Calif.
HANGAR DESTRATIFICATION INVESTIGATION Technical Note, FY82 - FY83
J. ASHLEY Apr. 1984 42 p
(AD-A145049; NCEL-TN-1692) Avail: NTIS HC A03/MF A01 CSCL 13A

Measurements made in military hangars indicated that stratification, the existence of a layer of hot air in a structure's overhead, is a typical phenomenon. Five destratification concepts (three commercial and two Navy-developed) were evaluated to determine the effectiveness and the adaptability of each concept for hangar applications. Only the Navy-developed concepts were found practical for hangar applications. Destratifier design and application guidelines were developed and are presented in the report. GRA

N85-10077# Strategic Air Command, Offutt AFB, Nebr. Aircraft Engineering Div.
AIRCRAFT CHOCKS Final Engineering Report
T. L. FUCHSER 24 Jul. 1984 69 p
(AD-A145135; SAC/LGME-P-425) Avail: NTIS HC A04/MF A01 CSCL 01E

A tire chock is the most common means to restrain an aircraft while it is parked. However, during certain ground operations, the chock is unable to restrain the aircraft. An analysis was done on the restrain capabilities of the current chocks used for the B-52 and -135 aircraft. From this analysis, safety factors and operating limitations were established. In addition, criteria was developed for chock improvements as they are related to the various engineers on the B-52G, B-52H, KC-135A, KC-135E and KC-135R. Author (GRA)

N85-10078# Seville Training Systems Corp., Pensacola, Fla.
TRAINING EFFECTIVENESS EVALUATION AND UTILIZATION DEMONSTRATION OF A LOW COST COCKPIT PROCEDURES TRAINER Final Report, Jun. 1978 - Jul. 1982
P. W. CARO, W. E. CORLEY, W. D. SPEARS, and A. S. BLAIWES Jun. 1984 84 p
(Contract N61339-78-C-0113)
(AD-A145179; SEVILLE-TR-83-25; NAVTRAEQUIPC-78-C-0113-3) Avail: NTIS HC A05/MF A01 CSCL 05I

The purpose of this study was to evaluate a prototype low cost cockpit procedures trainer (LCCPT) for the SH-3H aircraft. During Phase I of the study, pilots trained in the LCCPT were compared in subsequent SH-3H performance with a historical control group trained in Device 2C44, a much more expensive conventional cockpit procedures trainer. The LCCPT and 2C44 groups performed equally well in the SH-3H. For tasks practiced in the LCCPT, transfer of device training to SH-3H performance was 95 percent as estimated through a curve fitting technique. During Phase II, the adaptability of the LCCPT to student-directed instruction was evaluated. The students developed required levels of proficiency, and they appeared able to identify weaknesses in their performance and to direct their practice toward overcoming them. GRA

N85-10079# DCS Corp., Alexanderia, Va.
ANALYSIS OF ON-BOARD CIG (COMPUTER IMAGE GENERATOR) APPLICATIONS FOR AIRCREW TRAINING Final Technical Report, 1 Jul. 1983 - 30 Apr. 1984
D. B. COBLITZ Orlando, Fla. NTEC Apr. 1984 107 p
(Contract N60921-82-D-A075)
(AD-A145214; DCS-LT0010; NAVTRAEQUIPC-IH-353) Avail: NTIS HC A06/MF A01 CSCL 09B

This report presents the results of a study examining the potential use of on-board Computer Image Generation (CIG) for Naval aircrew training. Three criteria determine whether on-board CIG may be applied to a particular training task. The displays available in the cockpit must be suitable, generation of adequate imagery must be feasible, and the training problem must be appropriate. To determine each of these factors, surveys in each area were conducted. An analysis of the survey results is presented. The development and use of on-board CIG based training systems was concluded to be feasible and would enhance operational readiness. The report includes specific recommendations as regards training tasks that would benefit most from application of on-board CIG and would also be technically feasible. Three approaches to such application are: Utilization of existing and planned on-board hardware in training modes; Development of a training computer image generator as a pod to be mounted temporarily on a weapon station for training missions; Long term merging of training and tactical considerations in the development phase of a new weapon systems and avionics. All three approaches should be pursued in parallel. Author (GRA)

N85-10080# Canyon Research Group, Inc., Westlake Village, Calif.
CONTENT, VARIETY, AND AUGMENTATION OF SIMULATED VISUAL SCENES FOR TEACHING AIR-TO-GROUND ATTACK Final Interim Report, 1 Sep. 1981 - 31 Aug. 1984
G. LINTERN, K. E. THOMLEY, B. E. NELSON, and S. N. ROSCOE Orlando, Fla. NTEC Jul. 1984 90 p
(Contract N61339-81-C-0105)
(AD-A145218; NAVTRAEQUIPC-81-C-0105-3) Avail: NTIS HC A05/MF A01 CSCL 19E

The Visual Technology Research Simulator was used for quasi-transfer-of-training study in which 32 military pilots were taught to deliver bombs from a 30-degree dive. Sixteen of the pilots had a moderate amount of prior bombing experience (approximately 60 bombing runs) and the remainder had none. The pilots were given 80 training trials in the simulator under specific training conditions. Three factors were manipulated in training; those being level of detail in the visual scene, number of visual scenes, and augmented feedback in the form of artificial visual guidance. Differential transfer effects were assessed on the basis of performances on 30 transfer trials in the simulator. The transfer phase used a variety of visual scenes and varying levels of detail but no augmented feedback. All subjects flew the same set of conditions in the transfer phase. The scene-content issue is one of the most crucial for modern training simulators. These data are the first to show that scene content affects learning of flight skills. Simulator training of air-to-ground attack should be conducted with visual scenes that have features similar to those of our landscape. Variety was raised as a training issue. Augmented feedback proved to be helpful to inexperienced and more experienced pilots with their dive altitude control. It appears to be useful at least for primary and intermediate instruction. There is no evidence in this report that pilots with no experience in air-to-ground attack should be treated differently during training to pilots who have some experience in air-to-ground attack. GRA

N85-10081# Department of the Air Force, Washington, D.C.
AIRCRAFT CABIN PRESSURIZATION CONTROL SYSTEM TESTER Patent Application
K. J. WERLING, inventor (to Air Force) 19 Jun. 1984 16 p
(AD-D011225; US-PATENT-APPL-SN-622047) Avail: NTIS HC A02/MF A01 CSCL 14B

This patent application discloses an aircraft cabin pressure control system tester, including a first tester component having a vacuum pressure-sensing gage which indicates the static atmosphere in inches of Hg and a second tester component having a differential pressure-sensing gage which indicates the pressure/vacuum in inches of H2O. When the components of the tester are connected respectively in communication with lines connecting the controller of the system to static atmosphere ports and a pressure regulator valve, the tester can be used to determine which one, if any, of the pressure controller, air compressor and regulator valve of the pressure control system is faulty. GRA

N85-11009*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

COMPUTATIONS FOR THE 16-FOOT TRANSONIC TUNNEL, NASA, LANGLEY RESEARCH CENTER

C. E. MERCER, B. L. BERRIER, F. J. CAPONE, A. M. GRAYSTON, and C. D. SHERMAN Oct. 1984 189 p
(NASA-TM-86319; NAS 1.15:86319) Avail: NTIS HC A09/MF A01 CSCL 14B

The equations used by the 16 foot transonic tunnel in the data reduction programs are presented in eight modules. Each module consists of equations necessary to achieve a specific purpose. These modules are categorized in the following groups: (1) wind tunnel parameters, (2) jet exhaust measurements, (3) skin friction drag, (4) balance loads and model attitudes, (5) internal drag (or exit flow distributions), (6) pressure coefficients and integrated forces, (7) thrust removal options, and (8) turboprop options. R.J.F.

N85-11010# Maryland Univ., College Park. Dept. of Civil Engineering.

STRUCTURAL DESIGN GUIDELINES FOR HELIPORTS Final Report, 5 Dec. 1983 - 10 Oct. 1984

C. W. SCHWARTZ, M. W. WITCZAK, and R. B. LEAHY Washington FAA Oct. 1984 115 p refs Prepared for Systems Control Technoloy, Inc., West Palm Beach, Fla.
(Contract DTFA01-80-C-10080)
(FAA-PM-84-23) Avail: NTIS HC A06/MF A01

Current structural design guidelines for heliports are analyzed using data obtained from the literature and from surveys of helicopter manufacturers, heliport design consultants, and heliport operators. Primary topics of interest in these analyses are the loads on heliport structures caused by helicopter hard landing, rotor downwash, and helicopter vibrations. A new analysis, based on reliability theory, is proposed for determining the helicopter hard landing load magnitudes appropriate for structural design. Results from this analysis indicate that the current FAA heliport structural design guidelines are adequate for medium to high volume heliports and conservative for low volume facilities. Additional analyses indicate that rotor downwash pressures and helicopter-induced vibrations are not critical loading conditions for most heliport structures. Guidelines for appropriate load combinations for heliport structural design are also presented. Author

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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.

A85-12477#

DEVELOPMENT OF THE AEROSPACE STRUCTURES TECHNOLOGY DAMPING DESIGN GUIDE

J. SOOVERE (Lockheed-California Co., Burbank, CA), M. L. DRAKE (Dayton, University, Dayton, OH), V. R. MILLER, and L. C. ROGERS (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: International Conference on Recent Advances in Structural Dynamics, 2nd, Southampton, England, April 9-13, 1984, Proceedings. Volume 2 . Southampton, England, University of Southampton, 1984, p. 867-875. refs

The three phases of a program to compile a viscoelastic damping design guide are described. First, a technology survey was conducted, mainly in the U.S., to identify all individuals and organizations active in the field, revealing a heavy emphasis on use in R&D efforts. The guide was configured in three volumes: one summarizing work done to date and providing a bibliography; a second intended as a user-oriented design guide with equations/nomograms and worked examples; and, the third providing damping data needed by the designer. The guide was to be completed by July 1984. M.S.K.

N85-10096* Chrysler Corp., New Orleans, La.

RESULTS OF TESTS OF ADVANCED FLEXIBLE INSULATION VORTEX AND FLOW ENVIRONMENTS IN THE NORTH AMERICAN AERODYNAMICS LABORATORY LOWSPEED WIND TUNNEL USING 0.0405-SCALE SPACE SHUTTLE ORBITER MODEL 16-0 (TEST OA-309)

B. A. MARSHALL (Rockwell International Corp., Downey, Calif.) and M. E. NICHOLS (Rockwell International Corp., Downey, Calif.) Sep. 1984 118 p refs
(Contract NAS9-16283)
(NASA-CR-167692; NAS 1.26:167692; DMS-DR-2519) Avail: NTIS HC A06 CSCL 22B

An experimental investigation (Test OA-309) was conducted using 0.0405-scale Space Shuttle Orbiter Model 16-0 in the North American Aerodynamics Laboratory 7.75 x 11.00-foot Lowspeed Wind Tunnel. The primary purpose was to locate and study any flow conditions or vortices that might have caused damage to the Advanced Flexible Reusable Surface Insulation (AFRSI) during the Space Transportation System STS-6 mission. A secondary objective was to evaluate vortex generators to be used for Wind Tunnel Test OS-314. Flowfield visualization was obtained by means of smoke, tufts, and oil flow. The test was conducted at Mach numbers between 0.07 and 0.23 and at dynamic pressures between 7 and 35 pounds per square foot. The angle-of-attack range of the model was -5 degrees through 35 degrees at 0 or 2 degrees of sideslip, while roll angle was held constant at zero degrees. The vortex generators were studied at angles of 0, 5, 10, and 15 degrees. Author

N85-10100*# Auburn Univ., Ala. Dept. of Computer Sciences.

SINGULAR ASYMPTOTIC EXPANSIONS IN NONLINEAR ROTORDYNAMICS

W. B. DAY 10 Aug. 1984 24 p refs
(Contract NGT-01-002-099)
(NASA-CR-174012; NAS 1.26:174012) Avail: NTIS HC A02/MF A01 CSCL 21H

During hot firing ground testing of the Space Shuttle's Main Engine, vibrations of the liquid oxygen pump occur at frequencies which cannot be explained by the linear Jeffcott model of the rotor. The model becomes nonlinear after accounting for deadband, side forces, and rubbing. Two phenomena present in the numerical solutions of the differential equations are unexpected periodic orbits of the rotor and tracking of the nonlinear frequency. A multiple scale asymptotic expansion of the differential equations is used to give an analytic explanation of these characteristics. M.A.C.

N85-11051*# Morton Thiokol, Brigham City, Utah.
A PROOF-OF-PRINCIPLE GETAWAY SPECIAL FREE-FLYING SATELLITE DEMONSTRATION Abstract Only
R. G. MOORE *In* NASA. Marshall Space Flight Center 2nd Symp. on Space Industrialization p 349 Oct. 1984
Avail: NTIS HC A19/MF A01 CSCL 22B

An air traffic control radar calibration satellite is described that will be used by the U.S. Federal Aviation Administration, U.S. military agencies and cooperating governments around the world to measure antenna patterns associated with the existing international air traffic control network. The satellite will employ three L-band receivers, a UHF command receiver, a VHF telemetry transmitter, associated antennas, a microprocessor, fixed solar arrays, and a power supply to acquire, store and forward signal strength data from some of the tracking radars. A second satellite is planned for launch in 1986 into a high altitude polar orbit with a lifetime of several years in order to provide a long-lived calibration service to the entire international air traffic control system. The initial satellite and associated ground station are being designed and built by a volunteer consortium of three educational institutions and more than a dozen aerospace companies. Following this initial demonstration of a free-flying Getaway Special satellite, a substantial number of organizations are contemplating commercial uses of the concept. Discussions are being held with NASA concerning the establishing of an appropriate fee for this new class of service. M.A.C.

N85-11053*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DESIGN AND IMPLEMENTATION OF A LOW-GRAVITY SOLIDIFICATION EXPERIMENT PACKAGE FOR THE F-104
G. SMITH, R. MEAD, R. BOND, G. L. WORKMAN, and P. A. CURRERI *In its* 2nd Symp. on Space Industrialization p 362-367 Oct. 1984 Prepared in cooperation with Alabama Univ., Huntsville
Avail: NTIS HC A19/MF A01 CSCL 22A

The use of the F-104 Interceptor for low gravity materials processing experiments is extended to include alloy solidification studies above 1000 C. The F-104 can provide up to 60 seconds of low gravity, but requires a unique experiment package for integration into the aircraft, both physically and electronically. The current research with the F-104 experimental furnace system which has been used to process cast iron samples is described. Results demonstrate the capability of the facility and its operation. M.A.C.

N85-11084# Joint Publications Research Service, Arlington, Va.
USE OF GRAVITATIONAL STABILIZATION IN PERFORMANCE OF EXPERIMENTS Abstract Only
M. Y. BELYAYEV and T. N. TYAN *In its* USSR Rept.: Space (JPRS-USP-84-005) p 62 26 Oct. 1984 Transl. into ENGLISH from Kosmicheskiye Issled. (Moscow), v. 22, no. 2, Mar.-Apr. 1984 p 181-188
Avail: NTIS HC A07

Spacecraft such as the Salyut-6 use gravitational stabilization for the conduct of geophysical, astronomical and other experiments. Development of an effective strategy for controlling spacecraft in gravitational stabilization modes requires to study the specifics of motion of the spacecraft. The gravitational orientation of the station was studied by a mathematical model of motion considering the effect of gravitational, aerodynamic and magnetic disturbances, and by telemetry information from the control system of the angular position installed on the spacecraft. The true picture of motion of the spacecraft and practical recommendatins for the use of gravitational stabilization in performing scientific experiments are established. E.A.K.

N85-11085# Joint Publications Research Service, Arlington, Va.
CONTROL OF LATERAL CONJECTORY MOTION OF SPACECRAFT IN ATMOSPHERE Abstract Only
E. N. DUDAR and V. A. YAROSHEVSKIY *In its* USSR Rept.: Space (JPRS-USP-84-005) p 63 26 Oct. 1984 Transl. into ENGLISH from Kosmicheskiye Issled. (Moscow), v. 22, no. 2, Mar.-Apr. 1984 p 189-200
Avail: NTIS HC A07

The equation of motion of a spacecraft in the atmosphere has a time characteristic for the motion of the spacecraft about its center of mass which is usually significantly less than the time characteristic for the trajectory motion. In many cases, problems of optimal control of spacecraft trajectories are solved without consideration for its motion about its center of mass. The problem of control of the spatial trajectory of a spacecraft by changing the bank angle was studied. The control vector is included linearly in the right portion of the trajectory equations of motion, which can be linearized and applied to the apparatus of the theory of stochastically optical control systems. A control algorithm is suggested based on construction of areas of permissibility in the space of final parameters. Numerical examples are included. E.A.K.

N85-11124 Rice Univ., Houston, Tex.
MINIMAX OPTIMAL CONTROL IN THE REENTRY OF A SPACE GLIDER Ph.D. Thesis
P. VENKATARAMAN 1984 103 p
Avail: Univ. Microfilms Order No. DA8416550

The numerical solution of minimax problems of optimal control (also called Chebshev problems) arising in the reentry of a space glider are considered. First, a transformation technique is employed in order to convert minimax problems of optimal control into the Mayer-Bolza problem of the calculus of variations. The transformation requires the proper augmentation of the state vector x(t), the control vector u(t), and the parameter vector pi, as well as the proper augmentation of the constraining relations. As a result of the transformation, the unknown minimax value of the performance index becomes a component of the vector parameter being optimized. The transformation technique is then applied to the following Chebshev problems of interest in the reentry of a space glider: (Q1) minimization of the peak dynamic pressure; and (Q2) minimization of the peak heating rate. Dissert. Abstr.

N85-11125# Technische Univ., Munich (West Germany). Luft- und Raumfahrt.
WINGED FIRST STAGES OF SPACE TRANSPORT APPLIANCES [GEFLUEGELTE ERSTSTUFEN VON RAUMTRANSPORTGERAETEN]
H. O. RUPPE Apr. 1984 70 p Partly in GERMAN and ENGLISH
(TUM-RT-TB-84/3) Avail: NTIS HC A04/MF A01

Winged fully reusable rocket carriers are considered. Flying performances and flight costs were studied for a two stage vehicle with a liftoff mass of 1000 tons. It is found that such vehicles are feasible, but that ballistic first stages are more economical than winged fly back first stages. Winged stages are easier to operate than ballistic ones. Flight costs for reusable carriers are lower with frequent use (100 times or more) and large annual transport volumes (350 ton or more) to low Earth orbits. Author (ESA)

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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.

A85-10310* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OXIDATION-BASED MODEL FOR THERMAL BARRIER COATING LIFE
R. A. MILLER (NASA, Lewis Research Center, Cleveland, OH) American Ceramic Society, Journal (ISSN 0002-7820), vol. 67, Aug. 1984, p. 517-521. refs

A procedure is described for modeling the lives of thermal barrier coatings subjected to high-temperatrue environments. The models is used to calculate cycles-to-failure as a function of heating cycle duration. It is based on the presumption that oxidation is the single important time-dependent factor which limits the life of these coatings, and that oxidation-induced strains combine with cyclic strains to promote slow crack growth in the ceramic layer. Good agreement is obtained between calculated and experimental lives for specimens tested in a furnace. This shows that an oxidation-based approach is promising. The importance of reproducible specimen preparation is also discussed. Author

A85-10374
AERODYNAMICS OF PREMIXED FLAMES IN FLAT PLATE BOUNDARY LAYERS
C. TREVINO (Universidad Nacional Autonoma de Mexico, Villa Obregon, Mexico) and A. C. FERNANDEZ-PELLO (California, University, Berkeley, CA) Combustion Science and Technology (ISSN 0010-2202), vol. 38, Aug. 1984, p. 293-312. Research supported by the Fundacion de Estudios e Investigaciones Ricardo J. Zevada; Consejo Nacional de Ciencia y Tecnologia of Mexico. refs
(Contract CONACYT-PIT/QU/NSF/81/1357; NSF INT-81-15965)

Catalytic and noncatalytic plate cases are considered in the present analysis of the structure of a premixed flame that is stabilized in the boundary layer flow over a hot, impermeable flat plate, using governing equations that are solved by series expansion of a small parameter which controls the longitudinal diffusive processes. For low plate temperatures, a region of elevated pressure is generated in front of the flame leading edge which becomes weaker and is displaced above the flame and downstream from its leading edge as the plate temperature is increased. Diffusive processes, and especially the upstream diffusion of combustion products, affect the rate of the chemical reaction. Diffusive and chemical kinetic effect interactions are of primary importance in the determination of the flame's final structure. O.C.

A85-10557
COMPUTATION OF THE AEROTHERMODYNAMIC FIELD OF LAMINAR DIFFUSION FLAMES
D. P. S. ABAM (Shell Petroleum Development Company of Nigeria, Ltd., Port Harcourt, Nigeria; Cambridge University, Cambridge, England) Institution of Mechanical Engineers, Proceedings, Part C Mechanical Engineering Science (ISSN 0263-7154), vol. 198, no. 12, 1984, p. 175-187. refs

This paper describes a theoretical and experimental investigation of laminar diffusion flames leading to their structural characterization. A theoretical model is developed from experimental correlations of major species concentrations and temperature against suitably defined conserved species, otherwise called mixture fraction, using the Shvab-Zeldovich similarity principle. These correlations yield a set of similarity equations of stoichiometry which express implicit functional dependence of species concentrations and temperature on mixture fraction. The momentum conservation equation is then solved simultaneously with the conserved species equation to establish the aerothermodynamic field of the flame. In the form defined, the mixture fraction is measured, having well-defined initial and boundary conditions, and allows examination and identification of regions of the flame characterizing either diffusive flow or combined diffusive and chemically reactive flow. Furthermore, it is found experimentally that at a fixed value of mixture fraction $Z = 0.059$, corresponding to a methane/air equivalence ratio of 1.08, the local temperature maxima occur in the neighbourhood of the visible luminous flame boundary. This observation is used to check the accuracy of calculations of the physical dimensions of the flame. Good comparison is obtained between computed and measured values and distribution of the major species concentrations, temperature and velocities. The model allows investigation of the chemical kinetic structure through its effectiveness in the computation of reaction rates. Author

A85-10868#
REHEAT BUZZ - AN ACOUSTICALLY DRIVEN COMBUSTION INSTABILITY
A. P. DOWLING (Cambridge University, Cambridge, England) and G. J. BLOXSIDGE American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 7 p. Research supported by Rolls-Royce, Ltd.
(AIAA PAPER 84-2321)

Reheat buzz is a combustion instability involving the propagation of longitudinal acoustic waves in a duct. A theory is developed to describe the onset of buzz in ducts of simple geometry and to determine the unstable frequency. Theoretical predictions are compared with experimental data, and reasonable agreement is obtained. Author

A85-11614#
STATISTICAL FATIGUE CRACK PROPAGATION OF IN100 AT ELEVATED TEMPERATURES
J. N. YANG (George Washington University, Washington, DC), R. C. DONATH (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), and G. C. SALIVAR (Florida Atlantic University, Boca Raton, FL) IN: International Conference on Advances in Life Prediction Methods, Albany, NY, April 18-20, 1983, Proceedings . New York, American Society of Mechanical Engineers, 1983, p. 241-247. refs
(Contract F33615-80-C-5189)

A simple fracture mechanics-based statistical model for the fatigue crack propagation of IN100 is proposed and investigated. The statistical model is based on the Paris crack growth rate function and emphasis is placed on its simplicity for practical applications to life prediction of defect size limited structural components. The distributions of the propagation life to reach any specific crack size and the crack size at any service life are derived. Test results of IN100, a superalloy used in certain gas turbine engines, at various elevated temperatures, loading frequencies, stress ratios, etc., have been compiled and analyzed statistically. It is shown that the correlation between the test results and the statistical model is reasonable. Author

A85-11671*# Washington Univ., Seattle.
CRACK ARREST IN STRUCTURAL CERAMICS
A. S. KOBAYASHI, A. F. EMERY, and B. M. LIAW (Washington, University, Seattle, WA) IN: Failure prevention and reliability - 1983; Proceedings of the Fifth Conference, Dearborn, MI, September 11-14, 1983 . New York, American Society of Mechanical Engineers, 1983, p. 67-73. refs
(Contract NGL-48-002-004)

The non-unique, dynamic stress intensity factor versus crack-velocity relation as well as the lack of a dynamic arrest stress intensity factor in reaction bonded silicon nitride are contrasted with the gamma-shaped, dynamic stress intensity factor versus crack velocity relation and the dynamic arrest stress intensity factor of structural steel. These differences in dynamic fracture responses resulted in fracture of a hypothetical reaction bonded silicon nitride disk during a simulated start up condition of a gas turbine engine. A larger initial crack in a similar steel disk was arrested after propagating into a decreasing stress field generated by a steady state thermal gradient. Author

A85-11752
FATIGUE LIFE PREDICTION - METALS AND COMPOSITES
R. BADALIANCE (McDonnell Aircraft Co., St. Louis, MO) IN: Fracture mechanics methodology: Evaluation of structural components integrity . The Hague, Martinus Nijhoff Publishers, 1984, p. 1-34. refs

The application of fracture mechanics to the analysis of metallic and composite structural components for aircraft is reviewed and illustrated. For metals, the crack-propagation rate is treated as a function of the strain-energy-density-factor range during fatigue-spectrum loading, and explicit expressions are introduced to account for the effects of stress amplitude and mean stress. Constant-amplitude fatigue-crack-growth data are presented for several Al and Ti alloys and steels, and a cycle-by-cycle integration scheme is applied to predict the spectrum fatigue lives of panels with central cracks or surface flaws under a fighter-aircraft landing-gear load history. For composites, an analogous approach based on microcrack growth in the laminate matrix is developed and applied. The results are presented in detailed graphs, tables, diagrams, and photographs. T.K.

A85-11850
THE RECOVERY OF USED MS-8P OIL BY HIGH-VOLUME CONSUMERS [REGENERATSIIA OTRABOTANNOGO MASLA MS-8P U KRUPNYKH POTREBITELEI]
A. A. GUREEV, M. I. FALKOVICH, A. IU. EVDOKIMOV, and V. SAMIKH (Moskovskii Institut Neftekhimicheskoi i Gazovoi Promyshlennosti, Moscow, USSR) Khimiia i Tekhnologiia Topliv i Masel (ISSN 0023-1169), no. 9, 1984, p. 22-24. In Russian. refs

The effect of the viscosity and the degree of deterioration of used oils on the variables of the regeneration process is investigated using the percolation purification of industrial (I-20A) and aviation (MS-8p) oils as an example. Particular attention is given to the sorption capacity of sorbents with respect to the resins contained in the used oils. An analysis of the results obtained suggests that the adsorption purification of used oils should be carried out separately for each oil grade to reduce the loss of valuable components and to fully utilize the capacity of the sorbents. V.L.

A85-11897* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
REACTIONS OF NACL WITH GASEOUS SO3, SO2, AND O2
W. L. FIELDER, C. A. STEARNS, and F. J. KOHL (NASA, Lewis Research Center, Cleveland, OH) Electrochemical Society, Journal (ISSN 0013-4651), vol. 131, Oct. 1984, p. 2414-2417. Previously announced in STAR as N83-29358. refs

Hot corrosion of gas turbine engine components involves deposits of Na_2SO_4 which are produced by reactions between NaCl and oxides of sulfur. For the present investigation, NaCl single crystals were exposed at 100 to 850 C to gaseous mixtures of SO_3, SO_2, and O_2. The products formed during this exposure depend, primarily, on the temperatures. The four product films were: NaCl-SO_3; $Na_2S_2O_7$; Na_2SO_4; and NaCl-Na_2SO_4. The kinetics of the reactions were measured. Author

A85-11907
PARTIAL ALPHA-COLONY FRACTURES AND THEIR PROTRUSIONS DURING CYCLIC LOADING OF A TITANIUM ALLOY
D. W. HOEPPNER (Toronto, University, Toronto, Canada) and D. W. CAMERON Scripta Metallurgica (ISSN 0036-9748), vol. 18, Oct. 1984, p. 1161-1163. Research supported by the Rolls-Royce, Ltd.

The physical mechanisms causing the occurrence of loosely bound sections of material in the notch root of test specimens of the gas turbine alloy IMI829 were examined using successive frame SEM. The near-alpha Ti alloy was beta-annealed and had primary alpha phase on the beta grain boundaries. It is hypothesized that the tongues formed in the notches as crack branched around 'difficult' features and generated secondary cracks. Alpha colonies then separated from the bulk of the material where the microstructure permitted. Mode II-III deformation moved the fragments into the notch during continuous loading. The phenomenon deserved closer attention due to the possibility that the protruding fragments could break off and cause damage to other parts of an assembly. M.S.K.

A85-12098* Max-Planck-Inst. fuer Metallforschung, Stuttgart (West Germany).
A STUDY OF FATIGUE DAMAGE MECHANISMS IN WASPALOY FROM 25 TO 800 C
B. A. LERCH (Max-Planck-Institut fuer Metallforschung, Stuttgart, West Germany; Cincinnati, University, Cincinnati, OH), N. JAYARAMAN (Cincinnati, University, Cincinnati, OH), and S. D. ANTOLOVICH (Georgia Institute of Technology, Atlanta, GA) Materials Science and Engineering (ISSN 0025-5416), vol. 66, Sept. 15, 1984, p. 151-166. refs
(Contract NSG-3263)

The objective of the study was to examine the effect of various microstructures on the fatigue and damage accumulation behavior of Waspaloy, a nickel-base alloy commonly used in aircraft engines. Shearing was the dominant deformation mode in specimens with coarse grains and small (50-80 A) gamma prime particles, whereas Orowan looping was dominant in fine-grained specimens with large (about 900 A) gamma prime particles. At temperatures up to 500 C, cracks initiated transgranularly, while at 800 C the failure process was intergranular for both coarse-grained and fine-grained specimens. At temperatures above 500 C, a significant decrease in the fatigue life was observed for both coarse-grained and fine-grained material. V.L.

A85-12100
CREEP LIFE PREDICTIONS IN NICKEL-BASED SUPERALLOYS
A. K. KOUL (National Aeronautical Establishment, Structures and Materials Laboratory, Ottawa, Canada), R. CASTILLO, and K. WILLETT (Westinghouse Canada, Inc., Product Assurance Laboratory, Hamilton, Ontario, Canada) Materials Science and Engineering (ISSN 0025-5416), vol. 66, Sept. 15, 1984, p. 213-226. refs

Some of the basic creep design parameters generally used to predict the creep lives of nickel-based superalloys are critically reviewed, with emphasis on problems associated with scatter in creep life data and the inability to allow for service-induced material degeneration. A new creep design relationship is proposed which is based on the isolation of the tertiary creep life and strain from the overall creep curve. The proposed relationship systematically reveals the creep degeneration effects with increasing service life and is shown to be accurate over a wide range of stresses (350-700 MPa) and temperatures (760-890 C) for IN-738LC alloy. V.L.

A85-12354#
STRENGTHENING THE STUDY ON THE USABILITY OF AIRCRAFT MATERIALS
Y. WU (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 132-139. In Chinese, with abstract in English. refs

An exact definition of the usability of aircraft materials, which means the necessary properties which qualify a material for a specified aircraft structural part both in manufacturing and in service, is discussed. Optical measures and approaches for improving the usability of conventional aircraft materials, materials with low density, and super-alloys both metallurgically and technologically are presented. C.D.

A85-12358#
DELTA FUNCTION AND GENERALIZED TABLES OF THERMODYNAMIC PROPERTIES FOR CNHM-AIR SYSTEM COMBUSTION PRODUCTS
Z. FAN (Gas Turbine Research Institute, People's Republic of China) and X. FU (Beijing Research Institute, Beijing, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 163-167. In Chinese, with abstract in English. refs

A new kind of thermodynamic property is proposed designated and delta function = theta(2)- theta(1), where theta(1) and theta(2) are theta functions of two reference fuels which can be selected arbitrarily. The delta function is dependent only on temperature, and is independent of the hydrogen-carbon ratio of the fuel and the fuel-air ratio for a C(n)H(m)-air system. The delta function is used to develop a set of generalized tables of thermodynamic properties which can be applied to obtain the thermodynamic properties of C(n)H(m)-air system combustion products at any fuel-air ratio easily and accurately. A sample of the generalized tables is given. C.D.

A85-12651
HANDBOOK OF AVIATION FUEL PROPERTIES
Warrendale, PA, Society of Automotive Engineers, Inc., 1984, 120 p. No individual items are abstracted in this volume.
(CRC-530)

Fuels for aviation and airbreathing missile propulsion are respectively characterized by usage requirements and by detailed chemistry, but they all share the composition requirement that they consist entirely of hydrocarbon compounds (except for specified additives). Limits are placed, however, on such particular hydrocarbons as aromatics and olefins. Propulsion system demands are the primary determinants of specifications, and include such parameters as fluidity, combustion properties, corrosion protection, fuel stability, contaminant limits, and additives. Attention is given to the detailed specifications of reciprocating engine aviation gasoline, commercial and military turbine fuels, and hydrocarbon fuels for ramjet- and turbine-propelled missiles. O.C.

N85-10115# Joint Publications Research Service, Arlington, Va.
THERMAL FATIGUE OF GAS TURBINE ENGINE BLADES MADE OF MATERIAL BASED ON SILICON NITRIDE AND SILICON CARBIDE Abstract Only
G. N. TRETYACHENKO, B. S. KARPINOS, and B. D. KOSOV *In its* USSR Rept.: Mater. Sci. and Met., No. 93 (JPRS-84810) p 16 25 Nov. 1983 Transl. into ENGLISH from Probl. Prochnosti (Kiev), no. 7, Jul. 1983 p 9-12
Avail: NTIS HC A04

The strength of ceramic turbine engine blades in relation to thermal stress and static strength features of the materials used, Si3N4(59.1%)+SiC(39.4%)+MgO(1.47%), at 140, 180 and 220 MPa was studied. Effects of various temperatures up to 1373 K were registered on chrome-aluminum thermocouple meters and on tungsten-rhenium meters at 1373 to 1773 K, with the meters attached at diamond-cut grooves in key locations of the blades. Results showed a regular dependence of strength on temperature of operation. The heaviest loads were found at the output edges, where failure fractures consistently began. The time of thermal stress extremes was greater than the time of maximum temperature drop, and absolute values for temperature stress were basically proportional to the difference between maximum and minimum average temperature. Measurements during the cooling segment of the operational cycle showed that changes in the durability limits of the blade material simply changed the multiplier of the longevity dependence in relation to the magnitude of thermal stress at the output blade edge. The hypotheses generated were confirmed by statistical analysis. Author

N85-10147# Naval Postgraduate School, Monterey, Calif.
AN EXPERIMENTAL INVESTIGATION OF COMBUSTION PRESSURE OSCILLATIONS IN SOLID FUEL RAMJETS M.S. Thesis
T. M. PARAFIORITO Mar. 1984 48 p
(AD-A144870) Avail: NTIS HC A03/MF A01 CSCL 21B

An experimental investigation of the mechanisms involved in combustion pressure oscillations in solid fuel ramjets was conducted. Dynamic pressure measurements of the combustion chamber and air inlet were recorded, while a series of tests using Plexiglas as a fuel were performed. Combustion chamber geometric changes were systematically made in order to help isolate the causal mechanisms. The air inlet system resonant frequency coupling with reattachment zone flow was found to be the major source of pressure oscillations while bypass air injection was the major source of disturbance to the upstream reattachment region of flow. The combustion efficiency of a vitiated air heater was also evaluated using a gas chromatograph to measure unburned fuel in the exhaust. Negligible unburned gaseous fuel existed for all fuel-air ratios and temperatures. Author (GRA)

N85-10191*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MILLING OF SI3N4 WITH SI3N4 HARDWARE
T. P. HERBELL, M. R. FREEDMAN, and J. D. KISER Washington 1984 20 p refs Presented at the 13th Intern. Gas Turbine Conf., Houston, Tex., 17-21 Mar. 1984; sponsored by American Society of Mechanical Engineers
(NASA-TM-86864; E-2328; NAS 1.15:86864) Avail: NTIS HC A02/MF A01 CSCL 11G

The grinding of Si3N4 powder using reaction bonded Si3N4 attrition, vibratory, and ball mills with Si3N4 media was examined. The rate of particle size reduction and the change in the chemical composition of the powder were determined in order to compare the grinding efficiency of each technique and the increase in impurity content resulting from mill and media wear. Attrition and vibratory milling exhibited rates of specific surface area increase that were approximately eight times that observed in ball milling. Ball milling and attrition milling provided the least contamination while vibratory milling introduced the greatest amount of impurity pickup. Author

N85-10199# Massachusetts Inst. of Tech., Cambridge. Dept. of Ocean Engineering.
SELECTING THE PROPER CERAMIC MATERIAL FOR A REGENERATOR EXPERIENCING LARGE TEMPERATURE GRADIENTS M.S. Thesis
M. Y. KIKUTA Jun. 1984 153 p
(Contract N66314-70-A-0073)
(AD-A144796) Avail: NTIS HC A08/MF A01 CSCL 11B

The objective of this study is to select the optimum ceramic material for a new engine regenerator. The regenerator will be designed for operation at two working temperatures, a compressed air temperature of about 250 C and an exhaust gas temperature of about 1100 C. Candidate ceramic materials considered were of two types: (1) ceramic materials analyzed for operating temperatures up to 1200 C; and (2) ceramic materials analyzed for operating temperatures between 1200 C and 1400 C. A figure of merit (FOM) rating scheme was used to determine the most suitable ceramic material for the regenerator in terms of mechanical, thermal, fabrication and cost parameters. Also, an analysis was performed to determine the most appropriate regenerator passage geometry on an aero-thermodynamic basis. GRA

N85-10209*# SRI International Corp., Menlo Park, Calif.
CHEMISTRY OF FUEL DEPOSITS AND SEDIMENTS AND THEIR PREDURSORS Final Report
F. R. MAYO, B. Y. LAN, S. E. BUTTRILL, JR., and G. A. ST.JOHN Oct. 1984 50 p refs
(Contract NAS3-22510)
(NASA-CR-174778; NAS 1.26:174778; YU-2115) Avail: NTIS HC A03/MF A01 CSCL 21D

The mechanism of solid deposit formation on hot engine parts from turbine fuels is investigated. Deposit formation is associated with oxidation of the hydrocarbon fuel. Therefore, oxidation rates and soluble gum formation were measured for several jet turbine fuels and pure hydrocarbon mixtures. Experiments were performed at 130 C using thermal initiation and at 100 C using ditertiary butyl peroxide as a chemical initiator. Correlation of the data shows that the ratio of rate of oxidation to rate of gum formation for a single fuel is not much affected by experimental conditions, even though there are differences in the abilities of different hydrocarbons to initiate and continue the oxidation. This indicates a close association of gum formation with the oxidation process. Oxidations of n-dodecane, tetralin and the more unstable jet fuels are autocatalytic, while those of 2-ethylnaphthalene and a stable jet fuel are self-retarding. However, the ratio of oxidation rate to gum formation rate appear to be nearly constant for each substrate. The effect of oxygen pressure on gum and oxidation formation was also studied. Dependence of gum formation on the concentration of initiator at 100 C is discussed and problems for future study are suggested. Author

N85-11022*# Deere and Co., Moline, Ill.
LOW-GRAVITY SOLIDIFICATION OF CAST IRON AND SPACE TECHNOLOGY APPLICATIONS
J. A. GRAHAM *In* NASA. Marshall Space Flight Center 2nd Symp. on Space Industrialization p 75-81 Oct. 1984
Avail: NTIS HC A19/MF A01 CSCL 11F

Two types of analyses relating to cast iron solidification were conducted. A theoretical analysis using a computer to predict the cooling versus time relationship throughout the test specimen was performed. Tests were also conducted in a ground-based laboratory to generate a cooling time curve for cast iron. In addition, cast iron was cooled through the solidification period on a KC-135 and an F-104 aircraft while these aircraft were going through a period of low gravity. Future subjects for low gravity tests are enumerated. R.S.F.

N85-11040*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DIRECTIONAL SOLIDIFICATION OF FLAKE AND NODULAR CAST IRON DURING KC-135 LOW-G MANEUVERS
P. A. CURRERI, D. M. STEFANESCU (Alabama Univ., University), and J. C. HENDRIX (Alabama Univ., University) *In its* 2nd Symp. on Space Industrialization p 275-291 Oct. 1984 refs
Avail: NTIS HC A19/MF A01 CSCL 11F

Alloys solidified in a low-gravity environment can, due to the elimination of sedimentation and convection, form unique and often desirable microstructures. One method of studying the effects of low-gravity (low-g) on alloy solidification was the use of the NASA KC-135 aircraft flying repetitive low-g maneuvers. Each maneuver gives from 20 to 30 seconds of low-g which is between about 0.1 and 0.001 gravity. A directional solidification furnace was used to study the behavior of off eutectic composition case irons in a low-g environment. The solidification interface of hypereutectic flake and spheroidal graphite case irons was slowly advanced through a rod sample, 5 mm in diameter. Controlled solidification was continued through a number of aircraft parabolas. The known solidification rate of the sample was then correlated with accelerometer data to determine the gravity level during solidification for any location of the sample. The thermal gradient and solidification rate were controlled independently. Samples run on the KC-135 aircraft exhibited bands of coarser graphite or of larger nodules usually corresponding to the regions solidified under low-g. Samples containing high phosphorous (used in order to determine the eutectic cell) exhibited larger eutectic cells in the low-g zone, followed by a band of coarser graphite. R.J.F.

N85-11140*# California Inst. of Tech., Pasadena. Graduate Aeronautical Labs.
EFFECT OF STRESS CONCENTRATIONS IN COMPOSITE STRUCTURES Progress Report, 15 Jan. - 15 Jul. 1984
G. D. BABCOCK and W. G. KNAUSS 1984 22 p refs
(Contract NSG-1483)
(NASA-CR-173976; NAS 1.26:173976; SM-8417) Avail: NTIS HC A02/MF A01 CSCL 11D

The goal of achieving a better understanding of the failure of complex composite structure is sought. This type of structure requires a thorough understanding of the behavior under load both on a macro and micro scale if failure mechanisms are to be understood. The two problems being studied are the failure at a panel/stiffener interface and a generic problem of failure at a stress concentration. Author

N85-11141*# Lockheed-California Co., Burbank.
ADVANCED MANUFACTURING DEVELOPMENT OF A COMPOSITE EMPENNAGE COMPONENT FOR L-1011 AIRCRAFT Final Report
T. ALVA, J. HENKEL, R. JOHNSON, B. CARLL, A. JACKSON, B. MOSESIAN, R. BROZOVIC, R. OBRIEN, and R. EUDAILY 4 May 1982 86 p
(Contract NAS1-14000)
(NASA-CR-165885; NAS 1.26:165885) Avail: NTIS HC A05/MF A01 CSCL 11D

This is the final report of technical work conducted during the fourth phase of a multiphase program having the objective of the design, development and flight evaluation of an advanced composite empennage component manufactured in a production environment at a cost competitive with those of its metal counterpart, and at a weight savings of at least 20 percent. The empennage component selected for this program is the vertical fin box of the L-1011 aircraft. The box structure extends from the fuselage production joint to the tip rib and includes front and rear spars. During Phase 4 of the program, production quality tooling was designed and manufactured to produce three sets of covers, ribs, spars, miscellaneous parts, and subassemblies to assemble three complete ACVF units. Recurring and nonrecurring cost data were compiled and documented in the updated producibility/design to cost plan. Nondestruct inspections, quality control tests, and quality acceptance tests were performed in accordance with the quality assurance plan and the structural integrity control plan. Records were maintained to provide traceability of material and parts throughout the manufacturing development phase. It was also determined that additional tooling would not be required to support the current and projected L-1011 production rate. Author

N85-11220*# Lockheed-California Co., Burbank.
DEVELOPMENT OF POWDER METALLURGY 2XXX SERIES AL ALLOYS FOR HIGH TEMPERATURE AIRCRAFT STRUCTURAL APPLICATIONS Final Technical Report, 15 Aug. 1981 - 30 Sep. 1982
D. J. CHELLMAN Nov. 1984 58 p refs
(NASA-CR-172408; NAS 1.26:172408; LR-30322) Avail: NTIS HC A04/MF A01 CSCL 11F

The objective of the present investigation was to improve the strength and fracture toughness combination of P/M 2124 Al alloys in accordance with NASA program goals for damage tolerance and fatigue resistance. Two (2) P/M compositions based on Al-3.70 Cu-1.85 Mg-0.20 Mn with 0.12 and 0.60 wt. pct. Zr were selected for investigation. The rapid solidification rates produced by atomization were observed to prohibit the precipitation of coarse, primary Al3Zr in both alloys. A major portion of the Zr precipitated as finely distributed, coherent Al3Zr phases during vacuum preheating and solution heat treatment. The proper balance between Cu and Mg contents eliminated undissolved, soluble constituents such as Al2CuMg and Al2Cu during atomization. The resultant extruded microstructures produced a unique combination of strength and fracture toughness. An increase in the volume fraction of coherent Al3Zr, unlike incoherent Al20Cu2Mn3 dispersoids, strengthened the P/M Al base alloy either directly by dislocation-precipitate interactions, indirectly by a retardation of recrystallization, or a combination of both mechanisms. *Furthermore, coherent Al3Zr does not appear to degrade toughness* to the extent that incoherent Al20Cu2Mn3 does. Consequently, the addition of 0.60 wt. pct. Zr to the base alloy, incorporated with a 774K (935 F) solution heat treatment temperature, produces an alloy which exceeds all tensile property and fracture toughness goals for damage tolerant and fatigue resistant applications in the naturally aged condition. Author

N85-11224*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STUDIES ON THE HOT CORROSION OF A NICKEL-BASE SUPERALLOY, UDIMET 700
A. K. MISRA Nov. 1984 47 p refs
(Contract NCC3-43)
(NASA-TM-86882; E-2314; NAS 1.15:86882) Avail: NTIS HC A03/MF A01 CSCL 11F

The hot corrosion of a nickel-base superalloy, Udimet 700, was studied in the temperature range of 884 to 965 C and with different amounts of Na2SO4. Two different modes of degradation were identified: (1) formation of Na2MoO4 - MoO3 melt and fluxing by this melt, and (2) formation of large interconnected sulfides. The dissolution of Cr2O3, TiO2 in the Na2SO4 melt does not play a significant role in the overall corrosion process. The conditions for the formation of massive interconnected sulfides were identified and a mechanism of degradation due to sulfide formation is described. The formation of Ns2MoO4 - MoO3 melt requires an induction period and various physiochemical processes during the induction period were identified. The factors affecting the length of the induction period were also examined. The melt penetration through the oxide appears to be the prime mode of degradation whether the degradation is due to the formation of sulfides or the formation of the Na2MoO4 - MoO3 melt. Author

N85-11225*# Pratt and Whitney Aircraft, East Hartford, Conn.
HOT ISOSTATICALLY PRESSED MANUFACTURE OF HIGH STRENGTH MERL 76 DISK AND SEAL SHAPES Final Report
D. J. EVANS Jul. 1982 12 p 2 Vol.
(Contract NAS3-20072)
(NASA-CR-165550; NAS 1.26:165550; PWA-5574-149) Avail: NTIS HC A02/MF A01 CSCL 11F

The performance of a HIP MERL 76 disk installed in an experimental engine and exposed to realistic operating conditions in a 150 hour, 1500 cycle endurance test is examined. Post test analysis, based on visual, fluorescence penetrant and dimensional inspection, indicates that the disk performs satisfactorily. M.A.C.

N85-11252*# United Technologies Research Center, East Hartford, Conn.
EXTERNAL FUEL VAPORIZATION STUDY, PHASE 2 Interim Report
E. J. SZETELA and L. CHIAPPETTA Jan. 1981 27 p refs
(Contract NAS3-21971)
(NASA-CR-174079; NAS 1.26:174079; R81-915326-5) Avail: NTIS HC A03/MF A01 CSCL 21D

An analytical study was conducted to evaluate the effect of variations in fuel properties on the design of an external fuel vaporizaton system. The fuel properties that were considered included thermal stability, critical temperature, enthalpy a critical conditions, volatility, and viscosity. The design parameters that were evaluated included vaporizer weight and the impact on engine requirement such as maintenance, transient response, performance, and altitude relight. The baseline fuel properties were those of Jet A. The variation in thermal stability was taken as the thermal stability variation for Experimental Referee Broad Specification (ERBS) fuel. The results of the analysis indicate that a change in thermal stability equivalent to that of ERBS would increase the vaporization system weight by 20 percent, decrease oprating time between cleaning by 40 percent and make altitude relight more difficult. An increase in fuel critical temperature of 39 K would require a 40 percent increase in vaporization system weight. The assumed increase in enthalpy and volatility would also increase vaporizer weight by 40 percent and make altitude relight extremely difficult. The variation in fuel viscosity would have *a negligible effect on the design parameters.* R.S.F.

N85-11253# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
FLARES AND PHOTOFLASH ITEMS Final Report
27 Aug. 1984 14 p Supersedes MTP-4-2-130 dated 23 Nov. 1970
(AD-A145442; TOP-4-2-130; MTP-4-2-130) Avail: NTIS HC A02/MF A01 CSCL 19A

This document describes engineering tests of aircraft flares, surface flares, and photoflash cartridges. The procedures are also suitable for military potential tests, initial production tests, etc. Test phases include safety tests, environmental and handling tests, and performance tests. These test procedures do not apply to photoflash bombs or illuminating projectiles fired from artillery weapons or mortars. GRA

N85-11254# Monsanto Co., Dayton, Ohio. Dayton Lab.
VARIABILITY OF MAJOR ORGANIC COMPONENTS IN AIRCRAFT FUELS. VOLUME 3: SAMPLE DATA PACKAGE FOR THE REFERENCE JP-4 FUEL Interim Report, Dec. 1982 - Nov. 1983
B. M. HUGHES, G. G. HESS, K. SIMON, S. MAZER, and W. D. ROSS 27 Jun. 1984 84 p 3 Vol.
(Contract F08635-83-C-0067)
(AD-A145483; AFESC/ESL-TR-84-02-VOL-3) Avail: NTIS HC A05/MF A01 CSCL 21D

This report summarizes qualitative and quantitative data on the chemical variability of approximately 300 features (chemical components or mixtures of components) with concentrations greater than 0.1 mg/ml in Air Force distillate fuels obtained from over 50 sources. These data were obtained to better understand the environmental effects of possible fuel spills and to serve as a data baseline in photochemical smog an soot formation studies. Fifty-four petroleum-derived JP-4 fuels, one shale-derived JP-4 fuel, and one petroleum-derived JP-5 fuel were analyzed. GRA

N85-11255# Ohio State Univ., Columbus.
MOLECULAR INTERACTIONS OF HIGH ENERGY FUELS AND JET FUELS WITH ONCOGENIC VIRUSES AND ENDOGENOUS VIRUSES Final Report, 1 Jul. 1980 - 30 Sep. 1983
J. R. BLAKESLEE, JR. May 1984 147 p
(Contract F49620-80-C-0087)
(AD-A145484; AFOSR-84-0720TR) Avail: NTIS HC A07/MF A01 CSCL 06T

The objectives of this research were to develop rapid in-vitro assays, to evaluate the carcinogenic potential of chemicals used *by the U.S. Air Force. Snyder-Theilen Feline Sarcoma Virus* (ST-FeSV), quantitatively transforms human skin fibroblasts following second order kinetics. These studies were performed in order to determine whether chemicals altered ST-FeSV transformation in a predictable manner and to correlate the alteration with the carcinogenic or non-carcinogenic activity of the test chemical. The results, to date, show diverse carcinogens classed as: aromatic amines, polycyclic hydrocarbons, aminofluorenes, hydrazines, asbestos and mycotoxins inhibited virus transformation when virus infected cells (2 hours post-infection) were exposed to test chemical, while non-carcinogenic chemicals had no significant effect on transformation. Triton X-100, acetone, petroleum and shale oil derived JP5; RJ5 and diesel fuel, marine, demonstrated non-carcinogenic activity while formalin demonstrated carcinogenic activity. Experiments designed to show the specificity of the antagonistic effect of known carcinogens are reported. GRA

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N85-11256# Monsanto Research Corp., Dayton, Ohio.
VARIABILITY OF MAJOR ORGANIC COMPONENTS IN AIRCRAFT FUELS. VOLUME 1: TECHNICAL DISCUSSION Interim Report, Dec. 1982 - Nov. 1983
B. M. HUGHES, G. G. HESS, K. SIMON, S. MAZER, and W. D. ROSS Tyndall AFB, Fla. Air Force Engineering and Services Center 27 Jun. 1984 76 p
(Contract F08635-83-C-0067)
(AD-A145574; AFESC/ESL-TR-84-02-VOL-1) Avail: NTIS HC A05/MF A01 CSCL 21D

This report summarizes qualitative and quantitative data on the chemical variability of approximately 300 features (chemical components or mixtures of components) with concentrations greater than 0.1 mg/ml in Air Force distillate fuels obtained from over 50 sources. These data were obtained to better understand the environmental effects of possible fuel spills and to serve as a data baseline in photochemical smog and soot formation studies. Fifty-four petroleum-derived JP-4 fuels, one shale-derived JP-4 fuel, and one petroleum-derived JP-5 fuel were analyzed. The variability of the absolute concentrations in mg/ml was assessed for each feature in the capillary GC/FID (gas chromatography/flame-ionization detection) analysis of the 54 fuels. 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.

A85-10263#
A NEW DIGITAL X-BAND SLAR
D. R. INKSTER, D. GRANT (Intera Environmental Consultants, Ltd., Ottawa, Canada), and B. M. SORENSEN (INTRADAN Environmental Consultants, Kerteminde, Denmark) IN: International Symposium on Remote Sensing of Environment, 17th, Ann Arbor, MI, May 9-13, 1983, Proceedings. Volume 3 . Ann Arbor, MI, Environmental Research Institute of Michigan, 1984, p. 1157-1164.

A new X-band SLAR has been developed which is well suited to operation in a light aircraft, but which has resolution and swath width performance comparable to much larger systems. The size and weight of the system has been reduced through the use of a digital motion compensation system which eliminates the need for a mechanically stabilized antenna. Digital signal processing, recording and downlinking are employed to allow quantitative measurements of reflectivity to be made. The hardware consists of a TERMA SLAR system with processing, recording, display and downlinks specially designed to optimize the performance of the SLAR for ice reconnaissance and oil pollution monitoring tools. In this paper the design and specifications of the system are described, and its performance on various field projects are outlined. Author

A85-10360
A NOTE ON THE INSTABILITY OF COLUMNAR VORTICES
K. S. ECKHOFF (Bergen, Universitetet, Bergen, Norway) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 145, Aug. 1984, p. 417-421. refs

The instability induced in inviscid compressible columnar vortex flows by three-dimensional perturbations is investigated analytically, comparing the results of Eckhoff and Storesletten (1978) with those of Leibovich and Stewartson (1983) on incompressible fluids. The sufficient condition of instability in the compressible case is found to reduce to the condition of Leibovich and Stewartson in the incompressible limit. The imnplications of the analysis for vortex breakdown downstream of the wing tips of large aircraft are considered. T.K.

A85-10381
A STUDY OF FRICTION IN HIGH-SPEED FACE SEALS
H. HIRABAYASHI (Nippon Oil Seal Industry Co., Ltd., Fujisawa, Japan) and A. MATSUSHIMA (NOK, Inc., Bensenville, IL) Lubrication Engineering (ISSN 0024-7154), vol. 40, Sept. 1984, p. 533-538. refs

Internally pressurized, balanced metal-bellows type mechanical seals are used for high-speed conditions in the aircraft and automobile industries. This paper describes tests of such seals at speeds from 2000 to 40,000 rpm. Substantial differences in sealing characteristics and face wear were observed due to differences in seal construction, face waviness, and the thermodynamic properties of the oil used in these tests. Author

A85-10403
OPTIMAL FREQUENCY RESPONSE SHAPING BY APPENDANT STRUCTURES
O. KITIS (Worcester Polytechnic Institute, Worcester, MA), W. D. PILKEY (Virginia, University, Charlottesville, VA), and B. P. WANG (Texas, University, Arlington, TX) Journal of Sound and Vibration (ISSN 0022-460X), vol. 95, July 22, 1984, p. 161-175. Army-supported research. refs

Two frequency response optimization methods for vibrating systems are developed by appending absorbers to the original structure. The methods are suitable for discrete models with a large number of degrees of freedom and are applied to obtain optimal broadband response. Reanalysis and modal techniques are used in the structural dynamic analysis phase of the design algorithm and optimization is carried out by a feasible directions approach. The optimal design algorithm is illustrated by several numerical examples for a 39 DOF helicopter model with discrete conventional absorbers and beam absorbers. Author

A85-10543
THE DAMAGE TOLERANCE DESIGN PHILOSOPHY
G. HILAIRE and J. ODORICO (Societe Nationale Industrielle Aerospatiale, Paris, France) (Colloque Aciers et Alliages Speciaux dans l'Aeronautique, 10th, Le Bourget, Seine-Saint-Denis, France, June 2, 1983) L'Aeronautique et l'Astronautique (ISSN 0001-9275), no. 106, 1984, p. 3-13. In English and French.

Damage tolerance design philosophy being followed in the aircraft industry, particularly in Europe, is outlined. The arrival of jet aircraft led to the concepts of a safe life, i.e., no structural failure that would have catastrophic consequences, and a safe lifetime, replacement of a component after a predetermined interval of service. A fail-safe multiple load path theory has been devised to integrate the occurrences and extents of structural damage. Predictive capabilities have been augmented by weak point testing to gain flight worthiness certification. Linear fracture mechanics has progressed concomitantly and is applied to formulate damage laws that permit crack growth to be periodically inspected. Application of the concepts to combat aircraft components and engines is discussed, together with NDE techniques. M.S.K.

A85-10544
METALLURGICAL ASPECTS OF METALLIC MATERIALS AND DAMAGE TOLERANCE IN ACCESSORY GEARBOXES
G. LADOUX and J. BOUTRELLE (Hispano-Suiza, Saint-Cloud, Hauts-de-Seine, France) (Colloque Aciers et Alliages Speciaux dans l'Aeronautique, 10th, Le Bourget, Seine-Saint-Denis, France, June 2, 1983) L'Aeronautique et l'Astronautique (ISSN 0001-9275), no. 106, 1984, p. 14-22. In English and French.

The features of aircraft accessory gearboxes (AG) which include damage tolerance as part of the design process are described. AG primary metallic components are steels and Al and Ti alloys, which must be e.g., an order of magnitude more effective per unit weight than ground-based transmissions. The components either transfer mechanical power to an accessory or synchronize two rotating mechanical components; both functions involve a wide range of operational speeds and outputs for a 30,000-50,000 hr service life. Damage tolerance must include cumulative fatigue and accidental stresses and requires metallurgical characterization of each component's requirements before manufacturing so that a low sampling rate will furnish adequate quality control during manufacturing. Sample component characterizations for a cast casing, a case-hardened steel welded gear, and a cast bearing housing are provided. M.S.K.

A85-10550

SPONTANEOUS VAPOR CONDENSATION IN NONEQUILIBRIUM SUPERSONIC MONODISPERSE FLOW [SPONTANNAIA KONDENSATSIIA PARA V NERAVNOVESNOM SVERKHZVUKOVOM MONODISPERSNOM POTOKE]

A. L. STASENKO and I. B. SHAPSHAL Akademiia Nauk SSSR, Izvestiia, Energetika i Transport (ISSN 0002-3310), July-Aug. 1984, p. 138-146. In Russian. refs

Vapor-droplet monodisperse quasi-one-dimensional flow is investigated with allowance for the possibility of a spontaneous condensation of the vapor carrier and for the velocity and thermal nonequilibrium between the vapor and supermicron droplets undergoing surface phase transformations. It is shown that in the case where the relative content of the macrodroplets is small, spontaneous vapor condensation intensifies droplet vaporization, which smooths out the nonmonotonic dependence of the droplet size along the flow axis beyond the dew point. It is noted that the physical phenomenon considered here is essentially different from the effect of the addition of heterogeneous macroparticles on homogeneous condensation. V.L.

A85-10624

STRUCTURAL CRASHWORTHINESS; INTERNATIONAL SYMPOSIUM, 1ST, UNIVERSITY OF LIVERPOOL, LIVERPOOL, ENGLAND, SEPTEMBER 14-16, 1983, INVITED LECTURES

N. JONES, ED. (Liverpool, University, Liverpool, England) and T. WIERZBICKI, ED. (Polska Akademia Nauk, Warsaw, Poland; MIT, Cambridge, MA) London, Butterworths, 1983, 463 p. No individual items are abstracted in this volume.

The application of solid, structural, and experimental mechanics to predict the crumpling behavior and energy absorption of thin-walled structures under quasi-static compression and various dynamic crash loadings is examined in reviews of current research. Both fundamental aspects and specific problems in the design of crashworthy aircraft, automobiles, railroad cars, ships, and offshore installations are considered. Topics discussed include laterally compressed metal tubes as impact-energy absorbers, crushing behavior of plate intersections, axial crushing of fiber-reinforced composite tubes, finite-element analysis of structural crashworthiness in the automotive and aerospace industries, crash behavior of aircraft fuselage structures, aircraft crash analysis, ship collisions, and structural damage in airship and rolling-stock collisions. Photographs, graphs, drawings, and diagrams are provided. T.K.

A85-10634

VOLUME PHASE HOLOGRAMS AND THEIR APPLICATION TO AVIONIC DISPLAYS

B. H. WOODCOCK (Pilkington P. E., Ltd., Advanced Technology Dept., Saint Asaph, Wales) IN: Optical system design, analysis, and production; Proceedings of the Meeting, Geneva, Switzerland, April 19-22, 1983 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p. 333-338. refs

Certain types of holographic optical elements have been used as collimators and combiner mirrors in Head Up Displays (HUDs) and their unique properties have made possible a number of optical configurations. The elements considered are reflection holograms of point sources with the fringes roughly parallel to the surface. A particular element may be required to behave both as an efficient reflector and as a good transmitter at adjacent angles. Tight control over the fringe spacing and the degree of refractive index modulation is essential especially in systems requiring a combination of holographic elements. Author

A85-10886#

A RIVET HOLE SENSOR FOR MEASURING AIRPLANE FUSELAGE ACOUSTIC PRESSURES

R. M. ALLEN and E. I. PLUNKETT (Boeing Noise Technology Laboratory, Seattle, WA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 7 p.
(AIAA PAPER 84-2350)

An improved method was needed to measure incident acoustic pressures on airplane fuselages during flight. The principal requirements included simple flush-mounted installation at any location on a fuselage, insensitivity to weather and environmental conditions, and the ability to measure relatively low,sound pressure levels (SPL's) as well as the higher levels typically encountered during flight test. A survey of commercially-available pressure sensors, followed by laboratory evaluation tests, showed that small piezoresistive pressure transducers with high sensitivity could measure one-third ocrave band SPL's of 85 dB and lower (50 Hz to 10 kHz), with the transducers' noise floors inversely proportional to their sensitivities. These sensors also satisfied the other requirements of the study, and two .093-inch diameter transducers were installed in 747 fuselage rivet holes and flight tested. Measurements from one sensor compared well with those from adjacent air-condenser microphones in both high and low level sound fields. The failure of the other sensor to obtain useful data (because of a leaking reference pressure tube) pointed out the need to carefully check sensor assemblies again during installation. Author

A85-10971#

UNSTEADY FORCES ON A BODY IMMERSED IN VISCOUS FLUIDS. I - FOR A UNIFORMLY ACCELERATED ELLIPTIC CYLINDER

T. TANAHASHI, T. SAWADA, T. ANDO (Keio University, Yokohama, Japan), A. CHINO (Suwa Seikosha Co., Ltd., Suwa, Nagano, Japan), and S. KAWAMOTO (Nippon Sheet Glass Co., Ltd., Ichihara, Chiba, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 27, Aug. 1984, p. 1598-1606. refs

The forces acting on an elliptic cylinder moving with a uniform acceleration are analyzed using the methods of complex Fourier series expansion and boundary layer variable expansion. The approach used here is characterized by good convergence and accuracy at high Reynolds numbers, while being ten times as fast as the SOR method. The coefficients of drag, lift, and moment per unit spanlength are determined, and the distribution of vorticities on the surface of the cylinder is shown. It is noted that the separation time at the trailing edge given by Blasius' theory is characterized by a large error when the eccentricity of the elliptic cylinder deviates far from unity. V.L.

A85-11100*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EDDY CURRENT JET ENGINE DISK-CRACK MONITOR

J. P. BARRANGER (NASA, Lewis Research Center, Cleveland, OH) Materials Evaluation (ISSN 0025-5327), vol. 42, Oct. 1984, p. 1374-1378.

A disk-crack monitor is described that is suitable for use on the ground or in flight. The system consists of an engine-mounted eddy current sensor, a series capacitance in each leg of the sensor circuit, and a capacitance-conductance bridge followed by an oscilloscope capable of advanced signal processing. It was applied to the detection of service-induced cracks in the first-stage turbine wheel of a helicopter engine. A 3.5 mm long radial fatigue crack plus smaller cracks, all located in the blade root region of the wheel, were detected during engine test stand operation at ground idle speed and temperature. The calculation of the value of series capacitance is also presented. Author

A85-11264* Stanford Univ., Calif.
OPTICAL TOMOGRAPHY FOR FLOW VISUALIZATION OF THE DENSITY FIELD AROUND A REVOLVING HELICOPTER ROTOR BLADE
R. SNYDER and L. HESSELINK (Stanford University, Stanford, CA) Applied Optics (ISSN 0003-6935), vol. 23, Oct. 15, 1984, p. 3650-3656. refs
(Contract NCC2-188)

In this paper, a tomographic procedure for reconstructing the density field around a helicopter rotor blade tip from remote optical line-of-sight measurements is discussed. Numerical model studies have been carried out to investigate the influence of the number of available views, limited width viewing, and ray bending on the reconstruction. Performance is measured in terms of the mean-square error. It is found that very good reconstructions can be obtained using only a small number of views even when the width of view is smaller than the spatial extent of the object. An iterative procedure is used to correct for ray bending due to refraction associated with the sharp density gradients (shocks). Author

A85-11613#
A SIMPLIFIED APPROACH FOR ASSESSING SPECTRUM LOADING EFFECTS IN PRELIMINARY DESIGN
R. M. ENGLE, JR. (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: International Conference on Advances in Life Prediction Methods, Albany, NY, April 18-20, 1983, Proceedings . New York, American Society of Mechanical Engineers, 1983, p. 223-227. refs

A technique for predicting the flight-by-flight crack growth of aircraft components from preliminary design and material-test data is presented. A representative stress history is developed from the input stress-exceedance curve; an equivalent damage rate per flight is obtained on the basis of material crack-growth properties; load-interaction effects are accounted for by a spectrum retardation factor derived from the Wheeler (1972) model; and the life estimate and crack-growth curve are computed by integrating the equivalent damage relationship. Sample predictions for various design-limit stress levels during fighter-spectrum loading of 7075-T73 Al alloy are computed using a desk-top-computer program (CRACKS-PD) and compared with experimental data in tables and graphs. It is found that CRACKS-PD gives significantly better agreement than a technique which ignores load interactions. T.K.

A85-11619
LAMINAR TURBULENT BOUNDARY LAYERS; PROCEEDINGS OF THE ENERGY SOURCES TECHNOLOGY CONFERENCE, NEW ORLEANS, LA, FEBRUARY 12-16, 1984
E. M. URAM, ED. (Bridgeport, University; U.S. Navy, Naval Underwater Systems Center, Bridgeport, CT) and H. E. WEBER, ED. (Pennsylvania State University, University Park, PA) Conference sponsored by the American Society of Mechanical Engineers. New York, American Society of Mechanical Engineers (Fluids Engineering Symposia Series. FED Volume 11), 1984, 184 p. For individual items see A85-11620 to A85-11625.

Among the topics discussed are drag and aeroacoustic noise characteristics due to the coupled roughness and blowing of surfaces, skin friction and heat transfer for combined roughness and mass addition, the effect of drag-reducing additives on the development and separation of a turbulent boundary layer with adverse pressure gradient, numerical investigations of the microbubble drag reduction mechanism, the effects of damping on the hydrodynamic stability of flows over Kramer-type compliant surfaces, a rapid eigenvalue finder for flows over a compliant surface, and the mechanical properties of compliant coating materials. Also treated are the turbulent flow over compliant viscoelastic surfaces, marine applications of boundary layer control, liquid/solid surface slip effects in shear flows, laminarization effects on the dynamics of a disk, and boundary layer control for drag reduction in fully submerged bodies of revolution. O.C.

A85-11620#
DRAG AND AEROACOUSTIC NOISE CHARACTERISTICS GENERATED BY SURFACES FEATURING COUPLED ROUGHNESS AND BLOWING
A. L. LAGANELLI and J. SONTOWSKI (Science Applications, Inc., Wayne, PA) IN: Laminar turbulent boundary layers; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1984, p. 1-7. refs

The aeroacoustic and drag characteristics associated with attached, compressible turbulent boundary layers in the presence of both roughness and blowing are analyzed. The solution characterizing drag has its basis in the classic incompressible Prandtl-Schlichting skin friction laws, and employs reference enthalpy transformation functions from the incompressible to the compressible plane. The technique is extended to aeroacoustic noise, through the application of the transformation functions to the incompressible acoustic analytical and experimental results, respectively, of Lilley (1964) and Bull (1963). The results obtained are in excellent agreement with available compressible and incompressible data. O.C.

A85-11624*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
NASA RESEARCH ON VISCOUS DRAG REDUCTION II
D. M. BUSHNELL (NASA, Langley Research Center, Viscous Flow Branch, Hampton, VA) IN: Laminar turbulent boundary layers; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1984, p. 93-98. refs

An assessment is made of determinations from NASA research on viscous drag reduction for aircraft, which extends to both laminar flow control and turbulent drag reduction methods. Attention is given to achievements in natural and suction-induced laminar flow control, hybrid systems incorporating both principles, turbulent drag reduction by means of low momentum fluid injection from discrete tangential slots, large eddy breakup devices, and an 'ion wind' system that functions on an inversion of the corona wind phenomenon. Surface-based drag reduction effects under study involve 'riblets', or small longitudinal surface striations, convex curvatures, and rigid, wavy walls. O.C.

A85-11626
UNSTEADY TURBULENT BOUNDARY LAYERS AND FRICTION; PROCEEDINGS OF THE ENERGY SOURCES TECHNOLOGY CONFERENCE, NEW ORLEANS, LA, FEBRUARY 12-15, 1984
D. C. WIGGERT, ED. (Michigan State University, East Lansing, MI) and C. S. MARTIN, ED. (Georgia Institute of Technology, Atlanta, GA) Meeting sponsored by the American Society of Mechanical Engineers. New York, American Society of Mechanical Engineers (Fluids Engineering Symposia Series. FED Volume 12), 1983, 53 p. For individual items see A85-11627 to A85-11629.

The present conference discusses experiments in periodic turbulent pipe flow whose fluids include air, water, oil, and electrolyte solutions, as well as pressure and heat transfer measurements around a cylinder in pulsating crossflow and the calculation of oscillatory turbulent flows in open channels. Also considered are the transient response of a turbulent boundary layer to a spontaneous change in freestream velocity distribution, evidence of large scale time-dependent flow in a wing-wall interaction wake, and the effect of the interaction between mean and fluctuating velocity components on turbulent dispersion in unsteady turbulent boundary layers. O.C.

A85-11629#

EVIDENCE OF LARGE SCALE TIME DEPENDENT FLOW IN THE WING-WALL INTERACTION WAKE

E. P. ROOD and J. E. C. KELLER (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) IN: Unsteady turbulent boundary layers and friction; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1983, p. 39-44. refs

Results are presented from a wind tunnel experiment conducted to measure characteristics of turbulent large scale, time-dependent organized motion of the flow generated by a wing-wall junction. The motion is possibly associated with the known horseshoe root vortex. The experimental data provide qualitative proof that the structures exist, and that they exhibit out-of-phase motions at mirror-image positions across the plane of symmetry. Author

A85-11630* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMPUTATION OF INTERNAL FLOWS: METHODS AND APPLICATIONS; PROCEEDINGS OF THE ENERGY SOURCES TECHNOLOGY CONFERENCE, NEW ORLEANS, LA, FEBRUARY 12-16, 1984

P. M. SOCKOL, ED. (NASA, Lewis Research Center, Cleveland, OH) and K. N. GHIA, ED. (Cincinnati, University, Cincinnati, OH) Conference sponsored by the American Society of Mechanical Engineers. New York, American Society of Mechanical Engineers (Fluids Engineering Symposia Series. FED Volume 14), 1983, 182 p. For individual items see A85-11631 to A85-11648.

The present conference covers computational method applications, viscous-inviscid interaction techniques, viscous flow computational methods, and design-related methods. Attention is given to viscous flows in turbomachinery cascades, forbidden signals and apparent Mach numbers in supersonic cascades, the flow field in an engine particle separator, two-dimensional separated channel flows, turbulent separating flows over a rearward-facing step, the semielliptic analysis of two-dimensional internal and compressible viscous flows, spline solutions of the incompressible Navier-Stokes equations in a mildly nonorthogonal coordinate system, the design of highly loaded blades with blockage in cascade, and a finite analytic method for unsteady, three-dimensional Navier-Stokes equations. O.C.

A85-11635#

INTERNAL FLOWS OF RELEVANCE TO GAS-TURBINES

J. J. MCGUIRK and J. H. WHITELAW (Imperial College of Science and Technology, London, England) IN: Computation of internal flows: Methods and applications; Proceedings of the Energy Sources Technology Conference, New Orleans, LA, February 12-16, 1984 . New York, American Society of Mechanical Engineers, 1983, p. 37-51. refs

An attempt is made to formulate the best combination of equations, numerical discretization, and turbulence modeling assumptions for internal aerodynamic flows relevant to gas turbines. Typical of the problems treated are the solution of the three-dimensional, time-averaged Navier-Stokes equations for laminar and turbulent flow in 90-deg bends, and the relative advantages obtainable from parabolized forms in bends, in S-type intake ducts, in turbine blade passages, and in forced mixers. In the present discussion of the influence of numerical assumptions on the calculation of isothermal flow in gas turbine combustors, emphasis is given to the assessment and removal of numerical errors. O.C.

A85-11660#

THE AVERAGE $100,000,000 DESIGN ENGINEER

C. A. RODENBERGER, C. F. HERNDON, S. O. MAJORS, and W. A. ROGERS (General Dynamics Corp., Fort Worth, TX) IN: Computers in engineering 1983; Proceedings of the International Conference and Exhibit, Chicago, IL, August 7-11, 1983. Volume 1 . New York, American Society of Mechanical Engineers, 1983, p. 33-38. refs

The value of decisions made by the structural design engineer in designing a modern fighter is estimated over a billion dollars for a production run of 2500 aircraft. In the light of an analysis of the value of design decisions in the aerospace industry, it is shown that 100,000 dollars invested in computer aided design (CAD) support for the structural engineer can result in millions of dollars of savings for each percent improvement. It is emphasized that a particularly large increase in engineering productivity is achieved by integrating computer analyses with CAD systems. V.L.

A85-11666

FAILURE PREVENTION AND RELIABILITY - 1983; PROCEEDINGS OF THE FIFTH CONFERENCE, DEARBORN, MI, SEPTEMBER 11-14, 1983

G. M. KURAJIAN, ED. (Michigan, University, Dearborn, MI) Conference sponsored by the American Society of Mechanical Engineers. New York, American Society of Mechanical Engineers, 1983, 211 p. For individual items see A85-11667 to A85-11679.

Various papers on failure prevention and reliability are presented. Case studies on reliability, failure analysis, and testing are reported. The general topics addressed include: fatigue failure and crack growth; procedures, programs, and techniques for failure prevention and reliability; failure and related concepts; and stress and failure analysis of components. Individual subjects discussed include: probabilistic fatigue crack growth and design; fatigue crack growth analysis under random spectrum loading using the generalized Willenborg model; new method for determining threshold values of creep crack growth; study of elastic-plastic fracture problem using finite element technique; crack arrest in structural ceramics; fatigue behavior of notched thermoplastics. Also considered are: fatigue failure warning method for fiber-reinforced composite structures; reliability improvement by aerothermal analysis of high-speed rotating machinery; reliability estimates through statistics of random response excursions; stress analysis applications to service failures of travelling wave tubes; role of stress analysis in failure prevention; probabilistic design criteria for cylinders and spheres under thermal stresses. C.D.

A85-11668#

FATIGUE CRACK GROWTH ANALYSIS UNDER RANDOM SPECTRUM LOADING USING THE GENERALIZED WILLENBORG MODEL

J. M. WARANIAK (Northrop Corp., Advanced Systems Div., Pico Rivera, CA) IN: Failure prevention and reliability - 1983; Proceedings of the Fifth Conference, Dearborn, MI, September 11-14, 1983 . New York, American Society of Mechanical Engineers, 1983, p. 47-52. refs

The objective of this paper is to correlate the first order physical effects and the mechanics of fatigue crack growth retardation with the two most important input parameters in the Generalized Willenborg Model. These two parameters are the threshold maximum stress-intensity factor and the overload shut-off ratio. Spectrum fatigue crack growth predictions based on the Generalized Willenborg Model and the Forman crack growth rate equation are presented and discussed. Particular attention is addressed to load sequence and load interaction effects between cycles of different magnitudes. Analytical results indicate that using the model for predicting fatigue crack growth in aircraft structures subjected to typical fighter and transport load spectra may lead to opposite trends in expected behavior. Author

A85-11669#
A NEW METHOD FOR DETERMINING THRESHOLD VALUES OF CREEP CRACK GROWTH
W. N. SHARPE, JR. (Johns Hopkins University, Baltimore, MD) and J. J. SHEN (East China Petroleum Institute, People's Republic of China) IN: Failure prevention and reliability - 1983; Proceedings of the Fifth Conference, Dearborn, MI, September 11-14, 1983 . New York, American Society of Mechanical Engineers, 1983, p. 53-58. refs
(Contract F33615-81-K-5014)

This paper describes a computer-controlled laser-based interferometric technique that measures crack opening displacements over a gage length of 100 microns near the tip of a precracked specimen. The resolution of the measurement is approximately 0.01 micron, which permits an earlier determination of crack growth. Results are presented for a series of experiments on compact tension specimens of Inconel 718 tested at 650 C. Crack growth is evidenced by increasing crack opening displacement; when the measured displacement does not change, the threshold value is established. Extrapolation from tests lasting either 30 minutes or 5 hours produces a threshold value of approximately 10 Mpa-m to the 1/2 for this material under these conditions. Author

A85-11674#
RELIABILITY IMPROVEMENT OF AEROTHERMAL ANALYSIS OF HIGH SPEED ROTATING MACHINERY
M. P. BOYCE, G. MANI, and C. MEHER-HOMJI (Boyce Engineering International, Inc., Houston, TX) IN: Failure prevention and reliability - 1983; Proceedings of the Fifth Conference, Dearborn, MI, September 11-14, 1983 . New York, American Society of Mechanical Engineers, 1983, p. 89-96. refs

High speed rotating machinery represent very substantial investments and catastrophic failures can be both costly and dangerous. Moreover, several of these units often operate in critical unspared service in the petrochemical and gas transmission industries where down time costs are very high. Because of this, reliability improvement has been a major area of interest both by manufacturers and users. Traditionally, vibration spectrum analysis has been widely used as a measure of machinery health. It is the thesis of this paper that the machine's aerothermal performance parameters can at times be used for failure prognosis and reliability enhancement. Failure prognosis can be attained by the monitoring, manipulation and trending of aerothermal parameters such as flows, pressures and temperatures. In several cases, mechanical distress in turbomachinery will manifest itself as performance parameter changes. This paper will discuss the above concept and cause - symptom - manifestation relationships of aerothermal parameters. Practical aspects such as sensor choice, sensitivities and reliability will be discussed. Trending techniques will also be discussed. Author

A85-11722
EXPERIMENTAL RESEARCH ON THE DESIGN BASES FOR AERODYNAMIC SPRING BEARINGS [EXPERIMENTELLE UNTERSUCHUNGEN ZUR SCHAFFUNG VON AUSLEGUNGSGRUNDLAGEN FUER AERODYNAMISCHE FEDERLAGER]
M. EHINGER Karlsruhe, Universitaet, Fakultaet fuer Maschinenbau, Dr.-Ing. Dissertation, 1983, 122 p. In German. Sponsorship: Bundesministerium fuer Wirtschaft. refs
(Contract BMW-AIF-3596; BMW-AIF-4774)

Aerodynamic spring bearings to be used in small thermal turbomachines are studied. The performance of combinations of materials in meeting aerodynamic requirements is examined on a rotor test bed with various configurations and at different temperatures. Amplitude curves obtained under conditions of imbalance and other influences are presented and discussed, as is the system damping for a wide range of rotational velocities. Experimental results on the rate of revolution, systemic damping, and eigenfrequencies are found to be in good agreement with theoretical predictions, leading to the calculation of dynamic characteristic values for spring bearings. C.D.

A85-11729
THEORETICAL STUDY OF TWO-DIMENSIONAL AND THREE-DIMENSIONAL POTENTIAL FLOWS WITH ROTATIONAL SOURCE TERMS - APPLICATION TO TURBOMACHINES [ETUDE THEORIQUE D'ECOULEMENTS BIDIMENSIONNELS ET TRIDIMENSIONNELS POTENTIELS AVEC TERMES SOURCES ROTATIONNELS APPLICATION AUX TURBOMACHINES]
K. ALKALAI Lyon, Ecole Centrale, Docteur-Ingenieur Thesis, 1983, 206 p. In French. Research supported by the Alexander S. Onassis Public Benefit Foundation. refs

Analytical procedures are developed for computing the inviscid flow in a channel of arbitrary geometry, and applications to turbine blade cascades and axial compressors are presented and illustrated with drawings, diagrams, and graphs. The velocity field is decomposed into a scalar potential part and a vectorial rotational part, permitting the rotational functions to be introduced as (given) source terms in the calculation of the potential function. An iterative numerical algorithm using a multigrid discretization is employed in the solution of bidimensional problems with and without rotational source terms and of tridimensional incompressible nonrotational problems. T.K.

A85-11751
FRACTURE MECHANICS METHODOLOGY: EVALUATION OF STRUCTURAL COMPONENTS INTEGRITY
G. C. SIH, ED. (Lehigh University, Bethlehem, PA) and L. DE OLIVEIRA FARIA, ED. (Lisboa, Universidade Tecnica, Lisbon, Portugal) The Hague, Martinus Nijhoff Publishers (Engineering Applications of Fracture Mechanics. Volume 1), 1984, 191 p. For individual items see A85-11752 to A85-11755.

The application of fracture mechanics to structural-design problems is discussed in lectures presented in the AGARD Fracture Mechanics Methodology course held in Lisbon, Portugal, in June 1981. The emphasis is on aeronautical design, and chapters are included on fatigue-life prediction for metals and composites, the fracture mechanics of engineering structural components, failure mechanics and damage evaluation of structural components, flaw-acceptance methods, and reliability in probabilistic design. Graphs, diagrams, drawings, and photographs are provided. T.K.

A85-11754
CRITICAL ANALYSIS OF FLAW ACCEPTANCE METHODS
C. M. BRANCO (Minho, Universidade, Braga, Portugal) IN: Fracture mechanics methodology: Evaluation of structural components integrity . The Hague, Martinus Nijhoff Publishers, 1984, p. 151-168. refs

Flaw-acceptance methods based on defect-distribution analysis and NDE procedures are reviewed, with a focus on applications to aircraft structures and probabilistic failure prediction. The kinds of defects typically found in as-milled products and those introduced by processing or service are summarized, and the detection limits of current NDE methods are listed in a table. The steps in damage-tolerance assessment (preliminary damage-tolerance assessment, initial quality assessment, development of stress spectra, definition of operational limits and inspection requirements, and the individual aircraft tracking program) are characterized, and the flaw-acceptance criteria entailed in the British Standard document on defects in fusion-welded joints (1980) are examined in detail. This approach, based on COD testing, is found to give good results for brittle fracture below the yield stress but to be overly conservative for elastic-plastic analysis due to a lack of test data and insufficient accuracy in the computation of concentrated stress and strain fields. T.K.

A85-11755
RELIABILITY IN PROBABILISTIC DESIGN
L. FARIA (Lisboa, Universidade Tecnica, Lisbon, Portugal) IN: Fracture mechanics methodology: Evaluation of structural components integrity . The Hague, Martinus Nijhoff Publishers, 1984, p. 169-174. refs

Probabilistic approaches to the problem of reliability in structural design are reviewed, with a focus on aircraft applications. Factors to be considered include inspection procedures, materials, static and dynamic load-safety factors, stress-concentration locations, and load-transfer characteristics; fractrue-mechanics factors are incorporated in terms of fatigue-crack growth and damage tolerance. The need to design specimen tests to reflect the actual physics of the structural problem and to analyze results carefully applying the confidence-level concept is stressed. T.K.

A85-11842

AN EXPERIMENTAL STUDY OF THE START-UP OF A GAS TURBINE ENGINE BY MEANS OF COMPRESSED AIR AND AN ELECTRIC STARTER [EKSPERIMENTAL'NOE ISSLEDOVANIE ZAPUSKA GAZOTURBINNOGO DVIGATELIA S POMOSHCH'IU VOZDUSHNOGO NADDUVA I ELEKTROSTARTERA]

V. I. DAINENKO (Sevastopol'skii Priborostroitel'nyi Institut, Sevastopol, USSR) Energetika (ISSN 0579-2983), Sept. 1984, p. 110, 111. In Russian. refs

It is shown experimentally that starting a gas turbine engine by means of compressed air is less efficient than the use of an electric starter. However, starting with compressed air significantly simplifies the system and makes it more reliable. Also, the start-up in this case is 'softer' since the gas temperature at the turbine inlet is reduced by 100-120 C; as a result, the service life of the engine increases. Starting by compressed air does not require any changes in the design of the engine and càn be recommended as both the main and a backup starting procedure. V.L.

A85-11987#

BENDING EFFECTS ON STRUCTURAL DYNAMIC INSTABILITIES OF TRANSONIC WINGS

N. D. MALMUTH, S. R. CHAKRAVARTHY (Rockwell International Science Center, Thousand Oaks, CA), J. D. COLE (Rensselaer Polytechnic Institute, Troy, NY), and T. P. GOEBEL (Rockwell International Corp., El Segundo, CA) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 2, p. 753-766) Journal of Aircraft (ISSN 0021-8669), vol. 21, Nov. 1984, p. 913-920. Previously cited in issue 12, p. 1745, Accession no. A83-29887. refs

(Contract F33615-80-C-3208)

A85-12352#

NEW DEVELOPMENTS IN AEROELASTIC RESEARCH

D. GUAN (Shengyang Aircraft Corp., People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 112-117. In Chinese, with abstract in English.

Some new developments in aeroelastic research in China are reviewed. They include: calculation of unsteady transonic aerodynamic forces; HAJIF-II, a program system for dynamic analysis of aircraft structures and its application; YIDOYU-1, a program system for structural optimization with multiconstraints; and an experimental investigation on external stores flutter and active flutter suppression. Author

A85-12362#

AN EQUIVALENT STRENGTH METHOD FOR OPTIMUM DESIGN OF COMPOSITE LAMINATES

F. LIU (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 200-209. In Chinese, with abstract in English. refs

An equivalent strength method for optimum design of composite laminated plates subjected to an in-plane arbitrary loading is presented as an intuitive and simple engineering method. The method assumes that the design is optimum when the strength ratios of the lamina are equivalent and equal to one. The orientations of individual ply groups are considered to be determinate, but the thickness of each group can be adjusted in accordance with the principle of equivalent strength ratio, so that failure of each ply of laminate in static tension, compression, or shear under designated loads occurs at the same time. The thickness and weight of a laminated plate is minimized with this method. Numerical examples are given, and the results are shown to be better than those obtained with other methods. C.D.

A85-12363#

MODAL TEST AND PARAMETER IDENTIFICATION OF A FLUTTER WING MODEL WITH EXTERNAL MISSILES

L. ZHANG (Nanjing Aeronautical Institute, Nanjing, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 211-218. In Chinese, with abstract in English. refs

A85-12364#

AN EXPERIMENTAL STUDY ON EFFECT OF OVERLOAD ON FATIGUE LIFE

C. ZENG and K. GUO (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 5, June 1984, p. 219-224. In Chinese, with abstract in English. refs

Based on a large number of tests, the effects of overload on fatigue crack initiation life, fatigue crack propagation life, fatigue cumulative damage cyclic rate, and crack propagation retardation are studied. Experimental data on the influence of overload on the fatigue initiation life are summarized in a table. Three notched specimens are used to compare the influence of overload on fatigue crack propagation life with its influence on crack propagation retardation effect. The effect of overload on fatigue life is explained with regard to residual stress. C.D.

A85-12450#

SNAP-THROUGH OF INITIALLY BUCKLED BEAMS UNDER UNIFORM RANDOM PRESSURE

P. SEIDE (Southern California, University, Los Angeles, CA) IN: International Conference on Recent Advances in Structural Dynamics, 2nd, Southampton, England, April 9-13, 1984, Proceedings. Volume 1 . Southampton, England, University of Southampton, 1984, p. 329-340. refs

(Contract AF-AFOSR-79-0013)

The results of preliminary work on modeling the response of initially buckled beams is reported. An equation of motion is defined after assuming small strains, large deflections, and negligible longitudinal inertia. The shape and amplitude of a fully supported beam experiencing a buckling load are formulated and damping is considered. Attention is given to the distance the beam ends move toward each other, the deflection of the beam ends, beam stretching, and dynamic deformation. The crossover from stability to instability during loading is investigated, and an estimate is made of the critical spectral density parameter for snap-through under heavy loading and subsequent oscillation between buckled equilibrium positions. M.S.K.

A85-12472#

ACOUSTIC FATIGUE LIFE OF ADHESIVE BONDED STRUCTURES SUBJECTED TO ACOUSTIC LOADS

H. F. WOLFE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and I. HOLEHOUSE (Rohr Industries, Inc., Chula Vista, CA) IN: International Conference on Recent Advances in Structural Dynamics, 2nd, Southampton, England, April 9-13, 1984, Proceedings. Volume 2 . Southampton, England, University of Southampton, 1984, p. 763-773. refs

Acoustic fatigue damage to riveted metallic structures in aircraft due to high intensity noise has been recognized as a problem and design criteria have been developed to prevent such damage. However, very little design criteria are available for bonded and composite structures subjected to high intensity noise. A summary of the work completed in acoustic fatigue prediction techniques for weldbonded aluminum, adhesive bonded aluminum and adhesive bonded graphite-epoxy structures is discussed. These structures are more complex than riveted structures, more difficult to analyze and exhibit many different modes of failure which require a more detailed study to predict the sonic fatigue lifetime. Adequate performance under static loading did not guarantee adequate performance under dynamic loading. Some prediction methods have been developed for certain failure modes in adhesive bonded aluminum and graphite-epoxy bonded skin-stiffened structures. Further investigations are needed to adequately predict the acoustic fatigue life of adhesive bonded and graphite-epoxy aircraft structures. Author

A85-12473*# Lockheed-California Co., Burbank.
DYNAMIC RESPONSE AND ACOUSTIC FATIGUE OF STIFFENED COMPOSITE STRUCTURE
J. SOOVERE (Lockheed-California Co., Burbank, CA) IN: International Conference on Recent Advances in Structural Dynamics, 2nd, Southampton, England, April 9-13, 1984, Proceedings. Volume 2 . Southampton, England, University of Southampton, 1984, p. 775-786. Research supported by the Lockheed-California Co. refs
(Contract N62269-80-C-0239; NAS1-15069)

The results of acoustic fatigue and dynamic response tests performed on L-1011 graphite-epoxy (GrE) aileron and panel components are reported. The aileron featured glass microballoons between the GrE skins. Tests yielded random fatigue data from double and single cantilever coupons and modal data from impedance hammer and loudspeaker impulses. Numerical and sample test data were obtained on combined acoustic and shear loads, acoustic and thermal loads, random fatigue and damping of the integrally stiffened and secondary bonded panels. The fatigue data indicate a fatigue life beyond 10 million cycles. The acoustic data suggested that noise transmission could be enhanced in the integrally stiffened panels, which were more acoustic-fatigue resistant than were the secondary bonded panels. M.S.K.

A85-12474#
SONIC FATIGUE DESIGN METHOD FOR THE RESPONSE OF CFRP STIFFENED-SKIN PANELS
I. HOLEHOUSE (Rohr Industries, Inc., Chula Vista, CA) IN: International Conference on Recent Advances in Structural Dynamics, 2nd, Southampton, England, April 9-13, 1984, Proceedings. Volume 2 . Southampton, England, University of Southampton, 1984, p. 787-798. refs

A semi-empirical method for estimating the structural response of carbon fiber-reinforced plastic (CFRP) stiffened-skin panels experiencing random acoustic loading is presented. The technique was developed using experimental and numerical studies. CFRP skin stringer panels were exposed to high intensity noise in a progressive wave tube and finite element analyses characterized the static strains and natural frequencies. Stepwise regression analyses established the empirical relationships between the strain data and panel curvature and aspect ratio. Design equations were selected from the regression equations which most accurately predicted the data. The rms strain and acoustic levels, but not the spectra, were usable for design analyses, yielding strain level accuracies of 9 percent. M.S.K.

A85-12592
INSPECTING FASTENER HOLES ELECTRONICALLY - THE CAPACITANCE HOLE PROBE SYSTEM
H. S. GIBSON, JR. (Lockheed-Georgia Co., Marietta, GA) Lockheed Horizons, no. 16, 1984, p. 28-38.

It is pointed out that the efficient design of aircraft structural joints which are considered fracture and fatigue critical relies upon the use of mechanical fastener systems which will enhance the fatigue life of the assemblies. Suitable mechanical fastener systems reply upon fastener holes which adhere strictly to established parameters. Requirements for appropriate and efficient hole inspection procedures can be satisfied with the aid of the Capacitance Hole Probe (CHP) system. The CHP system is a high-technology electronics tool which accomplishes the hole inspection quantitatively and in a fraction of the time required for conventional inspection. Attention is given to the growth of fastener technology, the conventional inspection methods, the search for a better method, the principle of operation regarding the CHP system, the resulting combination of fastener science with electronics, and details concerning the CHP system. G.R.

A85-12609#
AERODYNAMIC VISUALIZATION TECHNIQUES [TECHNIQUES DE VISUALISATION EN AERODYNAMIQUE]
C. M. VERET (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (Congres International de Photographie Rapide et de Photonique, 16th, Strasbourg, France, Aug. 27-31, 1984) ONERA, TP, no. 1984-80, 1984, 9 p. In French. refs
(ONERA, TP NO. 1984-80)

Visualization methods employed by ONERA researchers to obtain qualitative flow data around various objects are outlined. Wall flows are visualized using colored or clear liquids spread on the surface or tufts. The flow is seeded with solid or liquid particles away from the wall, and bathed in sheets of light in regions where flow data is required and features such as vortices, circulation zones, etc., which are present in subsonic flows are being studied. Supersonic flows, which have progressive alterations of gas density, are examined using interferometry, schlieren photography, and shadowgraphy. High speed cameras equipped to run in the range 25-1 million frames/sec are employed for supersonic flow phenomena such as shock waves and turbulent structures. Data are recorded on photographic or holographic plates or video tape. M.S.K.

N85-10223# Barber-Nichols Engineering Co., Arvada, Colo.
MODELING OF A SECOND-GENERATION SOLAR-DRIVEN RANKINE AIR CONDITIONER Final Report
M. W. DENIUS and W. D. BATTON Jul. 1984 158 p refs
(Contract DE-AC03-81CS-30576)
(DE84-015132; DOE/CS-30576/T1) Avail: NTIS HC A08/MF A01

Ten configurations of a second-generation, solar-powered, Rankine-driven air conditioner were simulated and the data presented for use in companion studies. The results of the analysis show that the boiling-in-collector (BIC) configuratioon generates more power per collector area than the other configurations. The models used to simulate the configuration are presented. The generated data are also presented. Experimental work was done to both improve a novel refrigerant and oil lubrication system for the centrifugal compressor and investigate the aerodynamic unloading characteristics of the centrifugal compressor. The information generated was used to define possible turbo-gearbox configurations for use in the second generation computer simulation. DOE

N85-10299# Cambridge Univ. (England). Dept. of Engineering.
MEASUREMENT OF THE DEVELOPMENT OF THE BOUNDARY LAYER IN THE ANNULUS WALLS OF A FOURSTAGE COMPRESSOR
N. A. CUMPSTY 1984 23 p refs
(CUED/A-TURBO-TR-121; ISSN-0309-6521) Avail: NTIS HC A02/MF A01

There are few available measurements of boundary layers in multistage compressors when the repeating stage condition is reached. Tests were performed in a small four stage compressor; the flow was essentially incompressible and the Reynolds number based on blade chord was about 50,000. Two series of tests were performed: in one series the full design number of blades were installed; in the other series half the blades were removed to reduce the solidity and double the staggered spacing. Initially it was wished to examine the hypothesis proposed by L. H. Smith that staggered spacing is a particularly important scaling parameter for boundary layer thickness; the tests tend not to bear out this view. The integral thicknesses agree quite well with those published by Smith. Author

N85-10301*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CLASSICAL FREE-STREAMLINE FLOW OVER A POLYGONAL OBSTACLE Final Report
A. R. ELCRAT (Wichita State Univ., Kansas) and L. N. TREFETHEN (Massachusetts Inst. of Tech.) Sep. 1984 24 p refs
(Contract NAS1-17070; DE-AC02-76ER-03077-V)
(NASA-CR-172448; ICASE-84-45; NAS 1.26:172448) Avail: NTIS HC A02/MF A01 CSCL 20D

In classical Kirchhoff flow, an ideal incompressible fluid flows past an obstacle and around a motionless wake bounded by free streamlines. Since 1869 it has been known that in principle, the two-dimensional Kirchhoff flow over a polygonal obstacle can be determined by constructing a conformal map onto a polygon in the log-hodograph plane. In practice, however, this idea has rarely been put to use except for very simple obstacles, because the conformal mapping problem has been too difficult. This paper presents a practical method for computing flows over arbitrary polygonal obstacles to high accuracy in a few seconds of computer time. We achieve this high speed and flexibility by working with a modified Schwarz-Christoffel integral that maps onto the flow region directly rather than onto the log-hodograph polygon. This integral and its associated parameter problem are treated numerically by methods developed earlier by Trefethen for standard Schwarz-Christoffel maps. Author

N85-10303*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE EFFECT OF CHANNEL CONVERGENCE ON HEAT TRANSFER IN A PASSAGE WITH SHORT PIN FINS
B. A. BRIGHAM Oct. 1984 17 p refs
(NASA-TM-83801; E-2306; NAS 1.15:83801) Avail: NTIS HC A02/MF A01 CSCL 20D

Array averaged heat transfer coefficients were obtained for two configurations of short pin fins in a converging channel and for two flat plate configurations in a converging channel. The effect of flow acceleration due to channel convergence and the effect of varying pin length on the heat transfer was determined. Results are presented in the form of Nusselt number versus Reynolds number for the four geometries tested. Author

N85-10306*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A REVIEW AND ANALYSIS OF BOUNDARY LAYER TRANSITION DATA FOR TURBINE APPLICATION
R. E. GAUGLER Washington 1984 14 p refs Presented at the 13th Intern. Gas Turbine Conf. and Exhibit, Houston, Tex., 17-21 Mar. 1984; sponsored by the American Society of Mechanical Engineers
(NASA-TM-86880; E-2341; NAS 1.15:86880) Avail: NTIS HC A02/MF A01 CSCL 20D

A symposium on transition in turbines was held at the NASA Lewis Research Center. One recommendation of the working groups was the collection of existing transition data to provide standard cases against which models could be tested. A number of data sets from the open literature that include heat transfer data in apparently transitional boundary layers, with particular application to the turbine environment, were reviewed and analyzed to extract transition information from the heat transfer data. The data sets reviewed cover a wide range of flow conditions, from low speed, flat plate tests to full scale turbine airfoils operating at simulated turbine engine conditions. The results indicate that free stream turbulence and pressure gradient have strong, and opposite, effects on the location of the start of transition and on the length of the transition zone. R.S.F.

N85-10307# Massachusetts Inst. of Tech., Cambridge. Dept. of Ocean Engineering.
LAMINAR FLOW HEAT EXCHANGERS. VISCOSITY INDUCED NON-UNIFORM FLOW M.S. Thesis
G. R. PUTNAM Jun. 1984 33 p
(Contract N66314-70-A-0073)
(AD-A144777) Avail: NTIS HC A03/MF A01 CSCL 13A

Laminar flow heat exchangers which cool oil in non-interconnected parallel passages can experience non-uniform flows and reduction in the effective heat exchanger coefficient in a range of Reynolds number which varies with tube length and diameter, tube wall temperature and fluid inlet temperature. The method of predicting the reduction in effective heat transfer coefficient and the range of Reynolds number over which these instabilities exist is presented for a particular oil Mobil aviation oil 120. Also included is the prediction of the effect of radial viscosity variation on the constant property magnitudes of friction and heat transfer coefficient. GRA

N85-10345# Naval Research Lab., Washington, D. C.
SHIPBOARD MEASUREMENT OF CLOUD BASES AND AVERAGE SURFACE VISIBILITY WITH AN EYE-SAFE LIDAR Interim Report
W. P. HOOPER 9 Aug. 1984 19 p
(AD-A144889; AD-E000589; NRL-8819) Avail: NTIS HC A02/MF A01 CSCL 20E

An eye safe lidar, originally built by a Navy contractor, has been modified by the Naval Research Laboratory and evaluated at sea. The instrument operated in the severest weather encountered a moderate gale. Cloud bases below 2 km and visibilities less than 10 km were measured. Improvements are needed to reduce sky noise and increase receiver sensitivity, but the system is surprisingly resistant to ocean spray and shipboard vibration. GRA

N85-10355*# Texas A&M Univ., College Station. Dept. of Mechanical Engineering.
ROTORDYNAMIC ANALYSIS OF THE SSME TURBOPUMPS USING REDUCED MODELS
S. T. NOAH Sep. 1984 72 p refs
(Contract NAS8-34505)
(NASA-CR-171170; NAS 1.26:171170) Avail: NTIS HC A04/MF A01 CSCL 13K

Alternative methods for the rotor-dynamic and sensitivity analysis of large rotor systems are examined. The methods are assessed for their ability to utilize accurate models of reduced size along with effective procedures for describing the dynamic behavior of the systems. Frequency response-based techniques are developed for determining the steady state response to imbalance of the space shuttle main engine (SSME) turbopumps and the related eigenvalue problem. The rotor and housing are represented by reduced receptances associated with their coupling points. The housing may be described by all of its normal modes within a frequency range of interest. The effects of truncated higher and lower modes are accounted for in an approximate manner. A procedure is described for determining the sensitivity of the coupling forces to changes in the coupling elements and rotor speed of the turbopump systems. In addition, an eigenvalue sensitivity analysis technique is adopted for application to the systems. Computer programs were developed for the numerical implementation of the impedance and eigenvalue sensitivity formulated in this study. S.B.

N85-10373# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
EFFECT OF PENETRANT ON FATIGUE OF ALUMINUM ALLOY LAP JOINTS
H. J. KOLKMAN 1 Jul. 1982 20 p refs
(Contract NIVR-1725)
(NLR-TR-82104-U; AD-B086218) Avail: NTIS HC A02/MF A01

The effect of penetrant on the fatigue life of single shear riveted lap joints was investigated by flight simulation fatigue tests using the MINITWIST gust spectrum. The penetrant/material combination investigated was ARDROX 985 P3T and aluminum alloy 2024-T3 sheet material (both bare and clad). The effect of penetrant on the fatigue life is positive. Author (ESA)

N85-10385*# Naval Weapons Center, China Lake, Calif.
STRESS-DERIVATIVE CONTROL OF KEYSTONING DEFORMATION IN FINITE ELEMENT CODES
J. C. SCHULZ and O. E. R. HEIMDAHL *In* NASA. Langley Research Center Res. in Struct. and Dyn., 1984 p 111-122 Oct. 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 20K

The stress derivative technique for control of keystoning deformation in under-integrated finte elements is based on expansion of the stress in a Taylor series about the element center and retention of additional terms beyond the constant stress term. It has the advantage over other control techniques that keystoning resistance is provided by actual rather than artificial material properties. Application of this technique to the quadrilateral ring elements used for modelling solids of revolution subjected to axisymmetric loads is described. In a cylindrical coordinate system additional terms appear in the formulation which must be dealt with in arriving at a workable keystoning control scheme. E.A.K.

N85-10407# National Aerospace Lab., Tokyo (Japan). Second Airframe Div.
DISTRIBUTIONS OF FATIGUE LIFE AND FATIGUE STRENGTH IN NOTCHED SPECIMENS OF A CARBON 8-HARNESS-SATIN LAMINATE
T. SHIMOKAWA and Y. HAMAGUCHI May 1984 13 p refs
Presented at the 4th Intern. Conf. on Composite Mater., ICCM-4, Tokyo, 25-27 Oct. 1982
(NAL-TR-809T; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

The distribution properties of fatigue life and fatigue strength in sharply notched specimens of a carbon fabric laminate made up of three layers of eight harness satin/epoxy prepreg sheets were investigated. Fatigue life distributions were obtained at six stress levels by fatigue tests of four point plane bending under a constant temperature and humidity condition. Sample sizes were 30 for each of the three high stress levels and 12 for the three low stress levels. The amount of scatter and distributional form of fatigue life and fatigue strength are discussed. It is concluded that fatigue strength distribution is normal and its standard deviation is constant regardless of fatigue life. E.A.K.

N85-10410# George Washington Univ., Washington, D.C. Inst. for Reliability and Risk Analysis.
ESTIMATION OF THE THRESHOLD IN FATIGUE CRACK INITIATION MODELS: A BAYESIAN APPROACH
N. D. SINGPURWALLA and R. SOYER 25 Oct. 1983 31 p
(Contract N00019-82-C-0458)
(AD-A144847; AD-E751084; GWU/IRRA/TR-83/4) Avail: NTIS HC A03/MF A01 CSCL 20K

A Bayesian approach for the estimation of the threshold parameter in a probability model for fatigue crack failures is presented. The Weibull and the lognormal distributions are considered as suitable models for the number of cycles to crack initiation. The approach is discussed for the two models, and real life data from aircraft engine disks is analyzed. Author (GRA)

N85-10416# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
FLIGHT SIMULATION FATIGUE CRACK PROPAGATION IN METAL/CARBON-EPOXY LAMINATES
R. J. H. WANHILL Dec. 1982 37 p refs
(Contract NIVR-1891)
(NLR-TR-83006-U; AD-B086226) Avail: NTIS HC A03/MF A01

Flight simulation fatigue crack propagation tests with gust spectrum loading were carried out on laminates of aluminum alloy 2024-T3/carbon-epoxy, aluminum alloy 7475-T761/carbon-epoxy and titanium alloy Ti-6A1-4V/carbon-epoxy with nominal weight savings of 30% and 40% as compared to equivalent 2024-T3 Alclad and 7475-T761 panels. The performance of the 2024-T3/carbon-epoxy laminates is much superior to that of the other material combinations, and is very encouraging for the practical achievement of significant weight savings. Author (ESA)

N85-11298# Thomas Electronics Inc., Wayne N. J.
MANUFACTURING METHODS AND TECHNOLOGY (MM/T) SPECIFICATIONS FOR MINIATURE CATHODE RAY TUBE Quarterly Report, 1 Apr. - 30 Jun. 1984
F. M. BRUNO 30 Jul. 1984 13 p
(Contract DAAK70-80-C-0168)
(AD-A145597; TEI-A009-15; QR-15) Avail: NTIS HC A02/MF A01 CSCL 09A

The object of this study is to develop design, performance, and test specifications for the Miniature Cathode Ray Tube assembly suitable for use in the Integrated Helmet and Display Sight System (IHADSS) of the Army Advanced Attack Helicopter. GRA

N85-11319# Scientific Research Associates, Inc., Glastonbury, Conn.
FURTHER DEVELOPMENT OF A TRANSONIC CASCADE ANALYSIS Final Report, 10 Aug. 1982 - 10 Aug. 1983
S. J. SHAMROTH, R. J. YANG, and H. MCDONALD Sep. 1983 49 p
(Contract N00019-82-C-0298)
(AD-A145410; SRA-R83-920015-F) Avail: NTIS HC A03/MF A01 CSCL 20D

A compressible, time-dependent solution of the Navier-Stokes equations is obtained for both compressor and turbine cascade configurations in subsonic and transonic flows. The analysis uses the Briley-McDonald consistently split linearized block implicit (LBI) procedure to solve the governing equations. Comparisons with measured data are presented for both turbulence energy and mixing length turbulence models. In addition, consideration is given to boundary conditions for the cascade flutter problem. Author (GRA)

N85-11320# Georgia Inst. of Tech., Atlanta. School of Chemical Engineering.
EFFECT OF THE BASSET TERM ON PARTICLE RELAXATION BEHIND NORMAL SHOCK WAVES Final Report, 15 Mar. 1983 - 15 May 1984
L. J. FORNEY, A. E. WALKER, and W. K. MCGREGOR Jul. 1984 72 p
(Contract AF-AFOSR-0182-83)
(AD-A145446; AFOSR-84-0747TR) Avail: NTIS HC A04/MF A01 CSCL 20D

Small particles and droplets encounter normal shocks in a variety of applications. The particle-shock interaction subjects the particles to large unsteady drag forces behind the shock front. In this paper, an analysis has been made of the relative importance of the Basset history integral for particle displacement and velocity behind a normal shock wave. The effect of the Basset integral has been related to gas stagnation conditions and the local gas Mach number. In the present theoretical study it has been demonstrated that the particle velocity and displacement relative to the gas back of the shock is unaffected by the inclusion of the Basset term until the latter stages of particle relaxation. The effect of the Basset history integral, which results from diffusion of vorticity from the decelerating particle, has been shown to decrease the particle drag or increase the displacement of the particle back of the shock. The effect is magnified with increasing stagnation pressures and particle diameters but with decreasing gas stagnation temperatures. GRA

N85-11332# Royal Aircraft Establishment, Farnborough (England).
PRELIMINARY RESULTS USING A RAPID PHOTOGRAPHIC WAKE TRAVERSE SYSTEM
P. B. EARNSHAW Nov. 1983 12 p refs Original contains color illustrations
(RAE-TM-AERO-1987; BR92324) Avail: NTIS HC A02/MF A01
A rapid photographic wake traverse system was constructed for a 4 ft x 3 ft wind tunnel in order to assess the feasibility of, and design requirements for, a similar equipment to suit a 5 m wind tunnel. Sample photographs using a gothic wing and a Harrier model with and without stores show the ease with which useful information can be acquired. Author (ESA)

N85-11341# Army Engineer Waterways Experiment Station, Vicksburg, Miss. Geotechnical Lab.
EVALUATION OF LASER PROFILE AND DEFLECTION MEASURING SYSTEM Final Report, Aug. 1981 - Mar. 1984
A. J. BUSH, III and G. B. COX Washington FAA Sep. 1984 102 p refs Sponsored in part by Air Force
(Contract DTFA01-81-4-10584)
(FAA-PM-84-24) Avail: NTIS HC A06/MF A01
Lasers mounted on a 10-ft beam are used to measure pavement profiles and deflections near a loaded wheel. The lasers require no contact with the pavement surface. The algorithm for solution of the profile is presented along with the solutions for calibrating the system. The system is a promising tool for measuring surface roughness. Continued research is required to improve the system to provide the required accuracy. B.W.

N85-11364 Southern Methodist Univ., Dallas, Tex.
AEROELASTIC STABILITY ANALYSIS WITH INTERACTING STRUCTURAL NONLINEARITIES Ph.D. Thesis
C. L. LEE 1984 176 p
Avail: Univ. Microfilms Order No. DA8415029
The describing function approach to system linearization is successful in nonlinear flutter analysis because of its accuracy and versatility in handling a wide variety of nonlinearities with relative ease. However, difficulty occurs when many nonlinearities are present and knowledge of the oscillatory amplitude of each is required before the describing functions can be employed. To resolve this problem the theoretical development of an iterative procedure in the frequency domain is presented and involves alignment of the amplitudes in each nonlinear spring with the describing function predictions of stiffness prior to computing the final stability characteristics. The result is a system tuned to the flutter frequency at the time of instability. To support the development and validation of the procedure several describing functions are formulated and a quantitative measure of the errors in each is presented. Validation of the iterative method is accomplished through examples involving dynamic systems of increasing complexity coupled with state of the art representations of the unsteady aerodynamic forces. Both numerical simulations and experimental data are used to compare with the iterative predictions. Dissert. Abstr.

N85-11381*# National Aeronautics and Space Administration, Washington, D. C.
MEASUREMENT OF THE INERTIAL CONSTANTS OF A RIGID OR FLEXIBLE STRUCTURE OF ARBITRARY SHARE THROUGH A VIBRATION TEST
D. ENGRAND and J. CORTIAL Aug. 1983 23 p refs Transl. into ENGLISH from La Rech. Aerospatiale (France), no. 4, Jul. - Aug. 1970 p 213-219 Original language doc. previously announced in IAA as A70-41408 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-3199)
(NASA-TM-77557; NAS 1.15:77557) Avail: NTIS HC A02/MF A01 CSCL 20K
The inertial constants of an aircraft rocket, or of any other structure, are defined without materializing any rotating axis. The necessary equipment is very similar to that used normally for ground vibration tests. An elastic suspension is used to obtain the total natural modes corresponding to the motions of the structure as a solid. From the measurements of the generalized masses of these modes it is possible to compute the inertial constants: (1) center of inertia; (2) tensor of inertia; and (3) mass. When the structure is not strictly rigid a purification process, based on the mean square method makes it possible to rigidify it at the price of some approximations and a few more measurements. Eventual additional masses, that are not parts of the structure, can be taken into account. M.A.C.

N85-11701# Joint Publications Research Service, Arlington, Va.
LAMINAR-TO-TURBULENT FLOW TRANSITION UNDER INFLUENCE OF ACOUSTIC OSCILLATIONS Abstract Only
A. N. SHELPYAKOV, A. M. KASIMOV, and G. N. ISUPOV *In its* USSR Rept.: Phys. and Math. (JPRS-UPM-84-006) p 47 12 Sep. 1984 Transl. into ENGLISH from Inzh.-Fiz. Zh. (Minsk), v. 45, no. 4, Oct. 1983 p 560-563
Avail: NTIS HC A08/MF A01
Flow visualization with a smoke generator is employed to study the aerodynamic processes occurring during the transition between laminar and turbulent flow. Two conical flows are observed to form in the transitional segment between laminar and turbulent flows subjected to acoustic oscillations produced by a piezocrystal. The findings demonstrate the existence of acoustically differing sections within the laminar flow and a significant difference in the transition from laminar to turbulent flow caused by transverse flow and acoustic oscillations. Author

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GEOSCIENCES

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

A85-10846#
ASSESSMENT AND PREDICTION OF AIRCRAFT COMMUNITY NOISE ANNOYANCE
C. G. RICE (Southampton, University, Southampton, England) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs
(AIAA PAPER 84-2291)
The FAA has developed a balanced airport noise compatibility program intended to mitigate the noise impacts of airports upon neighboring communities. Questions arise regarding the evaluation of the 'noise annoyance' produced with respect to people exposed to aircraft noise, taking into account guidelines of the U.S. National Research Council for preparing environmental impact statements on noise. The present investigation is concerned with those questions. Important research issues are related to time of day effects, within source differences, between source differences, combinations of noise sources, and effects related to activity interference. Attention is given to the concept of predicted noise exposure, limitations of the dose-response relationship, the noise dose, psychosociological responses, and a model which focuses on activity interference as mediating the relationship between noise exposure and annoyance. G.R.

A85-10848*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

QUANTIFICATION OF ADVANCED TURBOPROP AIRCRAFT FLYOVER NOISE ANNOYANCE

D. A. MCCURDY (NASA, Langley Research Center, Acoustics and Noise Reduction Div., Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 9 p. refs (AIAA PAPER 84-2293)

A laboratory experiment was conducted to quantify the annoyance to advanced turboprop (propfan) aircraft flyover noise. A computer synthesis system was used to generate 45 realistic, time varying simulations of propeller aircraft flyover noise in which the tonal content was systematically varied to represent the factorial combinations of five fundamental frequencies, three frequency envelope shapes, and three tone-to-broadband noise ratios. In the experiment, 64 subjects judged the annoyance of recordings of the 45 synthesized flyover noises presented at three sound levels in a test facility which simulates the outdoor acoustic environment. Analyses of the judgements showed that frequency envelope shape did not significantly affect annoyance. The interaction of fundamental frequency with tone-to-broadband noise ratio did have a large and complex effect on annoyance. Duration corrected A-weighted sound pressure level with a modified tone correction predicted annoyance better than any other measurement procedure. Author

A85-11216

AN ALGORITHM FOR RADIOMETRIC AND GEOMETRIC CORRECTION OF DIGITAL SLAR DATA

P. HOOGEBOOM (Centrale Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek, Physisch Laboratorium TNO, The Hague, Netherlands), P. BINNENKADE (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands), and L. M. M. VEUGEN (Rijkswaterstaat, Delft, Netherlands) IEEE Transactions on Geoscience and Remote Sensing (ISSN 0196-2892), vol. GE-22, Nov. 1984, p. 570-576. refs

In The Netherlands an accurate SLAR system with digital data recording is used for measurements within the framework of the national microwave remote sensing research program. However, the images are disturbed by unwanted platform motions due to, e.g., turbulence at the low operating height (300-3000 m) of the SLAR system. An algorithm is developed for the geometric and radiometric correction of the radar data by means of aircraft attitude and position measurements. These measurements can be obtained from an Inertial Navigation System (INS) onboard the plane. Some additional information like the aircraft height and the measurement distance is obtained from the radar signal. The correction model is implemented in a computer program. The results clearly show an improvement of the image quality. Some specific problems that were encountered will be discussed and some results will be shown. Author

A85-12174

MICROBURST EXPLORED

H. HOPKINS Flight International (ISSN 0015-3710), vol. 126, Sept. 29, 1984, p. 812-816.

The atmospheric phenomenon of windshear is examined with emphasis on implications for commercial airline safety. The results of recent FAA investigations of the major airline disasters are reviewed in order to determine the major dynamic characteristics of windshear events for use in flight simulators. The experience gained from repeated simulations of take-offs and landings under windshear conditions is considered to be essential to detecting and avoiding windshear conditions, and for negotiating them when they are unavoidable. Several recommendations are offered for flight training programs to inform pilots of the hazards of windshear on the basis of flight simulator tests. I.H.

N85-10451# Sandia Labs., Livermore, Calif. Solar Components Div.

TECHNICAL REVIEW OF THE SOLID PARTICLE RECEIVER PROGRAM

P. K. FALCONE, comp. Jul. 1984 47 p Meeting held in Livermore, Calif., 25-26 Jan. 1984
(Contract DE-AC04-76DR-00789)
(DE84-015181; SAND-84-8229) Avail: NTIS HC A03/MF A01

The use of solid particles as the working fluid and storage medium in solar central receivers is one approach to delivering solar energy at temperatures above the nominal 550 C (1100 F) peak of current water-steam and molten salt central receiver technologies. The technical feasibility of the solid particle concept is the subject of an ongoing examination at Sandia National Laboratories Livermore (SNLL). A review of the individual investigations in this program was conducted. The meeting was held to discuss the status of the technical feasibility investigations one year into this phase of study and to set direction for the future. Summaries of each of the individual presentations at the review meeting, as well as an overview of the program are presented. DOE

N85-10491# National Center for Atmospheric Research, Boulder, Colo.

THE MICROBURST AS A HAZARD TO AVIATION: STRUCTURE, MECHANISMS, AND NOWCASTING

J. MCCARTHY and J. W. WILSON *In* ESA Nowcasting 2. Mesoscale Observations and Very-Short-Range Weather Forecasting p 21-30 Jun. 1984 refs Sponsored by NSF
Avail: NTIS HC A23/MF A01

The convective microburst is shown to be a serious world-wide aviation hazard. Multiple Doppler and surface mesonet analyses from the Joint Airport Weather Studies Project show the microburst as a concentrated down- and outflow having an average horizontal dimension of 3 km and a headwind/tailwind shear averaging 25 m/sec with a mean lifetime of 10 min. Microbursts can be imbedded in thunderstorm precipitation or in benign-appearing virga. Five mechanisms govern microburst formation: subcloud cooling from evaporating precipitation, cooling from melting, frictional drag from falling precipitation, dynamically induced vertical pressure gradients, and downward transport of horizontal momentum. Aviation safety improvements and nowcasting techniques using meteorological precursors derived from proximity sounding studies and from Doppler radar are discussed. Author (ESA)

N85-10558*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

MERIT: A MAN/COMPUTER DATA MANAGEMENT AND ENHANCEMENT SYSTEM FOR UPPER AIR NOWCASTING/FORECASTING IN THE UNITED STATES

R. STEINBERG *In* ESA Nowcasting 2. Mesoscale Observations and Very-Short-Range Weather Forecasting p 465-471 Jun. 1984 refs
Avail: NTIS HC A23/MF A01

It is suggested that the very short range forecast problem for aviation is one of data management rather than model development and the possibility of improving the aviation forecast using current technology is underlined. The MERIT concept of modeling technology, and advanced man/computer interactive data management and enhancement techniques to provide a tailored, accurate and timely forecast for aviation is outlined. The MERIT includes utilization of the Langrangian approach, extensive use of the automated aircraft report to complement the present data base and provide the most current observations; and the concept that a 2 to 12 hour forecast provided every 3 hr can meet the domestic needs of aviation instead of the present 18 and 24 hr forecast provided every 12 hr. Author (ESA)

N85-10571# Air Force Global Weather Central, Offutt AFB, Nebr.

AUTOMATED AIRCRAFT ICING FORECAST TECHNIQUE Final Project Report

M. V. MANSUR 31 May 1984 73 p

(AD-A144853; AD-E850732; AFGWC-PR-84-001) Avail: NTIS HC A04/MF A01 CSCL 04B

This project report provides a comprehensive overview of the state of the art in icing forecasting and its associated problems. It describes the attempt to automate a manual icing forecast technique. The weaknesses, software design and algorithms are discussed. Attempts to filter out what was felt to be excess areal coverage, as produced by other automated procedures, was unsuccessful. Moderating the filtering resulted in a sieve effect with no better results than forecasts already produced by other automated methods. Final examination revealed other reasons for the poor performance in the automated mode. The manual technique had the advantage of human pattern recognition which is vastly superior to the coarse mesh grid data used in this study, as well as access to frontal positions. There were some valuable lessons learned regarding theoretical limitations to skill scores and the inherent limitations of the models. GRA

N85-11501# National Center for Atmospheric Research, Boulder, Colo. Joint Airport Weather Studies Project.

MICROBURST WIND STRUCTURE AND EVALUATION OF DOPPLER RADAR FOR WIND SHEAR DETECTION Final Report

J. W. WILSON, C. KESSINGER, R. D. ROBERTS, and J. MCCARTHY Washington FAA Oct. 1984 43 p refs

(Contract DTFA01-82-Y-10513)

(DOT/FAA/PM-84/29) Avail: NTIS HC A03/MF A01

Doppler weather radar data from the Joint Airport Weather Studies Project are used to determine the horizontal and vertical structure of airflow within microbursts. Typically, the associated downdraft is about 1 km wide and begins to spread horizontally at a high below 1 km. The median time is 5 min from initial divergence at the surface to maximum differential wind velocity across the microburst. The height of maximum differential velocity is 75 m. The median velocity differential is 22 m/sec over an average distance of 3.1 km. The outflow is assymetric, averaging twice as strong along the maximum shear axis compared to the minimum axis. Doppler radar could be an effective means for identifying microbursts and warning aircraft of wind shear hazards. For microburst detection such radar must be able to measure wind velocities in clear air as well as heavy rain and hail. Scan update rates should be approximately every 2 min and the lowest few hundred meters of the atmosphere must be observed. Ground clutter must be considerably reduced from levels typically obtained with present Doppler radars. R.S.F.

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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.

A85-10562#

CONVERSATIONAL TIME DOMAIN ANALYSIS FOR STRUCTURAL DYNAMICS AND CONTROL INTERACTION PROBLEMS

M. A. CUTCHINS (Auburn University, Auburn, AL) American Institute of Aeronautics and Astronautics, Guidance and Control Conference, Seattle, WA, Aug. 20-22, 1984. 7 p. refs

(AIAA PAPER 84-1871)

With rising aerospace vehicle performance levels, the need to analyze increasingly complicated systems in the time domain becomes greater and greater. The present investigation is concerned with the use of conversational time domain software for the solution of the arising problems, taking into account a context which is similar to that considered by Agler (1983). An attempt has been made not to duplicate Agler's work, but to augment it, giving attention to structural dynamic/control interactions rather than systems engineering. The problems and trends in the programming of complex engineering simulations are considered along with useful features of the ACSL language for control/structural dynamics problems. It is found that software and hardware developments point to increasingly user-friendly means of modeling control and structural dynamic-oriented engineering problems. G.R.

A85-10998#

ROBUST MODEL FOLLOWING SYSTEM AND ITS APPLICATION

T. OKADA, M. KIHARA, and O. ASAI (Defense Academy, Yokosuka, Japan) (Japan Society for Aeronautical and Space Sciences, Annual Conference, 19th, Chubu and Kansai, Japan, Nov. 24, 1982) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, Aug. 1984, p. 78-93. refs

A Robust Following Model (RMF) system for linearizing the control parameters of CCV aircraft is presented. The system is designed to formulate a series of equations which provides linear values for the nonlinear parameters of asymptotic tracking, internal stability, and disturbance rejection with parametric perturbations. The system was tested in numerical simulation of backlash and dead zone response and of the direct side force control (DSFC) in a modified CCV jet trainer. It is shown that RMF can yield linear DSFC parameters which are consistent with changes of flight condition. A schematic illustration of the system architecture is provided. I.H.

A85-11083* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

INFLUENCE OF SAMPLING RATE ON THE CALCULATED FIDELITY OF AN AIRCRAFT SIMULATION

J. C. HOWARD (NASA, Ames Research Center, Flight Systems and Simulation Research Div., Moffett Field, CA) IN: Modeling and simulation. Volume 14 - Proceedings of the Fourteenth Annual Pittsburgh Conference, Pittsburgh, PA, April 21, 22, 1983. Parts 1-2 . Research Triangle Park, NC, Instrument Society of America, 1983, p. 485-493. Previously announced in STAR as N83-23267. refs

One of the factors that influences the fidelity of an aircraft digital simulation is the sampling rate. As the sampling rate is increased, the calculated response of the discrete representation tends to coincide with the response of the corresponding continuous system. Because of computer limitations, however, the sampling rate cannot be increased indefinitely. Moreover, real-time simulation requirements demand that a finite sampling rate be adopted. In view of these restrictions, a study was undertaken to determine the influence of sampling rate on the response characteristics of a simulated aircraft describing short-period oscillations. Changes in the calculated response characteristics of the simulated aircraft degrade the fidelity of the simulation. In the present context, fidelity degradation is defined as the percentage change in those characteristics that have the greatest influence on pilot opinion: short period frequency omega, short period damping ratio zeta, and the product omega zeta. To determine the influence of the sampling period on these characteristics, the equations describing the response of a DC-8 aircraft to elevator control inputs were used. The results indicate that if the sampling period is too large, the fidelity of the simulation can be degraded. Author

A85-11661#

AN EFFECTIVE INTERFACE BETWEEN COMPUTER-STORED DESIGN DESCRIPTIONS AND ANALYSIS TOOLS

A. JAY, N. MILLER, and W. MARLER (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) IN: Computers in engineering 1983; Proceedings of the International Conference and Exhibit, Chicago, IL, August 7-11, 1983. Volume 1 . New York, American Society of Mechanical Engineers, 1983, p. 43-46.

This paper describes a computer based system for generating finite element models from computer-stored design descriptions. The Initial Graphics Exchange Specification (IGES) standard serves as the vehicle for transferring geometry definitions from the geometric modeler or drafting system database to the finite element modeling program. The program has been designed to meet the needs of the engine designer/analyst for generating shell of revolution finite element models of gas turbine components.
Author

N85-11613# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

EXPERT SYSTEMS IN MAINTENANCE DIAGNOSTICS FOR SELF-REPAIR OF DIGITAL FLIGHT CONTROL SYSTEMS

J. DAVISON *In* Denver Research Inst. Artificial Intelligence in Maintenance p 293-304 Jun. 1984

(AD-P003933) Avail: NTIS HC A22/MF A01 CSCL 14B

This article covers three basic components of this program. One is an overview and the progress of the program starting off with the battle damage statistics that are supplied to us by aircraft battle damage repair people. These statistics are the drivers that influence the self-repairing program. These are gathered primarily from Southeast Asian data, updated from the Falklands conflict and Israeli data. Secondly, the article discusses briefly about the self-repairing concept, and thirdly, the status of our expert system for maintenance diagnostics.
GRA

16

PHYSICS

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

A85-10827*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

AERODYNAMIC SOUND GENERATION INDUCED BY FLOW OVER SMALL, CYLINDRICAL CAVITIES

S. P. PARTHASARATHY, Y. I. CHO, and L. H. BACK (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 9 p. Army-NASA-sponsored research. refs

(AIAA PAPER 84-2258)

An experimental investigation has been conducted on the production of high intensity tones by small cylindrical cavities in a flat surface. The application of such a mechanism is to the acoustic coding of moving objects containing drilled holes. The sound intensity and frequency have been determined as functions of flow velocity, diameter and depth of the cavities. As a practical matter, it is possible to produce a whistle producing 106 dB at 30.5 cm distance from a cylindrical hole of 0.5 cm diameter and 1.2 cm deep with an airflow of 60 m/s past the hole. Author

A85-10830*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

THE EFFECTS OF INSTALLATION ON SINGLE- AND COUNTER-ROTATION PROPELLER NOISE

P. J. W. BLOCK (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 13 p. refs

(AIAA PAPER 84-2263)

In order to understand the effects of installation on propeller noise, numerous measurements are required to define the directivity of the noise as well as the level. An experimental study was designed to map the noise radiation pattern for various single-rotation propeller (SRP) and counter-rotation propeller (CRP) installations covering + or 60 deg from the propeller disk plane and + or - 60 deg laterally. Configurations that were considered included an SRP at angle of attack and in tractor and pusher operations and a CRP. A first principles linear theory was validated for the SRP tractor operation over the angle range mentioned above. The increases in noise that arise from an unsteady loading operation such as an SRP pusher or CRP exceed 15 dB and depend on the observer location. In particular, the majority of the additional noise appears to radiate in the axial directions. Author

A85-10832*# Santa Clara Univ., Calif.

HELICOPTER NOISE AS PREDICTED BY THREE-DIMENSIONAL MONOPOLE AND QUASI-STEADY FULL-POTENTIAL DIPOLE SOURCES

H. R. AGGARWAL (Santa Clara, University, Santa Clara, CA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 10 p. refs

(Contract NCC2-191)

(AIAA PAPER 84-2267)

A three-dimensional quasi-steady full-potential rotor-flow-analysis program, called ROT22 developed at NASA Ames Research Center is run in conjunction with Farassat's (1981) helicopter-noise-prediction code to assess the thickness and loading noises made by a rotor blade. As a model example, the case of a 1/7th UH-1H NACA-0012-profile straight nonlifting rotor blade in hover is studied. Results for tip Mach numbers ranging from .4 to .962 are presented. Also presented is the effect of blade-tip loading on the overall noise and of profile curvature on the thickness noise. The study confirms that the blade volume displacement is a dominant source of helicopter noise and further concludes that the blade tip makes only a small noise contribution that steadily decreases with increasing tip Mach numbers, and that the inclusion of blade profile curvature tends to improve the negative peak amplitudes overpredicted by Schmitz and Yu (1983). Author

A85-10833*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

COMPARISON OF EXPERIMENTAL AND ANALYTICAL PREDICTIONS OF ROTOR BLADE-VORTEX INTERACTIONS USING MODEL SCALE ACOUSTIC DATA

R. M. MARTIN (NASA, Langley Research Center, Hampton, VA), J. W. ELLIOTT, and D. R. HOAD (U.S. Army, Structures Laboratory, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 14 p. refs

(AIAA PAPER 84-2269)

Helicopter blade-vortex interaction (BVI) noise is studied using a model scale rotor acoustic data base and an analytical rotor wake prediction method. The variation of BVI acoustic levels with vehicle flight conditions (forward speed and disk attitude) is presented. Calculations of probable BVI locations on the rotor disk are made for a range of operating conditions using the measured acoustic signals and an acoustic ray tracing technique. Analytical predictions of possible BVI locations on the rotor disk are made using a generalized distorted wake analysis program. Comparisons of the interaction locations are made with the results of both the analytic approach and the acoustic ray tracing technique. Author

A85-10838*# Florida State Univ., Tallahassee.

ON THE RELATIONSHIP BETWEEN BROADBAND SHOCK ASSOCIATED NOISE AND SCREECH TONES

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(Contract NAG1-421)
(AIAA PAPER 84-2276)

It is recognized that the three principal components of the noise of shock containing supersonic jets, namely, the dominant part of turbulent mixing noise, the broadband shock associated noise and the screech tones are all generated directly by the large scale turbulence structures/instability waves of the jet flow. In this paper the relationship between broadband shock associated noise and screech tones is examined. It is shown that from the spectral characteristics point of view, the screech tones may be regarded as special cases of broadband shock associated noise. Theoretical calculations for the peak frequencies of broadband shock associated noise and the fundamental frequencies of stable screech tones are carried out. The calculated results are found to agree favorably with experimental measurements. Author

A85-10839*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

CONTROL OF JET SHOCK ASSOCIATED NOISE BY A REFLECTOR

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(AIAA PAPER 84-2279)

Due to the discrete noise radiation from an imperfectly expanded supersonic jet, a reflecting surface can be used to impart changes to the jet. Powell's model of screech generation is used to analytically design the reflector size necessary to cause destruction of the feedback cycle inherent to screech production. This enabled experiments to be performed over a wide range of supersonic flow conditions for a sonic nozzle in the presence of a remotely controlled reflector. Results show that not only the screech amplitude can be controlled, but that marked changes in the jet structure and broadband noise production can also be effected by changing the position of the reflector. Author

A85-10842#

FINITE ELEMENT MODELLING OF ACOUSTIC SINGULARITIES WITH APPLICATION TO NEAR AND FAR FIELD PROPELLER NOISE

W. EVERSMAN (Missouri-Rolla, University, Rolla, MO) and J. E. STECK American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 12 p. refs
(AIAA PAPER 84-2286)

Numerical formulations and results are presented which expand on recent developments in the finite element modelling of acoustic volume sources and acoustic dipoles. It is shown that with a suitable structuring of the acoustic field equations, it is possible to include monopoles and dipoles within the same analysis framework as has been extensively used for interior duct acoustics and for duct inlet radiation problems. This allows the extension of the finite element modelling method to include the noise sources in such applications as propellers enclosed in a duct or in free space with mean flows. The necessary structuring of the acoustic field equations is shown, and example calculations are given for the case of one-dimensional sources and body forces in the presence of mean flow, two-dimensional sources, axial body forces, and transverse body forces in the presence of uniform mean flow. Three dimensional non axial sources and dipoles are modelled as the Fourier sum of axially symmetric solutions without the necessity of introducing 'singular elements'. It is further demonstrated that distributions of singularities can be readily modelled, and an example is given of the computation of the near and far field radiation of a propeller. Comparison of the far field radiation directivity is made with the Gutin theory. Author

A85-10843*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AEROACOUSTIC INTERACTION OF A DISTRIBUTED VORTEX WITH A LIFTING JOUKOWSKI AIRFOIL

J. C. HARDIN (NASA, Langley Research Center, Hampton, VA) and S. L. LAMKIN (Kentron International, Inc., Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 12 p. refs
(AIAA PAPER 84-2287)

A first principles computational aeroacoustics calculation of the flow and noise fields produced by the interaction of a distributed vortex with a lifting Joukowski airfoil is accomplished at the Reynolds number of 200. The case considered is that where the circulations of the vortex and the airfoil are of opposite sign, corresponding to blade vortex interaction on the retreating side of a single helicopter rotor. The results show that the flow is unsteady, even in the absence of the incoming vortex, resulting in trailing edge noise generation. After the vortex is input, it initially experiences a quite rapid apparent diffusion rate produced by stretching in the airfoil velocity gradients. Consideration of the effects of finite vortex size and viscosity causes the noise radiation during the encounter to be much less impulsive than predicted by previous analyses. Author

A85-10845*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NUMERICAL SOLUTIONS OF ACOUSTIC WAVE PROPAGATION PROBLEMS USING EULER COMPUTATIONS

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(Contract NAS1-17070)
(AIAA PAPER 84-2290)

This paper reports solution procedures for problems arising from the study of engine inlet wave propagation. The first problem is the study of sound waves radiated from cylindrical inlets. The second one is a quasi-one-dimensional problem to study the effect of nonlinearities and the third one is the study of nonlinearities in two dimensions. In all three problems Euler computations are done with a fourth-order explicit scheme. For the first problem results are shown in agreement with experimental data and for the second problem comparisons are made with an existing asymptotic theory. The third problem is part of an ongoing work and preliminary results are presented for this case. Author

A85-10847#

DESCRIPTORS FOR ROTARY WING AIRCRAFT NOISE

P. D. SCHOMER (U.S. Army, Construction Engineering Research Laboratory, Champaign, IL) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 8 p. refs
(AIAA PAPER 84-2292)

Various hypotheses of needed noise level standards for areas around military air bases with rotary wing aircraft were tested in terms of literature surveys, laboratory tests, and community surveys. The hypotheses tested comprised the validities of A-weighted sound levels, an energy model, and a standard 10 dB difference between day and night (D-N) sound levels. The data base covered annoyance surveys near bases and questionnaires filled out to express the level of perceived annoyance. An energy model was found suitable for helicopter noise, particularly with regard to avoiding rattling buildings, a condition which raises the annoyance levels significantly. The studies supported continuance of the traditional 10 dB D-N noise differential. M.S.K.

A85-10849#
PROPOSED CRITERIA FOR SOUND PRESSURE LEVELS IN USAF AIRCRAFT
E. R. HUGHES and G. SZAFRANSKI (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 7 p. refs
(AIAA PAPER 84-2294)

The specification of Sound Pressure Level (SPL) criteria for modern military aircraft involves safety, human performance and system life cycle cost. Current specifications which establish SPL criteria are critiqued. Human Factor considerations of noise induced hearing damage, temporary threshold shifts, performance degradation, and annoyance are briefly reviewed. A proposed approach for the specification of Sound Pressure Levels in aircraft is outlined. This method uses a 'Daily Limiting Dose' concept for hearing conservation criteria. Modified Rhyme Testing and other predictive analytical techniques (e.g., Articulation Index) will be used as applicable for communication requirements. Standard methods for measurement are also established. All of these requirements are based on predicted mission profiles and aircraft usage, and are 'tailorable' to reflect unique system requirements and missions. Author

A85-10851#
CONTROL OF FLOW SEPARATION BY SOUND
K. K. AHUJA and R. H. BURRIN (Lockheed-Georgia Co., Marietta, GA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 15 p. refs
(Contract F33615-83-C-3240)
(AIAA PAPER 84-2298)

The objectives of the study described here are twofold: (1) to demonstrate experimentally if acoustic excitation can control flow separation over airfoils of different sizes, and establish scaling between the acoustic parameters, airfoil size, and flow velocity; (2) to evaluate experimentally if sound emitted within the airfoil body is as effective as sound irradiated from an external source in controlling flow separation. These objectives have been accomplished by conducting model-scale experiments in high-quality wind tunnels using existing instrumented airfoils. Both quantitative data and flow visualization results are presented. Author

A85-10853#
WEAKLY NONLINEAR THEORY OF SUPERSONIC TURBOPROPELLER NOISE
C. K. W. TAM (Florida State University, Tallahassee, FL; Lockheed-Georgia Co., Marietta, GA) and M. SALIKUDDIN (Lockheed-Georgia Co., Marietta, GA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs
(AIAA PAPER 84-2302)

An acoustic and weak shock wave propfan noise theory is developed which accounts for nonlinear propagation effects. The approach is that of a boundary value problem using the equations of motion of an inviscid compressible fluid for the governing equations in a cylindrical coordinate system centered about the propfan axis. A thin airfoil approximation allows setting the boundary conditions on the mean blade surface. The linearized boundary values then correspond to the thickness noise and loading noise, and weakly nonlinear propagation is considered in terms of disturbance velocity changes caused by fluid particle motion and sonic velocity alteration from compression and rarefaction. The three-dimensional shock structure emanating from the blades is generated and includes frequency and spectral data. Nonlinear propagation is demonstrated to be significant in the upstream direction. The model is concluded useful for predicting community and cabin noise levels. M.S.K.

A85-10854*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE UNIFIED ACOUSTIC AND AERODYNAMIC PREDICTION THEORY OF ADVANCED PROPELLERS IN THE TIME DOMAIN
F. FARASSAT (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs
(AIAA PAPER 84-2303)

This paper presents some numerical results for the noise of an advanced supersonic propeller based on a formulation published last year. This formulation was derived to overcome some of the practical numerical difficulties associated with other acoustic formulations. The approach is based on the Ffowcs Williams-Hawkings equation and time domain analysis is used. To illustrate the method of solution, a model problem in three dimensions and based on the Laplace equation is solved. A brief sketch of derivation of the acoustic formula is then given. Another model problem is used to verify validity of the acoustic formulation. A recent singular integral equation for aerodynamic applications derived from the acoustic formula is also presented here. Author

A85-10856#
NOISE OF COUNTER-ROTATION PROPELLERS
D. B. HANSON (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 16 p. refs
(AIAA PAPER 84-2305)

Theory is presented for noise generation of counter-rotation (CR) propellers based on extensions of the author's unified theory for noise and performance analysis. Special emphasis is given to the effects of acoustic and aerodynamic interference between the two rotors of a CR propeller. New radiation formulas are given for noise caused by unsteady loading. Spinning mode characteristics similar to those of turbofans are explicitly displayed so that reinforcements and cancellations between acoustic fields of two rotors or between acoustic modes of one rotor can be studied. Mode orders and cut-off criteria are compared with well-known results from spinning mode theory of turbofans and compressors. A new theoretical wake model is also presented so that the roles of viscous and potential flow can be seen. Noise predictions for an existing CR propeller airplane are compared with data and projections for a CR Prop-Fan are given. Author

A85-10859*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AIRFOIL TIP VORTEX FORMATION NOISE
T. F. BROOKS and M. A. MARCOLINI (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 12 p. refs
(AIAA PAPER 84-2308)

Spectral data are presented for the noise produced due to the turbulent three-dimensional vortex flow existing near the rounded tip of lifting airfoils. The results are obtained by the comparison of sets of two- and three-dimensional test data for different airfoil model sizes, angles of attack, and tunnel flow velocities. Microphone cross-correlation and cross-spectral methods were used to determine the radiated noise. Corrections were made for tunnel shear layer and source directivity effects. Interpretation of the results are aided by a three-dimensional flow analysis developed for this study which determines open tunnel and finite aspect ratio corrections heretofore neglected in tip vortex studies. Hot wire measurements were made in the tip vortex formation region for the specification of governing flow parameters. The spectral data is normalized in a format considered most useful for subsequent quantitative prediction of this noise mechanism for practical systems such as helicopter rotors. Comparison is made to the analysis of George and Chou. A recommended prediction method is given. Author

A85-10860#
FLOW FIELD AND ACOUSTICS OF TWO-DIMENSIONAL TRANSONIC BLADE-VORTEX INTERACTIONS
A. R. GEORGE (Cornell University, Ithaca, NY) and S.-B. CHANG American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 48 p. refs
(AIAA PAPER 84-2309)

Blade-vortex interaction noise from full-scale helicopters is shown to involve unsteady transonic flow phenomena which can be modeled as two-dimensional. An unsteady, small-disturbance-theory, numerical analysis, is used to model the interaction of an airfoil with a finite-core, locally-convected vortex using the vortex-in-cell method with multiple branch cuts accounting for the distributed vortices' potential jumps. Strong disturbances propagating from the blade-vortex interaction are associated with occurrence of Tijdeman's Type C flow on the airfoil's lower surface. In this type of flow, the shock which initially terminates a supersonic zone propagates through it and forward off the airfoil. The effects of airfoil shape, angle of attack, Mach number, vortex strength, and vortex miss distance on the flow and on waves radiated forward are investigated. It is found that stronger radiated waves are associated with narrow supersonic regions and near-sonic base flow. Also, stronger vortices generate stronger radiated waves, but miss distance is not as important a factor. Author

A85-10863#
THE INFLUENCE OF MEAN FLOW ON THE ACOUSTIC PROPERTIES OF A TUBE BANK
M. S. HOWE (Southampton, University, Southampton, England) and M. C. QUINN American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 12 p. refs
(AIAA PAPER 84-2312)

The theory of sound propagation through a bank of rigid parallel tubes in the presence of a nominally steady, low Mach number cross flow is discussed. A detailed diffraction analysis is given for the idealized but mathematically tractable case of a bank of strips set at zero angle of attack to the mean flow. Various approximations for the dispersion equation governing the propagation of long waves are derived, including the influence of acoustically induced vortex shedding from the strip trailing edges and of hydrodynamic interactions between neighboring strips. The sound is attenuated by a transfer of energy to the kinetic energy of the essentially incompressible field of the shed vorticity. It is shown how the principle of conservation of energy and a Kramers-Kronig dispersion relation can be combined to yield an alternative derivation of the dispersion equation. This procedure is applicable to a simplified model of propagation through a bank of rigid tubes of circular cross section, and an approximation to the dispersion equation is obtained in this case. The relevance of these results to bound resonances in tube bank cavities is discussed. Author

A85-10865#
THE ROLE OF EXCITATION ON MODIFYING THE SOUND SOURCES
R. R. MANKBADI (Rutgers University, New Brunswick, NJ) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 10 p. refs
(AIAA PAPER 84-2317)

Lighthill's stress tensor is decomposed into contributions from the organized fluctuations and from the random fluctuations. The far-field sound of a round jet is viewed as produced by organized and random sources. The developments of these sources under pure tone excitation are analyzed. Excitation at Strouhal number range of 0.6-1.0 was found to generate strong subharmonics that undergo pairing with the fundamental. The peak subharmonic amplification increases as the excitation level increases to a specific level beyond which the mean flow saturates and the subharmonic amplification is suppressed. The location of pairing moves closer to the nozzle exit with increasing the excitation level. The forced component and its generated subharmonic were found to enhance the random fluctuations. The predicted development of the organized and random sources agree favorably with experimental observations. This suggests that the model can be used to study the effect of excitation on the far-field sound with the source term calculated based on energy conservation principles. Author

A85-10866#
MECHANISM OF BROADBAND JET NOISE AMPLIFICATION AND SUPPRESSION UNDER CONTROLLED EXCITATION
K. B. M. Q. ZAMAN (George Washington University, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 9 p. refs
(AIAA PAPER 84-2319)

The broadband jet noise amplification and suppression phenomena are investigated under controlled excitation. The amplification is found to be maximum for excitation in the St(D) range of 0.65-0.85, where St(D) is the Strouhal number based on the jet diameter. Spectral analysis of the flow-field and the near sound pressure field indicate that pairing of the large scale coherent structures, induced by the excitation, is primarily responsible for the amplification. The suppression is found to be optimum for excitation at St(theta) = 0.017, St(theta) being the Strouhal number based on the initial shear layer momentum thickness. The suppression occurs only for jets with initially laminar boundary layers. The large scale coherent structures, which are more energetic for the jet with this initial condition, are weakened by the excitation, thus, resulting in the suppression of turbulence as well as of broadband noise. Author

A85-10867*# Texas A&M Univ., College Station.
PHASE AVERAGED ACOUSTIC MEASUREMENTS FOR A MACH NUMBER 0.6 JET
G. L. MORRISON (Texas A&M University, College Station, TX) and S. EMAMI American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 7 p. refs
(Contract NAG1-112)
(AIAA PAPER 84-2320)

Acoustic phase (ensemble) averaged measurements were performed in a cold, axisymmetric, Mach number 0.6 jet of air. These measurements show that the noise directly radiated by the coherent structure in the jet flow field was responsible for the directivity of the acoustic field. Comparison of phase averaged acoustic spectra with phase averaged radial velocity fluctuations within the jet illustrate the direct link between the two and show that different regions of the jet are responsible for producing the noise measured at various locations in the acoustic field. Author

A85-10871#
VIBRATION RESPONSE AND SOUND RADIATION FROM BEAMS, PLATES, AND CYLINDERS EXCITED BY NONHOMOGENEOUS RANDOM PRESSURE FIELDS
G. SENGUPTA (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs
(AIAA PAPER 84-2327)

It is shown that a time and space random nonhomogeneous excitation source can be represented in terms of a multiple wavenumber-frequency spectrum. The structural response and interior noise can then be obtained from the summation of responses to an infinite number of traveling waves with amplitude and phase velocities determined by the above spectrum. Because of the nonhomogeneity of the excitation field, the cost of computing the above quantities is expected to be an order of magnitude higher than that for the case of a homogeneous excitation. The complexity can be reduced by ignoring the decay of cross-correlation coefficient. Based on a preliminary examination of existing propeller wind tunnel and flight test data, the above assumption does not appear to be unreasonable. The procedure for deriving the wavenumber-frequency spectrum is described for various structural members such as beams, plates, and cylinders.

The wavenumber-frequency spectra presented in this paper are based on the assumption that the nonhomogeneous excitation field is symmetric with respect to the plane of the propeller. This allows the above spectra to be derived in a relatively simple manner. For a more general case where the trace-velocities and amplitude decay parameters are significantly different in areas forward and aft of the propeller, such simplifications may not be possible and one may have to resort to a numerical integration scheme.

Author

A85-10873*# Bionetics Corp., Hampton, Va.

NOISE TRANSMISSION THROUGH AN ACOUSTICALLY TREATED AND HONEYCOMB STIFFENED AIRCRAFT SIDEWALL

F. W. GROSVELD (Bionetics Corp., Hampton, VA) and J. S. MIXSON (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 12 p. refs

(Contract NAS1-16978)

(AIAA PAPER 84-2329)

The noise transmission characteristics of test panels and acoustic treatments representative of an aircraft sidewall are experimentally investigated in the NASA Langley Research Center transmission loss apparatus. The test panels were built to represent a segment sidewall in the propeller plane of a twin-engine, turboprop light aircraft. It is shown that an advanced treatment, which uses honeycomb for structural stiffening of skin panels, has better noise transmission loss characteristics than a conventional treatment. An alternative treatment, using the concept of limp mass and vibration isolation, provides more transmission loss than the advanced treatment for the same total surface mass. Effects on transmission loss of a variety of acoustic treatment materials (acoustic blankets, septa, damping tape, and trim panels) are presented. Damping tape does not provide additional benefit when the other treatment provides a high level of damping. Window units representative of aircraft installations are shown to have low transmission loss relative to a completely treated sidewall.

Author

A85-10877*# Missouri Univ., Rolla.

APPLICATIONS OF FINITE ELEMENT AND WAVE ENVELOPE ELEMENT APPROXIMATIONS TO TURBOFAN ENGINE NOISE RADIATION INCLUDING FLIGHT EFFECTS

A. V. PARRETT (GM Noise and Vibration Laboratory, Milford, MI) and W. EVERSMAN (Missouri-Rolla, University, Rolla, MO) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs

(Contract NAG1-198)

(AIAA PAPER 84-2333)

The problem of acoustic radiation from turbofan engine inlets in flow has not lent itself fully to analysis by numerical means because of the large domains and high frequencies involved. The current work has extended the use of finite elements and wave envelope elements, elements which simulate decay and wavelike behaviour in their interpolation functions, from the no-flow case in which they have been proven, to cases incorporating mean flow. By employing an irrotational mean flow assumption, the acoustics problem has been posed in an axisymmetric formulation in terms of acoustic velocity potential, thus minimizing computer solution storage requirements. The results obtained from the numerical procedures agree well with known analytical solutions, static experimental jet engines inflow data, and also with flight test results.

Author

A85-10879#

AN ACOUSTIC MODE MEASUREMENT TECHNIQUE

P. D. JOPPA (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 8 p. refs

(AIAA PAPER 84-2337)

Turbomachinery noise propagates in aircraft jet engine ducts in a complicated manner. Measurement of this propagation is useful both to identify source mechanisms and to design efficient linings. A practical method of making these measurements has been developed, using linear arrays of equally spaced microphones mounted flush with the duct wall. Circumferential or axial arrays are analyzed by spatial Fourier transform, giving sound level as a function of spinning order or axial wavenumber respectively. Complex demodulation is used to acquire data in a modest bandwidth around a high frequency of interest. A joint NASA/Boeing test of the system used 32 microphones in a JT15D turbofan engine inlet. A 400-Hz bandwidth centered at blade passage frequency and at half blade passage frequency was studied. The theoretically predicted modes were clearly seen at blade passage frequency; broadband noise at half blade passage frequency was biased towards modes corotating with the fan. Interference between similar modes was not a significant problem. A lining design study indicated a 15 percent improvement in lining efficiency was possible when mode data were used, for this particular engine. The technique has proven reliable and useful for source diagnostics and lining design.

Author

A85-10880#

INFLUENCE OF VISCOSITY ON THE VORTEX SOUND

T. KAMBE (Tokyo, University, Tokyo, Japan) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 8 p. refs

(AIAA PAPER 84-2339)

Acoustic emission from vortex system is considered by taking account of viscosity effect. The acoustic pressure in the far field is represented in terms of the velocity and vorticity distributions of the acoustically compact source flow at low Mach number and high Reynolds number. It is found that the wave pressure is composed of a quadrupole and two isotropic monopole-like components, all of which are influenced by viscosity. A numerical example of head-on collision of two vortex-rings is presented and wave components are computed. The profiles are compared with those of observation and inviscid theory.

Author

A85-10883#

APPLICATION OF ACTIVE NOISE CONTROL TO MODEL PROPELLER NOISE

M. SALIKUDDIN, H. K. TANNA, R. H. BURRIN, and W. E. CARTER (Lockheed-Georgia Co., Marietta, GA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 12 p. refs

(AIAA PAPER 84-2344)

Techniques for applying active noise control (ANC) to cabin noise reduction on turboprop aircraft are described. Tests were performed using analog simulations from actual propeller noise recordings and with a 1/10th scale model C-130 aircraft propeller for the primary source and an acoustic driver as the secondary source. The propeller noise was sensed by microphones, subjected to sinusoidal analyses, and used to generate cancelling noise modified in amplitude and phase from the driver. A minimization algorithm was defined to analyze the input and guide the output of the driver. Although good results were obtained using analog simulations, actual propeller tests failed due to contamination of the primary noise by the secondary noise and distortion of the output by the driver. Further hardware development is indicated for effective implementation of ANC in the real world.

M.S.K.

A85-10884*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

PREDICTED CHANGES IN ADVANCED TURBOPROP NOISE WITH SHAFT ANGLE OF ATTACK

S. L. PADULA and P. J. W. BLOCK (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 10 p. refs
(AIAA PAPER 84-2347)

Advanced turboprop blade designs and new propeller installation schemes motivated an effort to include unsteady loading effects in existing propeller noise prediction computer programs. The present work validates the prediction capability while studing the effects of shaft inclination on the radiated sound field. Classical methods of propeller performance analysis supply the time-dependent blade loading needed to calculate noise. Polar plots of the sound pressure level (SPL) of the first four harmonics and overall SPL are indicative of the change in directivity pattern as a function of propeller angle of attack. Noise predictions are compared with newly available wind tunnel data and the accuracy and applicability of the prediction method are discussed. It is concluded that unsteady blade loading caused by inclining the propeller with respect to the flow changes the directionality and the intensity of the radiated noise. These changes are well modeled by the present quasi-steady prediction method. Author

A85-10889#

GROUND PLANE MICROPHONE INSTALLATION FOR MEASUREMENT OF AIRCRAFT FLYOVER NOISE

B. N. SHIVASHANKARA and G. W. STUBBS (Boeing Commerical Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 9 p.
(AIAA PAPER 84-2353)

Ground interference distortion is present in aircraft flyover noise spectra acquired using microphones mounted on poles, such as the 1.2m height required for noise certification. This spectral distortion is undesirable and can be avoided by using microphones that are mounted flush with the surface of a large, flat, acoustically-hard surface. However, flush mounting is usually not possible. As a practical implementation of a flush installation, Boeing has developed the flush-dish microphone that consists of a dish placed on the ground with its convex side up. The microphone is flush mounted at the center of the dish. Two designs of this concept, circular and exponential flush-dish microphones, are described in this paper. The first design, the circular flush-dish, was found to be free from ground interference effects for all incidence angles except for angles within about 15 deg of the overhead position. In this region, it exhibited periodic spectral modulation due to interaction between direct and edge diffracted waves. To diminish the edge effect, a new design, the exponential flush-dish, was conceived. The edge was shaped to match the impedance between the dish and the ground gradually and to avoid in-phase adddition of edge diffracted waves. The experimental results showed the exponential dish to be free from edge diffraction and ground interference effects. Furthermore, the response was insensitive to whether the flush-dish was mounted on an acoustically-hard surface or a typical natural terrain. Author

A85-10890#

DOPPLER FREQUENCY SHIFT FOR AIRCRAFT NOISE IN A REFRACTIVE ATMOSPHERE

D. ROY (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 12 p.
(AIAA PAPER 84-2354)

A general derivation is given for the Doppler-shifted received frequency due to source and receiver motion of uniform velocity, in a steady-state, refractive medium with spatial gradients in velocity and temperature. Results from three cases of this generalized equation are especially important. First is the wind-tunnel case in which a stationary noise source is tested; in-flow or out-of-flow measurements at a fixed receiver should show no Doppler frequency shift. Second is the outdoor flyover noise test case, where a source is moving in an atmosphere with wind and temperature gradients. Doppler frequency effects measured at a stationary microphone are different from that of the zero-wind, isothermal case; actual flyover data support this theoretical result. Third, the generalized Doppler frequency shift equation shows different frequencies of sound received by moving air particles at different heights; these frequencies can be incorporated into an atmospheric absorption model with varying wind and temperature. Author

A85-10891#

DE-DOPPLERISATION AND ACOUSTIC IMAGING OF AIRCRAFT FLYOVER MEASUREMENTS

G. P. HOWELL, A. J. BRADLEY, M. A. MCCORMICK, and J. D. BROWN (Rolls-Royce, Ltd., Derby, England) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 12 p.
(AIAA PAPER 84-2355)

The technique described in this paper eliminates the Doppler effect from aircraft flyover noise measurements and generates narrowband spectra at required angles. This new capability allows more accurate interpretation of flight data, and is essential for a detailed comparison with predictions and static measurements. Until now, only 1/3 octave levels, before de-Dopplerization, have been available, and these yield little information on tonal content. The paper explains how a single microphone output is de-Dopplerized, and includes details of aircraft tracking and computer simulation of flyover measurements. The technique is especially relevant to the analysis of noise from contra-rotating propeller driven aircraft, and results are shown for an Avro Shackleton. It is also applied to a Boeing 757, with high bypass ratio turbofan engines. Narrowband spectra at selected angles, density plots of complete flyovers, and field shapes at constant frequencies are all presented. Acoustic imaging, achieved by focusing the de-Dopplerized signals from an array of microphones, is also described, and results from a Lockheed TriStar graphically illustrate its capability. Author

A85-10894#

SCALING LAWS FOR JET MIXING NOISE IN SIMULATED FLIGHT AND THE PREDICTION SCHEME ASSOCIATED

R. BUCKLEY and C. L. MORFEY (Southampton, University, Southampton, England) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 9 p. refs
(AIAA PAPER 84-2360)

Numerical models are described for predicting the effects of forward aircraft speed on jet mixing noise, and thereby extracting information on physical characteristics of shear layer turbulence. The model is based on Lighthill's acoustic analogy modified by geometrical acoustics. The turbulent eddies are modeled using a least squares analysis and formulations are derived for the 1/3 octave power spectral intensity at specific frequencies and observation angles. The quadrupole and dipole dominant spectra are defined as functions of the Strouhal number, source emission angle and the ratio of simulated to real jet speed. The transverse wavenumber scaling factor is obtained solely for wavenumbers normal to the jet axis, with compressibility being a factor at supersonic speeds. Estimations are calculated for the axial wavenumber scaling factor and the eddy convection speed ratio. Finally, comparisons are made between predictions and data for jet speeds of Mach 0.5-1.5 and flight speed ratios from 0-0.3, showing high accuracies except at low velocities and high frequencies. M.S.K.

A85-10895#

COAXIAL JET NOISE SOURCE DISTRIBUTIONS

P. J. R. STRANGE, G. PODMORE, M. J. FISHER, and B. J. TESTER (Rolls-Royce, Ltd., Derby, England) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 16 p. refs (AIAA PAPER 84-2361)

Experimental techniques and data are presented which are aimed at enhancing the automatic source breakdown (ASB) parametric method for quantifying the strengths and dependencies of jet noise sources. The ASB technique was tested for effectiveness in separating the core and jet mixing noise of a single stream engine. The source was expressed as a line distribution and the noise intensity/distance downstream ratio. Comparisons were made between the projected and measured source images, the latter derived by a Fourier transform of coherence data. Data from static and simulated flight tests were also examined and jet noise is noted to be composed of two internal noise sources and two distributed sources of mixing noise in the exhaust. The ASB method is concluded valid for deriving the 1/3 octave breakdown and positions of noise from narrow-band coherence data and requires less computational time than previous methods. M.S.K.

A85-10896#

JET AND WING/FLAP INTERACTION NOISE

W. H. BROWN and K. K. AHUJA (Lockheed-Georgia Co., Advanced Flight Sciences Dept., Marietta, GA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 15 p. Research sponsored by the Lockheed-Georgia Co. refs (AIAA PAPER 84-2362)

A detailed experimental study, using a model-scale jet and wing/flap configuration to represent an under-the-wing engine installation for a conventional take-off and landing aircraft, was carried out in the Lockheed anechoic wind tunnel. The objective was to determine the dependence of far-field noise on the important flow and geometric parameters. In particular, for a range of jet exit velocities and forward speeds, the experiments were designed to study the variation of noise as a function of: (1) longitudinal and transverse location of the jet exit with respect to the wing, (2) flap angle, (3) angle of attack, and (4) spanwise gap between flap segments. It is shown that the effects of those variables on far-field noise are most evident in the mid-frequency range but sometimes are seen outside that range. The mid-frequency hump is attributed primarily to interaction between the jet and the flap. Other noise contributions (over the jet alone case) are attributed to jet noise amplification at all frequencies by the sound generated in the jet/flap interaction and to the reflection of jet noise from the wing and flap surfaces. Author

A85-11823

THE EFFECT OF ACOUSTIC DISTURBANCES ON THE VIBRATIONS OF A MULTILAYER PLATE [O VLIIANII ZVUKOVYKH VOZMUSHCHENII NA KOLEBANIIA MNOGOSLOINOI PLASTINKI]

V. V. KARACHUN, V. S. DIDKOVSKII, and A. V. KUZMENKO (Kievskii Politekhnicheskii Institut, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), Sept. 1984, p. 94-96. In Russian.

The noise of a jet stream, with the sound pressure amplitude changing randomly over a wide spectrum, can produce resonant vibrations in the structural elements of a flight vehicle, resulting in their rapid fatigue. Here, an analysis is made of the effect of a plane sound wave on a two-layer plate. An expression is obtained which describes the motion of an infinite plate for the case where sound passes through a two-layer obstacle. It is shown that a two-layer structure significantly reduces the acoustically induced flexural vibrations and thus increases the reliability of the structural elements. V.L.

A85-12300

ESTIMATING THE TRAJECTORY OF AN ACCELERATIONLESS AIRCRAFT BY MEANS OF A STATIONARY ACOUSTIC SENSOR

F. DOMMERMUTH and J. SCHILLER (Forschungsgesellschaft fuer angewandte Naturwissenschaften, Forschungsinstitut fuer Hochfrequenzphysik, Wachtberg-Werthhoven, West Germany) Acoustical Society of America, Journal (ISSN 0001-4966), vol. 76, Oct. 1984, p. 1114-1122. refs

To estimate the flight parameter of an aircraft moving without acceleration, a procedure has been proposed which employs the time delay measurements of an acoustic sensor consisting of three or four microphones. The retardation effect is exploited in particular to estimate the velocity of the target. Extended simulations show that the algorithm which provides the maximum likelihood estimate works reliably and fast. The estimate is nearly unbiased with minimal variance when averaged over a large region of flight parameters. Applications to real data and additional simulation studies suggest that the sensors should be confined to three horizontally mounted microphones. C.D.

N85-10788*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

OBSERVATIONS FROM VARYING THE LIFT AND DRAG INPUTS TO A NOISE PREDICTION METHOD FOR SUPERSONIC HELICAL TIP SPEED PROPELLERS

J. H. DITTMAR Sep. 1984 21 p refs
(NASA-TM-83797; E-2295; NAS 1.15:83797) Avail: NTIS HC A02/MF A01 CSCL 20A

Previous comparisons between calculated and measured supersonic helical tip speed propeller noise show them to have different trends of peak blade passing tone versus helical tip Mach number. It was postulated that improvements in this comparison could be made first by including the drag force terms in the prediction and then by reducing the blade lift terms at the tip to allow the drag forces to dominate the noise prediction. Propeller hub to tip lift distributions were varied, but they did not yield sufficient change in the predicted lift noise to improve the comparison. This result indicates that some basic changes in the theory may be needed. In addition, the noise predicted by the drag forces did not exhibit the same curve shape as the measured data. So even if the drag force terms were to dominate, the trends with helical tip Mach number for theory and experiment would still not be the same. The effect of the blade shock wave pressure rise was approxmated by increasing the drag coefficient at the blade tip. Predictions using this shock wdave approximation did have a curve shape similar to the measured data. This result indicates that the shock pressure rise probably controls the noise at supersonic tip speed and that the linear prediction method can give the proper noise trend with Mach number. R.S.F.

N85-10822# Department of the Army, Washington, D. C.

MOVING OBJECT DETECTION SYSTEM USING INFRARED SCANNING Patent Application

H. PARDES and W. J. MILLS, inventors (to Army) 9 Aug. 1984 15 p
(AD-D011222; US-PATENT-APPL-SN-639054) Avail: NTIS HC A02/MF A01 CSCL 17E

An infrared moving object detection system comprising first and second infrared detectors and an optical scanning system mounted in an aircraft for scanning along first and second paths on the ground, with the detectors receiving infrared radiation from objects in the two paths. One path is a small angle ahead of the aircraft, and the second path is the same as the first path when the aircraft is directly above it. Electronic circuit means compares the infrared information in the two paths to determine whether hot objects are in the same place in both paths, and, if they are not, it is known that one or more objects are moving objects. GRA

N85-10823# Department of the Air Force, Washington, D.C.
METHOD FOR MEASURING HAZE IN TRANSPARENCIES Patent Application
H. L. TASK, inventor (to Air Force) 22 Jun. 1984 32 p
(AD-D011233; US-PATENT-APPL-SN-623667) Avail: NTIS HC A03/MF A01 CSCL 20F

A method of measuring haze in a transparency includes the steps of illuminating a transparency to be measured from one side using a semi-collimated light source disposed in a predetermined angular relationship to the transparency, measuring the illumination (E) falling on a surface of the transparency from the one side thereof, then along a predetermined line of measurement through the transpoarency using a photometer to measure the veiling luminance (L) within the transparency from another side thereof, and, finally, calculating the haze index of the transparency by solving H(i) = L/E. Author (GRA)

N85-11788*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ANALYSIS OF NOISE MEASURED FROM A PROPELLER IN A WAKE
P. J. W. BLOCK Nov. 1984 49 p refs
(NASA-TP-2358; L-15808; NAS 1.60:2358) Avail: NTIS HC A03/MF A01 CSCL 20A

In this experimental study, the acoustic characteristics of a propeller operating in a wake were studied. The propeller performance and noise were measured from two 0.25 scale propellers operating in an open jet anechoic flow environment with and without a wake. One propeller had NACA 16 series sections; the other, ARA-D. Wake thicknesses of 1 and 3 propeller chords were generated by an airfoil which spanned the full diameter of the propeller. The airfoil wake profiles were measured. Noise measurements were made in and out of the flow. The propellers were operated at 40, 83, and 100 inf of thrust. The acoustic data are analyzed, and the effects on the overall sound pressure level (OASPL) and scaled A weighted sound level L sub A with propeller thrust, wake thickness, and observer location are presented. The analysis showed that, generally, the wake increased the overall noise (OASPL) produced by the propeller; increased the harmonic content of the noise, thus the scaled L sub a; and produced an azimuthal dependence. With few exceptions, both propellers generally produced the same trends in delta OASPL and delta L sub a with thrust and wake thickness. Author

N85-11790*# Douglas Aircraft Co., Inc., Long Beach, Calif.
JET NOISE SUPPRESSION BY POROUS PLUG NOZZLES Final Report
A. B. BAUER, V. KIBENS (McDonell Douglas Research Lab., St. Louis), and R. W. WLEZIEN (McDonnell Douglas Research Lab., St. Louis) Washington NASA Oct. 1982 173 p refs
(Contract NAS1-16284)
(NASA-CR-3613; NAS 1.26:3613; MDC-J2475) Avail: NTIS HC A08/MF A01 CSCL 20A

Jet noise suppression data presented earlier by Maestrello for porous plug nozzles were supplemented by the testing of a family of nozzles having an equivalent throat diameter of 11.77 cm. Two circular reference nozzles and eight plug nozzles having radius ratios of either 0.53 or 0.80 were tested at total pressure ratios of 1.60 to 4.00. Data were taken both with and without a forward motion or coannular flow jet, and some tests were made with a heated jet. Jet thrust was measured. The data were analyzed to show the effects of suppressor geometry on nozzle propulsive efficiency and jet noise. Aerodynamic testing of the nozzles was carried out in order to study the physical features that lead to the noise suppression. The aerodynamic flow phenomena were examined by the use of high speed shadowgraph cinematography, still shadowgraphs, extensive static pressure probe measurements, and two component laser Doppler velocimeter studies. The different measurement techniques correlated well with each other and demonstrated that the porous plug changes the shock cell structure of a standard nozzle into a series of smaller, periodic cell structures without strong shock waves. These structures become smaller in dimension and have reduced pressure variations as either the plug diameter or the porosity is increased, changes that also reduce the jet noise and decrease thrust efficiency. Author

N85-11791*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
TURBOFAN NOISE GENERATION. VOLUME 2: COMPUTER PROGRAMS Final Report
C. S. VENTRES, M. A. THEOBALD, and W. D. MARK Jul. 1982 206 p 2 Vol.
(Contract NAS3-21252)
(NASA-CR-167952; NAS 1.26:167952; BBN-4770) Avail: NTIS HC A10/MF A01 CSCL 20A

The use of a package of computer programs developed to calculate the in duct acoustic mods excited by a fan/stator stage operating at subsonic tip speed is described. The following three noise source mechanisms are included: (1) sound generated by the rotor blades interacting with turbulence ingested into, or generated within, the inlet duct; (2) sound generated by the stator vanes interacting with the turbulent wakes of the rotor blades; and (3) sound generated by the stator vanes interacting with the velocity deficits in the mean wakes of the rotor blades. The computations for three different noise mechanisms are coded as three separate computer program packages. The computer codes are described by means of block diagrams, tables of data and variables, and example program executions; FORTRAN listings are included. M.G.

N85-11794# Georgia Inst. of Tech., Atlanta. Systems Engineering Lab.
AUDITORY INFORMATION SYSTEMS IN MILITARY AIRCRAFT: CURRENT CONFIGURATIONS VERSUS THE STATE OF THE ART Final Report, 1 May - 30 Sep. 1983
T. J. DOLL, D. J. FOLDS, and L. A. LEIKER Jun. 1984 122 p
(Contract F33615-82-D-0601)
(AD-A145469; USAFSAM-TR-84-15) Avail: NTIS HC A06/MF A01 CSCL 20A

The complete ensembles of auditory signals in selected USAF aircraft (the F-4D, F-15, two models of the F-16, the C-5, and the C-141) are described and evaluated. Human factors research related to the design of speech and non-speech and non-speech auditory signals is reviewed and the fundamentals of speech synthesis technology are described. Major findings are: that auditory signals are not well standardized among the aircraft, even between those with similar combat roles that a relatively large number of non-speech auditory signals are used, which may make it difficult for the aircrew to recall the meanings of all the signals; that some non-speech signals are sufficiently similar that they may be confused, particularly in high workload and stressful conditions; and that the criticality of the warnings is not reliably indicated by any characteristic of the signals. Five problem areas requiring further research are discussed: reduction of signal loudness, annoyance, and disruption of other functions; enhancement of the distinctiveness and masking resistance of non-speech signals; effects of concurrent warning signals on aircrew performance in critical operational contexts; additional uses of auditory information in order to relieve visual workload; the need for guidelines for deciding which information should be provided aurally, which should be speech versus non-speech, and for designing speech messages; and optimization of synthesized speech for cockpit applications, including its attention-getting capability, distinctiveness, intelligibility, and ease of comprehension. Author (GRA)

N85-11862*# Connecticut Univ., Storrs. Dept. of Mechanical Engineering.
BIAXIAL CONSTITUTIVE EQUATION DEVELOPMENT FOR SINGLE CRYSTALS Semiannual Status Report, 6 Jan. - 6 Jul. 1984
E. H. JORDAN 1984 29 p
(Contract NAG3-512)
(NASA-CR-174056; NAS 1.26:174056) Avail: NTIS HC A03/MF A01 CSCL 20L

Current gas turbine engines utilize large single crystal superalloy components in the hot section. Structural analysis of these components requires a valid stress strain temperature constitutive equation. The goal of the program described is to create one or more models and verify these models. A constitutive equation based on an assumed slip behavior of a single slip system was formulated, programmed, and debugged. Specifically, the basic theory for a model based on aggravating slip behavior on individual slip systems was formulated and programmed and some simulations were run using assumed values of constants. In addition, a formulation allowing strain controlled simulations was completed. An approach to structural analysis of the specimen was developed. This approach uses long tube consistancy conditions and finite elements specially formulated to take advantage of the symmetry of 100 oriented specimens. R.S.F.

17

SOCIAL SCIENCES

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

A85-10049

DESTRUCTION OF KOREAN AIR LINES BOEING 747 OVER SEA OF JAPAN, 31 AUGUST 1983

P. MARTIN (Frere Cholmeley, London, England) Air Law (ISSN 0165-2079), vol. 9, no. 3, 1984, p. 138-148. refs

The legal repercussions of the destruction of flight KE007 by a Soviet interceptor are examined. The provisions of the Chicago Convention of 1944 and of international customary law regarding the rights and obligations of territorial states in cases of intrusion of a commercial aircraft are reviewed, and the Soviet and ICAO reports on the KE007 incident are compared and found to be in sharp disagreement. With respect to the liability claims being litigated on behalf of the families of the victims against the airline, the manufacturers of the aircraft and navigation aids, and the US government (for neglecting to warn the air crew of its true location), it is argued that the US and manufacturers are probably not liable, while the airline liability depends on the applicability of the Warsaw Convention (to which the US is party) or the amended version Warsaw/Hague (to which Korea is a party) in the US courts and on the question of the USSR's compliance with Article 25 of the Chicago Convention (requiring states to assist aircraft in distress). T.K.

A85-10050

US JURISDICTION AND BILATERAL AIR AGREEMENTS

H. A. WASSENBERGH Air Law (ISSN 0165-2079), vol. 9, no. 3, 1984, p. 170-183. refs

The opinion of the US Court of Appeals in the case Laker vs. Sabena/KLM in March, 1984, is examined in detail as an example of US legal doctrine with regard to bilateral air-transport agreements. The litigation history of the case is reviewed, and such aspects as immunity, jurisdiction, discrimination, interest balancing, and international comity are explored. The US view that free competition and antitrust control should coexist is found to be in disagreement with the practices of many other states. T.K.

A85-11665#

COMPUTER SIMULATION OF HOVERCRAFT HEAVE DYNAMICS AND CONTROL

J. R. AMYOT (National Research Council, Div. of Mechanical Engineering, Ottawa, Canada) IN: Computers in engineering 1983; Proceedings of the International Conference and Exhibit, Chicago, IL, August 7-11, 1983. Volume 1 . New York, American Society of Mechanical Engineers, 1983, p. 245-249. refs

A nonlinear synchronous computer modeling technique using experimental fan and skirt characteristics has been developed for studying the vertical (heave) dynamics of air cushion vehicles. The application of the technique to an evaluation of the potential of automatic valve control of heave dynamics is discussed, and simulation results are examined. In particular, attention is given to the effects of cushion volume and bearing area variations on damping. It is shown that the highly destabilizing effect of cushion volume increases of up to 90 percent over the nominal value can be completely neutralized by vent valve control. A physical experiment is being designed to provide further validation of the analytical work and to investigate its further implications. V.L.

A85-11937

A LEGAL ANALYSIS OF THE SHOOTING OF KOREAN AIRLINES FLIGHT 007 BY THE SOVIET UNION

F. HASSAN (Willamette University, Salem, OR; San Diego, University, San Diego, CA) Journal of Air Law and Commerce (ISSN 0021-8642), vol. 49, no. 3, 1984, p. 555-588. refs

A legal analysis is offered examining the central issue in the controversy over the shooting of the Korean commercial airliner KAL 007 by the Soviet Union in 1983: the legal status of a trespassing civilian aircraft in the airspace of another country. The application of international law to this issue is considered, with emphasis given to the evolution of legal doctrine since the Chicago Convention of 1955. Attention is also given to a number of legal precedents upon which the general principle has been established that it is unlawful to fire upon an intruder civilian aircraft without first making an attempt to force the aircraft to land. It is concluded on the basis of evidence now available about the KAL 007 incident, that the Soviet Union did act illegally in its response to the trespass of the foreign aircraft. I.H.

A85-11938

FAA REGULATION OF ULTRALIGHT VEHICLES

S. THOMPSON Journal of Air Law and Commerce (ISSN 0021-8642), vol. 49, no. 3, 1984, p. 591-620. refs

The development of FAA standards and operating regulations for ultralight aircraft is discussed. Particular emphasis is given to the definition of aircraft design characteristics, registration and flight certification requirements for ultralight pilots, as well as the operating rules governing right of way, and times and areas of legal operation. Attention is also given to the beneficial effects of self-regulation by the ultralight manufacturers and pilots in order to avoid what are considered to be the inhibiting aspects of FAA regulation. A complete list of proposed FAA regulations is provided in a series of footnotes. I.H.

N85-10856*# National Aeronautics and Space Administration, Washington, D. C.

DATA INPUT, PROCESSING AND PRESENTATION

H. J. LANGER Jul. 1984 55 p Transl. into ENGLISH of "Datenaufnahme, Verarbeitung und Darstellung" rept. Deutsche Forschungs und Versuchsanstalt fuer Raumfahrt eV, Brunswick, 1984 p 1-53 Transl. by Kanner (Leo) Associates, Redwood City, Calif.

(Contract NASW-3541)

(NASA-TM-77739; NAS 1.15:77739) Avail: NTIS HC A04/MF A01 CSCL 05B

The problems of data acquisition, processing and display are investigated in the case of a helicopter rotor balance. The types of sensors to be employed are discussed in addition to their placement and application in wind tunnel trials. Finally, the equipment for data processing, evaluation and storage are presented with a description of methods. Author

N85-11899# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CHARACTERISTICS OF SYSTEMS ENGINEERING IN AVIATION SCIENCE RESEARCH
L. DA-LI and W. JIE-ZHI 20 Aug. 1984 16 p Transl. into ENGLISH from Guoji Hangkong (China), no. 2(252), 28-29 Feb. 1984 p 2-5;
(AD-A145602; FTD-ID(RS)T-0708-84) Avail: NTIS HC A02/MF A01 CSCL 05A

There are five phases in aviation science research: fundamental research (to develop scientific theories), applied research (to generate technical projects), preliminary development (to test and verify technology, leading to product design), model development (to produce prototypes) and improvement after usage (or to develop practical models) Preliminary research and development include fundamental research, applied research and preliminary development. In general, the main objective of the first two phases is to understand the subject, i.e., to explore the aviation science. The objective of the other three phases is to improve the status, that is to develop the aviation technology. Considering aviation science research as a whole, it has many static characteristics such as divisibility, interrelatedness, stepwise progression, integrity, subordinateness, uncertainty, etc. however, the dynamic characteristics are more important which we would like to discuss in detail. That is the systems engineering of the aviation science research. GRA

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GENERAL

N85-11971# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
AGARD BULLETIN TECHNICAL PROGRAMME, 1985
Loughton, England Aug. 1984 38 p
(AGARD-BUL-84-2) Avail: NTIS HC A03/MF A01

The 1985 program approved by the AGARD National Delegates Board is presented. A chronological listing of the meetings tentatively scheduled to take place during 1985 are included. A detailed description of the Individual Panel Programs, the Consultant and Exchange Program, and the Military Committee Studies Program is given. The total budget required to support the proposed programs is presented. The AGARD publications scheduled for publication in 1985 are identified. B.G.

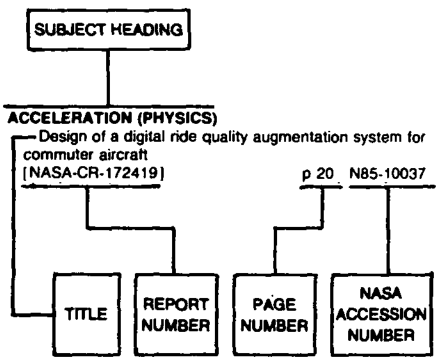
N85-11972# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
AGARD HIGHLIGHTS
Sep. 1984 34 p In ENGLISH and FRENCH
(AGARD-HIGHLIGHTS-84/2) Avail: NTIS HC A03/MF A01

The mission of AGARD which is to bring together the leading personalities of the NATO nations in the fields of science and technology relating to aerospace is discussed. The purposes of AGARD are to: (1) exchange scientific and technical information; (2) continuously stimulate advances in the aerospace sciences relevant to strengthening the common defence posture; (3) improve the cooperation among member nations in aerospace research and development; (4) provide scientific and technical advice and assistance to the North Atlantic Military Committee in the field of aerospace research and development; (5) render scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field; (6) provide assistance to member nations for the purpose of increasing their scientific and technical potential; (7) recommend effective ways for the member nations to use their research and development capabilities for the common benefit of the NATO community. Topics include: the role of AGARD in the NATO planning process; trends in guidance and control; large scale computing in aeronautics. E.A.K.

N85-11973*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RESEARCH AND TECHNOLOGY Annual Report, 1984
Washington Nov. 1984 110 p
(NASA-TM-86321; NAS 1.15:86321) Avail: NTIS HC A06/MF A01 CSCL 05B

The role of the Langley Research Center is to engage in the basic and applied research necessary for the advancement of aeronautics and space flight, to enerate new and advanced concepts for the accomplishment of related national goals, and to provide research advice, technological support, and assistance to other NASA installations, other government agencies, and industry. Highlights of the major accomplishments and applications made during the past year are described. The highlights illustrate both the broad range of the research and technology activities at the Langley Research Center and the contributions of this work toward maintaining United States leadership in aeronautics and space research. M.A.C.

Typical Subject Index Listing



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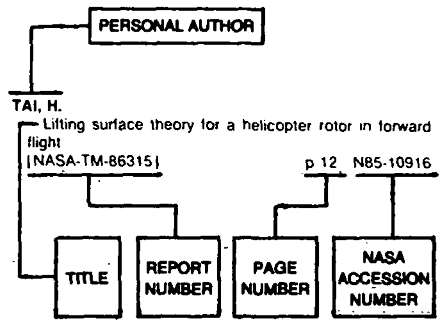

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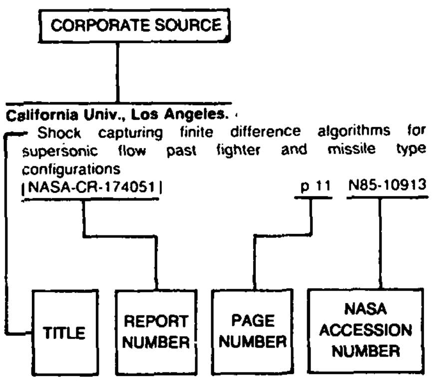

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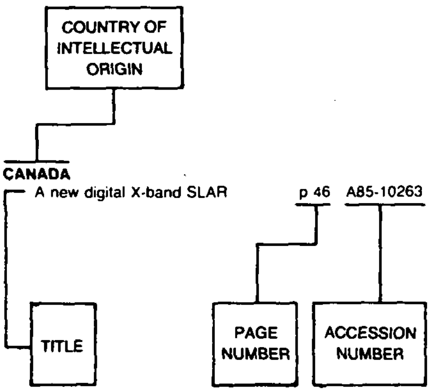

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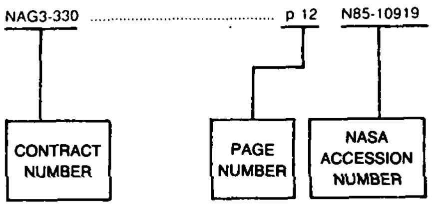

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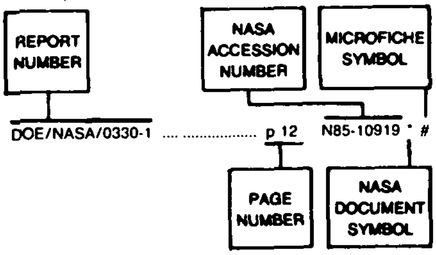

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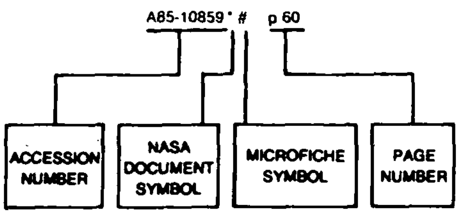

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