NASA SP-7037 (315)
March 1995

P-84

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
Scientific and Technical Information Office
Washington, DC 1995

This publication was prepared by the NASA Center for AeroSpace Information,
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INTRODUCTION

This issue of *Aeronautical Engineering — A Continuing Bibliography with Indexes* (NASA SP-7037) lists 217 reports, journal articles, and other documents recently announced in the NASA STI Database.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)	N95-13610 — N95-15918
Open Literature (A-60000 Series)	A95-61680 — A95-62970

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 publication 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.

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

A cumulative index for 1995 will be published in early 1996.

The NASA CASI price code table, addresses of organizations, and document availability information are located at the back of this issue.

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TYPICAL REPORT CITATION AND ABSTRACT

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ACCESSION NUMBER → **N95-10318*#** Dow Chemical Co., Midland, MI. ← **CORPORATE SOURCE**

TITLE → **NOVEL MATRIX RESINS FOR COMPOSITES FOR AIRCRAFT PRIMARY STRUCTURES, PHASE 1 Final Report, Apr. 1989 - Mar. 1992**

AUTHORS → EDMUND P. WOO, P. M. PUCKETT, S. MAYNARD, M. T. BISHOP, K. J. BRUZA, J. P. GODSCHALX, AND M. J. MULLINS Aug. 1992 ← **PUBLICATION DATE**
164 p

CONTRACT NUMBERS → (Contracts NAS1-18841; RTOP 510-02-11-02)

REPORT NUMBERS → (NASA-CR-189657; NAS 1.26:189657) Avail: CASI HC A08/MFA02 ← **AVAILABILITY AND PRICE CODE**

The objective of the contract is the development of matrix resins with improved processability and properties for composites for primarily aircraft structures. To this end, several resins/systems were identified for subsonic and supersonic applications. For subsonic aircraft, a series of epoxy resins suitable for RTM and powder prepreg was shown to give composites with about 40 ksi compressive strength after impact (CAI) and 200 F/wet mechanical performance. For supersonic applications, a thermoplastic toughened cyanate prepreg system has demonstrated excellent resistance to heat aging at 360 F for 4000 hours, 40 ksi CAI and useful mechanical properties at greater than or equal to 310 F. An AB-BCB-maleimide resin was identified as a leading candidate for the HSCT. Composite panels fabricated by RTM show CAI of approximately 50 ksi, 350 F/wet performance and excellent retention of mechanical properties after aging at 400 F for 4000 hours. Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

ACCESSION NUMBER → **A95-60192*** National Aeronautics and Space Administration. Ames. ← **CORPORATE SOURCE**
Research Center, Moffett Field, CA.

TITLE → **AERODYNAMIC INTERACTIONS BETWEEN A ROTOR AND WING IN HOVER**

AUTHORS → FORT F. FELKER NASA. Ames Research Center, Moffett Field, ← **AUTHOR'S AFFILIATION**
CA, US and JEFFREY S. LIGHT NASA. Ames Research Center,
Moffett Field, CA, US Journal of the American Helicopter Society ← **JOURNAL TITLE**

PUBLICATION DATE → 2 Jun. 1986 p. 53-61

REPORT NUMBER → (HTN-94-00714) Copyright

An experimental investigation of rotor/wing aerodynamic interactions in hover is described. The investigation consisted of both a large-scale and a small-scale test. A 0.658-scale V-22 rotor and wing was used in the large-scale test. Wing download, wing surface pressure, rotor performance, and rotor downwash data from the large-scale test are presented. A small-scale experiment was conducted to determine how changes in the rotor/wing geometry affected the aerodynamic interactions. These geometry variations included the distance between the rotor and wing, wing incidence angle, wing flap angle, rotor rotation direction, and configurations both with the rotor axis at the tip of the wing (tilt rotor configuration) and with the rotor axis at the center of the wing (compound helicopter configuration). Author (Herner)

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 315)

March 1995

ABSTRACTS

01
AERONAUTICS (GENERAL)

A95-61734
ADVANCEMENTS IN AUTOMATIC FASTENING TECHNOLOGY
Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 9 September 1993 p. 7-9
(BTN-94-EIX94461290277) *Copyright*

By using machines that merge the latest in electronic control and feedback devices with innovative mechanical design, manufacturing cost can be reduced while productivity and quality are increased. One machine which does just that is the Gemcor wing fastening system which uses a six-position upper head - a closed loop servo controlled mechanism that employs a linear encoder and precision linear guide bearings to obtain a high degree of positioning accuracy. EI

N95-13642*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MODIFICATION OF THE AMES 40- BY 80-FOOT WIND TUNNEL FOR COMPONENT ACOUSTIC TESTING FOR THE SECOND GENERATION SUPERSONIC TRANSPORT
F. H. SCHMITZ, J. R. ALLMEN, and P. T. SODERMAN Oct. 1994 41 p
(Contract(s)/Grant(s): RTOP 505-38-13)
(NASA-TM-108850; A-94143; NAS 1.15:108850) Avail: CASI HC A03/MF A01

The development of a large-scale anechoic test facility where large models of engine/airframe/high-lift systems can be tested for both improved noise reduction and minimum performance degradation is described. The facility development is part of the effort to investigate economically viable methods of reducing second generation high speed civil transport noise during takeoff and climb-out that is now under way in the United States. This new capability will be achieved through acoustic modifications of NASA's second largest subsonic wind tunnel: the 40-by 80-Foot Wind Tunnel at the NASA Ames Research Center. Three major items are addressed in the design of this large anechoic and quiet wind tunnel: a new deep (42 inch (107 cm)) test section liner, expansion of the wind tunnel drive operating envelope at low rpm to reduce background noise, and other promising methods of improving signal-to-noise levels of inflow microphones. Current testing plans supporting the U.S. high speed civil transport program are also outlined. Author

N95-13662*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
USER'S GUIDE FOR ENSAERO: A MULTIDISCIPLINARY PROGRAM FOR FLUID/STRUCTURAL/CONTROL INTERACTION STUDIES OF AIRCRAFT (RELEASE 1)
GURU P. GURUSWAMY Oct. 1994 47 p
(Contract(s)/Grant(s): RTOP 509-10-11)
(NASA-TM-108853; A-94148; NAS 1.15:108853) Avail: CASI HC A03/MF A01

Strong interactions can occur between the flow about an aerospace vehicle and its structural components resulting in several important aeroelastic phenomena. These aeroelastic phenomena can significantly influence the performance of the vehicle. At present, closed-form solutions are available for aeroelastic computations when flows are in either the linear subsonic or supersonic range. However, for aeroelasticity involving complex nonlinear flows with shock waves, vortices, flow separations, and aerodynamic heating, computational methods are still under development. These complex aeroelastic interactions can be dangerous and limit the performance of aircraft. Examples of these detrimental effects are aircraft with highly swept wings experiencing vortex-induced aeroelastic oscillations, transonic regime at which the flutter speed is low, aerothermoelastic loads that play a critical role in the design of high-speed vehicles, and flow separations that often lead to buffeting with undesirable structural oscillations. The simulation of these complex aeroelastic phenomena requires an integrated analysis of fluids and structures. This report presents a summary of the development, applications, and procedures to use the multidisciplinary computer code ENSAERO. This code is based on the Euler/Navier-Stokes flow equations and modal/finite-element structural equations. Author

N95-13891*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DYNAMICS OF THE MCDONNELL-DOUGLAS LARGE SCALE DYNAMIC RIG AND DYNAMIC CALIBRATION OF THE ROTOR BALANCE
KHANH NGUYEN and BENTON LAU Oct. 1994 28 p
(Contract(s)/Grant(s): RTOP 505-59-36)
(NASA-TM-108855; A-94007; NAS 1.15:108855) Avail: CASI HC A03/MF A01

A shake test was performed on the Large Scale Dynamic Rig in the 40- by 80-Foot Wind Tunnel in support of the McDonnell Douglas Advanced Rotor Technology (MDART) Test Program. The shake test identifies the hub modes and the dynamic calibration matrix of the rotor balance. For hub mode identification, three configurations were tested: wind tunnel scale unlocked with dampers engaged and disengaged, and wind tunnel scale locked. Test data were analyzed with a multi-degree-of-freedom time domain algorithm to identify the modal properties of the hub modes. The damping of the low frequency hub modes (ground resonance modes) increases significantly with the wind tunnel dampers engaged. For dynamic calibration of the rotor balance, the shake test was performed only with the wind tunnel dampers engaged. The dynamic calibration matrix, computed from the shake test data using a least squares error method, is used to correct the five-per-rev vibratory balance readings. The corrections are large for the side force, moderate for the axial force and inplane hub moments, and small for the normal force. Author

N95-14144# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DAMAGE TOLERANT REPAIR TECHNIQUES FOR PRESSURIZED AIRCRAFT FUSELAGES M.S. Thesis
ROBERT S. FREDELL 1994 280 p
(AD-A281982; AFIT/CI/CIA-94-095) Avail: CASI HC A13/MF A03

Concerns over the safety of the continued use of aging transport aircraft have been voiced in the industry. A key component in the

structural integrity of aging aircraft is the damage tolerance of fuselage structural repairs. The investigation focuses on the analysis and testing of contemporary repair methods and develops two improvements. The first technique, known as soft patching, is appropriate for damage tolerant riveted repairs to incidental fuselage damage. Soft patching involves the use of high strength, moderate elastic modulus GLARE 3 fiber metal laminate patches. They extend the fatigue life of riveted repairs to monolithic aluminum fuselages while reducing life cycle costs. The second technique involves bonded crack patching of intact fatigue cracks in fuselage skins. An easy to use analysis program is presented along with analytical and test results of a low cost, high performance patch material known as GLARE 2. The findings demonstrate that GLARE 2 can replace the expensive boron/epoxy composites used in fuselage crack patching applications. DTIC

N95-14419*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HIGHER HARMONIC CONTROL ANALYSIS FOR VIBRATION REDUCTION OF HELICOPTER ROTOR SYSTEMS
KHANH Q. NGUYEN Oct. 1994 138 p
(Contract(s)/Grant(s): RTOP 505-61-51)
(NASA-TM-103855; A-91113; NAS 1.15:103855) Avail: CASI HC A07/MF A02

An advanced higher harmonic control (HHC) analysis has been developed and applied to investigate its effect on vibration reduction levels, blade and control system fatigue loads, rotor performance, and power requirements of servo-actuators. The analysis is based on a finite element method in space and time. A nonlinear time domain unsteady aerodynamic model, based on the indicial response formulation, is used to calculate the airloads. The rotor induced inflow is computed using a free wake model. The vehicle trim controls and blade steady responses are solved as one coupled solution using a modified Newton method. A linear frequency-domain quasi-steady transfer matrix is used to relate the harmonics of the vibratory hub loads to the harmonics of the HHC inputs. Optimal HHC is calculated from the minimization of the vibratory hub loads expressed in term of a quadratic performance index. Predicted vibratory hub shears are correlated with wind tunnel data. The fixed-gain HHC controller suppresses completely the vibratory hub shears for most of steady or quasi-steady flight conditions. HHC actuator amplitudes and power increase significantly at high forward speeds (above 100 knots). Due to the applied HHC, the blade torsional stresses and control loads are increased substantially. For flight conditions where the blades are stalled considerably, the HHC input-output model is quite nonlinear. For such cases, the adaptive-gain controller is effective in suppressing vibratory hub loads, even though HHC may actually increase stall areas on the rotor disk. The fixed-gain controller performs poorly for such flight conditions. Comparison study of different rotor systems indicates that a soft-inplane hingeless rotor requires less actuator power at high speeds (above 130 knots) than an articulated rotor, and a stiff-inplane hingeless rotor generally requires more actuator power than an articulated or a soft-inplane hingeless rotor. Parametric studies for a hingeless rotor operating in a transition flight regime and for an articulated rotor operating at the level-flight boundary (high speed and high thrust conditions) indicate that blade parameters including flap, lag, torsion stiffness distributions, linear pretwist, chordwise offset of center-of-mass from elastic axis and chordwise offset of elastic axis from aerodynamic center can be selected to minimize the actuator power requirements for HHC.
Author

N95-14477*# Monash Univ., Clayton (Australia). Dept. of Mechanical Engineering.
DEVELOPMENT OF A COMPOSITE REPAIR AND THE ASSOCIATED INSPECTION INTERVALS FOR THE F-111C STIFFENER RUNOUT REGION
R. JONES, L. MOLENT, J. PAUL, T. SAUNDERS, and W. K. CHIU *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 339-350 Sep. 1994
Avail: CASI HC A03/MF A04

This paper presents an overview of the structural aspects of the design and development of a local reinforcement designed to lower the stresses in a region of the F-111C wing fitting which is prone to cracking. The stress analysis, with particular emphasis on the use of a unified constitutive model for the cyclic inelastic response of the structure, representative specimen testing, thermal analysis and full scale static testing of this design are summarized. Author

N95-14921*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AIR-BREATHING AEROSPACE PLANE DEVELOPMENT ESSENTIAL: HYPERSONIC PROPULSION FLIGHT TESTS
UNMEEL B. MEHTA Nov. 1994 16 p Presented at the Second European Symposium on Aerothermodynamics for Space Vehicles, ESTEC, Noordwijk (The Netherlands), 21-23 Nov. 1994
(Contract(s)/Grant(s): RTOP 505-59-53)
(NASA-TM-108857; A-95017; NAS 1.15:108857) Avail: CASI HC A03/MF A01

Hypersonic air-breathing propulsion utilizing scramjets can fundamentally change transatmospheric accelerators for low earth-to-orbit and return transportation. The value and limitations of ground tests, of flight tests, and of computations are presented, and scramjet development requirements are discussed. It is proposed that near full-scale hypersonic propulsion flight tests are essential for developing a prototype hypersonic propulsion system and for developing computational-design technology so that it can be used for designing this system. In order to determine how these objectives should be achieved, some lessons learned from past programs are presented. A conceptual two-stage-to-orbit (TSTO) prototype/experimental aerospace plane is recommended as a means of providing access-to-space and for conducting flight tests. A road map for achieving these objectives is also presented.
Author

N95-15331# Sytronics, Inc., Dayton, OH.
MORE SUPPORTABLE T-38A ENHANCEMENT STUDY Final Report, Dec. 1993 - Jun. 1994
WILLIAM T. KILPATRICK 20 Jun. 1994 312 p
(Contract(s)/Grant(s): F33657-93-C-2440)
(AD-A283671; DOC-0710-001) Avail: CASI HC A14/MF A03

The purpose of the More Supportable T-38A Enhancement Study was to investigate methods of improving T-38A fleet readiness and reduce operational support costs. A comparative and functional analysis approach was utilized to identify specific T-38A aircraft design and system support deficiencies that could be improved through a redesign effort or maintenance procedural changes. Several aircraft components were identified and targeted as potential redesign candidates. These T-38A components are also common to the F-5 and improvements to these components will enhance both T-38 and F-5 supportability. DTIC

02 AERODYNAMICS

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

A95-61728
COMPOSITE PROPELLER SYSTEM FOR DORNIER 328
LINDA E. TREGO Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 12 December 1993 p. 7-29
(BTN-94-EIX94461290506) Copyright

The composite propeller system HD-E6 was selected for the Dornier 328 regional airliner. It was chosen because it best met the stringest noise, weight and performance requirements of the aircraft

Dornier 328. The system features a propeller control unit, lightweight aluminum hub design, dual-acting cylinder, and lightweight composite blades. EI

N95-13701*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering.
AERODYNAMIC SHAPE OPTIMIZATION OF A HSCT TYPE CONFIGURATION WITH IMPROVED SURFACE DEFINITION
Progress Report, 1 May 1993 - 30 Jun. 1994
ALMUTTIL M. THOMAS and SURENDRA N. TIWARI Oct. 1994 32 p
(Contract(s)/Grant(s): NCC1-68)
(NASA-CR-197011; NAS 1.26:197011) Avail: CASI HC A03/MF A01

Two distinct parametrization procedures of generating free-form surfaces to represent aerospace vehicles are presented. The first procedure is the representation using spline functions such as nonuniform rational b-splines (NURBS) and the second is a novel (geometrical) parametrization using solutions to a suitably chosen partial differential equation. The main idea is to develop a surface which is more versatile and can be used in an optimization process. Unstructured volume grid is generated by an advancing front algorithm and solutions obtained using an Euler solver. Grid sensitivity with respect to surface design parameters and aerodynamic sensitivity coefficients based on potential flow is obtained using an automatic differentiator precompiler software tool. Aerodynamic shape optimization of a complete aircraft with twenty four design variables is performed. High speed civil transport aircraft (HSCT) configurations are targeted to demonstrate the process. Author

N95-13719*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VUV SHOCK LAYER RADIATION IN AN ARC-JET WIND TUNNEL EXPERIMENT
ROGER A. CRAIG (MCAT Inst., Moffett Field, CA.), GIUSEPPE PALUMBO (Eloret Corp., Santa Clara, CA.), and ARMANDO CARRASCO *In* MCAT Inst., Planetary Entry Experiments 27 p Jul. 1994
(Contract(s)/Grant(s): NCC2-653)
Avail: CASI HC A03/MF A02

Measurements were made of the radiating gas cap of a blunt body in a NASA-Ames 20 MW arc-jet wind tunnel. The test gas was air. Spectra of the flux incident on a small aperture centered at the stagnation region were obtained. A helium-cooled, magnesium fluoride window transmitted the flux into an evacuated collimating system that focused the aperture onto the entrance slit of a spectrometer. Data were obtained with films and by photomultipliers. The spectral ranges covered were the vacuum ultraviolet, VUV, (120 nm to 200 nm) and the ultraviolet to near infrared (200 nm to 900 nm) with resolutions from 0.05 nm to 0.5 nm. This paper presents the preliminary VUV results from the experiment. Results from the 200 nm to 900 nm spectral range have been presented elsewhere. Representative spectral records from 120 nm to 200 nm are shown. The intense atomic oxygen and nitrogen lines which are of concern to hypersonic flight are measured. Carbon lines are are also seen. These results will be used to help develop and validate aerothermodynamic computational models of arc-jet wind tunnel performance and help to assess the importance of VUV heating to entering spacecraft. Author

N95-13720*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MEASURED AND CALCULATED SPECTRAL RADIATION FROM A BLUNT BODY SHOCK LAYER IN AN ARC-JET WIND TUNNEL
DIKRAN S. BABIKIAN (Eloret Corp., Palo Alto, CA.), GIUSEPPE PALUMBO (Eloret Corp., Palo Alto, CA.), ROGER A. CRAIG (MCAT Inst., Moffett Field, CA.), CHUL PARK, GRANT PALMER, and SURENDRA P. SHARMA *In* MCAT Inst., Planetary Entry Experiments 11 p Jul. 1994 Presented at the 32d Aerospace Sciences Meeting, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA
(Contract(s)/Grant(s): NCC2-653)
(AIAA PAPER 94-0086) Avail: CASI HC A03/MF A02

Spectra of the shock layer radiation incident on the stagnation point of a blunt body placed in an arc-jet wind tunnel were measured over the wavelength range from 600 nm to 880 nm. The test gas was a mixture of 80 percent air and 20 percent argon by mass, and the run was made in a highly nonequilibrium environment. The observed spectra contained contributions from atomic lines of nitrogen, oxygen, and argon, of bound-free and free-free continua, and band systems of N2 and N2(+). The measured spectra were compared with the synthetic spectra, which were obtained through four steps: the calculation of the arc-heater characteristics, of the nozzle flow, of the blunt-body flow, and the nonequilibrium radiation processes. The results show that the atomic lines are predicted approximately correctly, but all other sources are underpredicted by orders of magnitude. A possible explanation for the discrepancy is presented. Author

N95-14103# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
SCALE EFFECTS ON AIRCRAFT AND WEAPON AERODYNAMICS [LES EFFETS D'ECHELLE ET L'AERODYNAMIQUE DES AERONEFS ET DES SYSTEMES D'ARMES]
A. BARRY HAINES (Aircraft Research Association Ltd., Bedford, England.) and A. D. YOUNG Jul. 1994 247 p
(AGARD-AG-323; ISBN-92-835-0754-1) Copyright Avail: CASI HC A11/MF A03

The present state of knowledge on scale effects at high lift and low speeds, at transonic speeds, and on aircraft drag are presented. In addition, scale effects in various important specific scale-sensitive areas such as forebody vortex flows, the flow in and near open cavities, the flow into an air intake, the flow over propellers, and on ice accretion simulation testing are discussed. The emphasis is on scale effects that have been observed in flight-tunnel comparisons for specific aircraft. It is concluded that much has been learned about scale effects; however, precise prediction can still be difficult. Twenty recommendations for further research are mentioned. This AGARDograph has been produced at the request of the Fluid Dynamics Panel of AGARD. Author

N95-14197# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
QUALITY ASSESSMENT FOR WIND TUNNEL TESTING [L'APPRECIATION DE LA QUALITE POUR LES ESSAIS EN SOUFFLERIE]
Jul. 1994 92 p
(AGARD-AR-304; ISBN-92-835-0753-3) Copyright Avail: CASI HC A05/MF A01

The wind tunnel continues to be the main instrument for providing experimental aerodynamic data to the aerospace industry and the aerodynamic researcher for the purpose of load and performance evaluation of theoretical results. In both cases, it is imperative that the user has confidence in the quality of the results, which means that he must have information of what accuracy to attach to the data. This report describes a practical approach for assessing the uncertainty of experimental measurements. Although it concentrates on aerodynamic references data, the approach presented can be used to report data and associated uncertainties for any other condition. The methodology described is designed to facilitate communications and to encourage professional and practical analyses of complex problems. The most recent accepted technical concepts have been included in the methodology. This report presents the results of a study by Working Group 15 of the AGARD Fluid Dynamics Panel. Author

N95-14229*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
FOURTH HIGH ALPHA CONFERENCE, VOLUME
1 Jul. 1994 212 p Conference held at Edwards, CA, 12-14 Jul. 1994
(Contract(s)/Grant(s): RTOP 505-68-30)

(NASA-CP-10143-VOL-1; H-2007-VOL-1; NAS 1.55:10143-VOL-1)
Avail: CASI HC A10/MF A03

The goal of the Fourth High Alpha Conference was to focus on the flight validation of high angle-of-attack technologies and provide an in-depth review of the latest high angle-of-attack activities. Areas that were covered include: high angle-of-attack aerodynamics, propulsion and inlet dynamics, thrust vectoring, control laws and handling qualities, tactical utility, and forebody controls. For individual titles, see N95-14230 through N95-14238.

N95-14230*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HIGH ALPHA TECHNOLOGY PROGRAM (HATP) GROUND TEST TO FLIGHT COMPARISONS Status Report

R. M. HALL, D. W. BANKS, DAVID F. FISHER, F. GHAFFARI, D. G. MURRI, J. C. ROSS, and WENDY R. LANSER *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 1 25 p Jul. 1994
Avail: CASI HC A03/MF A03

This status paper reviews the experimental ground test program of the High Alpha Technology Program (HATP). The reasons for conducting this ground test program had their origins during the 1970's when several difficulties were experienced during the development programs of both the F-18 and F-16. A careful assessment of ground test to flight correlations appeared to be important for reestablishing a high degree of confidence in our ground test methodology. The current paper will then focus on one aspect of the HATP program that is intended to improve the correlation between ground test and flight, high-alpha gritting. The importance of this work arises from the sensitivity of configurations with smooth-sided forebodies to Reynolds number. After giving examples of the effects of Reynolds number, the paper will highlight efforts at forebody gritting. Finally, the paper will conclude by summarizing the charter of the HATP Experimental Aerodynamics Working Group and future experimental testing plans. Author

N95-14231*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.

FLIGHT AND FULL-SCALE WIND-TUNNEL COMPARISON OF PRESSURE DISTRIBUTIONS FROM AN F-18 AIRCRAFT AT HIGH ANGLES OF ATTACK

DAVID F. FISHER and WENDY R. LANSER *In its* Fourth High Alpha Conference, Volume 1 20 p Jul. 1994
Avail: CASI HC A03/MF A03

Pressure distributions were obtained at nearly identical fuselage stations and wing chord butt lines in flight on the F-18 HARV at NASA Dryden Flight Research Center and in the NASA Ames Research Center's 80 by 120 ft wind tunnel on a full-scale F/A-18 aircraft. The static pressures were measured at the identical five stations on the forebody, three stations on the left and right leading-edge extensions, and three spanwise stations on the wing. Comparisons of the flight and wind-tunnel pressure distributions were made at alpha = 30 deg, 45 deg, and 60 deg/59 deg. In general, very good agreement was found. Minor differences were noted at the forebody at alpha = 45 deg and 60 deg in the magnitude of the vortex footprints and a Mach number effect was noted at the leading-edge extension at alpha = 30 deg. The inboard leading edge flap data from the wind tunnel at alpha = 59 deg showed a suction peak that did not appear in the flight data. This was the result of a vortex from the corner of the leading edge flap whose path was altered by the lack of an engine simulation in the wind tunnel. Author

N95-14232*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NUMERICAL SIMULATION OF THE FLOW ABOUT AN F-18 AIRCRAFT IN THE HIGH-ALPHA REGIME

SCOTT M. MURMAN (MCAT Inst., Moffett Field, CA.) and YEHIA M. RIZK *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 1 33 p Jul. 1994
Avail: CASI HC A03/MF A03

The current research is aimed at developing and extending numerical methods to accurately predict the high Reynolds number flow about the NASA F-18 HARV at large angles of attack. The resulting codes are validated by comparison of the numerical results with in-flight aerodynamic measurements and flow visualization obtained on the HARV. Further, computations have been used to provide an analysis and numerical optimization of a pneumatic slot blowing concept, and a mechanical strake concept, for use as potential forebody flow control devices in improving high-alpha maneuverability. Author

N95-14233*# Analytical Services and Materials, Inc., Hampton, VA.

HYBRID STRUCTURED/UNSTRUCTURED GRID COMPUTATIONS FOR THE F/A-18 AT HIGH ANGLE OF ATTACK

ROBERT T. BIEDRON and DAVID L. WHITAKER *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 1 17 p Jul. 1994
Avail: CASI HC A03/MF A03

At high angles of attack, vortical flows play a crucial role in the maintenance of lift for fighter aircraft. However, under certain conditions, the vortical flow can have an adverse effect on the aircraft. On the F/A-18 the LEX vortex can impinge on the tail; at high angles of attack the unsteady flow from vortex bursting can cause structural fatigue on the vertical tails. At high angles of attack, the flow field can be quite complex, and a computational analysis challenging. A full configuration analysis with viscous structured grids can be computationally expensive and the task of generating the requisite grids can be quite difficult. To mitigate these difficulties and provide a medium-fidelity analysis tool, a hybrid structured/unstructured approach was adopted for this work. In this analysis, the formation and roll-up of the LEX vortex is computed with a structured Navier-Stokes solver, and the resulting vortex propagated downstream with an unstructured Euler solver. Author

N95-14234*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPARISON OF X-31 FLIGHT, WIND-TUNNEL, AND WATER-TUNNEL YAWING MOMENT ASYMMETRIES AT HIGH ANGLES OF ATTACK

BRENT R. COBLEIGH (Planning Research Corp., Edwards, CA.), MARK A. CROOM, and B. F. TAMRAT *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 1 p 21 Jul. 1994
Avail: CASI HC A03/MF A03

The X-31 aircraft are being used in the enhanced fighter maneuverability (EFM) research program, which is jointly funded by the (U.S.) Advanced Research Projects Agency (ARPA) and Germany's Federal Ministry of Defense (FMOD). The flight test portion of the program, which involves two aircraft, is being conducted by an International Test Organization (ITO) comprising the National Aeronautics and Space Administration (NASA), the U.S. Navy, the U.S. Air Force, Rockwell International, and Deutsche Aerospace (DASA). The goals of the flight program are to demonstrate EFM technologies, investigate close-in-combat exchange ratios, develop design requirements, build a database for application to future fighter aircraft, and develop and validate low-cost prototype concepts. For longitudinal control the X-31 uses canards, symmetrical movement of the trailing-edge flaps, and pitch deflection of the thrust vectoring system. The trim, inertial coupling, and engine gyroscopic coupling compensation tasks are performed primarily by the trailing-edge flaps. For lateral-directional control the aircraft uses differential deflection of the trailing-edge flaps for roll coordination and a conventional rudder combined with the thrust vectoring system to provide yaw control. The rudder is only effective up to about 40 deg angle of attack (alpha), after which the thrust vectoring becomes the primary yaw control effector. Both the leading-edge flaps and the inlet lip are scheduled with the angle of attack to provide best performance. Author

N95-14235*# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. of Flight Mechanics.
PARAMETER IDENTIFICATION FOR X-31A AT HIGH ANGLES OF ATTACK
S. WEISS, D. ROHLF, and ERMIN PLAETSCHKE *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 1 12 p Jul. 1994
Avail: CASI HC A03/MF A03

The U.S./German experimental aircraft X-31A was designed and constructed to demonstrate enhanced fighter maneuverability. Post-stall maneuvering is enabled by applying new technologies such as high angle of attack aerodynamics and flight control system integrated thrust vectoring. Two demonstrator aircraft have been built by the main contractors, Rockwell International and Deutsche Aerospace (formerly MBB). Flight testing started in October 1990 and before the end of 1992 both aircraft had accomplished a significant number of flights covering the entire AoA regime from about -5 to 70 deg. Throughout the envelope expansion, DLR Institute of Flight Mechanics conducted parameter identification (PID) to determine the aerodynamic parameters of the aircraft from flight test data and to compare the results to the predictions from the aerodynamic dataset (ADS). The application of system identification to high AoA / post-stall flight data raises some major problems, which are discussed in this paper. Results from both longitudinal and lateral-directional motion will be presented. *Author*

N95-14236*# Bihrle Applied Research, Inc., Jericho, NY.
VALIDATION OF THE NASA DRYDEN X-31 SIMULATION AND EVALUATION OF MECHANIZATION TECHNIQUES
EDWARD DICKES, JACOB KAY, and JOHN RALSTON *In* NASA. *Dryden Flight Research Center, Fourth High Alpha Conference,* Volume 1 23 p Jul. 1994
Avail: CASI HC A03/MF A03

This paper shall discuss the evaluation of the original Dryden X-31 aerodynamic math model, processes involved in the justification and creation of the modified data base, and comparison time history results of the model response with flight test. Author

N95-14237*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FREE-TO-ROLL TESTS OF X-31 AND F-18 SUBSCALE MODELS WITH CORRELATION TO FLIGHT TEST RESULTS
DAVID L. WILLIAMS, II (Notre Dame Univ., IN.), ROBERT C. NELSON (Notre Dame Univ., IN.), and DAVID F. FISHER *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 1 28 p Jul. 1994
Avail: CASI HC A03/MF A03

This presentation will concentrate on a series of low-speed wind tunnel tests conducted on a 2.5 percent subscale F-18 model and a 2 percent subscale X-31 model. The model's control surfaces were unaugmented; and for the most part, were deflected at a constant angle throughout the tests. The tests consisted mostly of free-to-roll experiments conducted with the use of an air-bearing, surface pressure measurements, off-surface flow visualization, and force-balance tests. Where possible the results of the subscale tests have been compared to flight test data, or to other wind tunnel data taken at higher Reynolds numbers. Author

N95-14238*# Eidetics Aircraft, Inc., Torrance, CA.
STATIC AND DYNAMIC FORCE/MOMENT MEASUREMENTS IN THE EIDETICS WATER TUNNEL
CARLOS J. SUAREZ and GERALD N. MALCOLM *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 1 24 p Jul. 1994
(Contract(s)/Grant(s): NAS2-13571)
Avail: CASI HC A03/MF A03

Water tunnels have been utilized in one form or another to explore fluid mechanics and aerodynamics phenomena since the days of Leonardo da Vinci. Water tunnel testing is attractive because of the relatively low cost and quick turn-around time to perform flow visualization experiments and evaluate the results. The principal limitation of a water tunnel is that the low flow speed, which provides for detailed visualization, also results in very small hydrodynamic (aerodynamic) forces on the model, which, in the past, have proven to be difficult to measure accurately. However, the advent of semi-conductor strain gage technology and devices associated with data acquisition such as low-noise amplifiers, electronic filters, and digital recording have made accurate measurements of very low strain levels feasible. The principal objective of this research effort was to develop a multi-component strain gage balance to measure forces and moments on models tested in flow visualization water tunnels. A balance was designed that allows measuring normal and side forces, and pitching, yawing and rolling moments (no axial force). The balance mounts internally in the model and is used in a manner typical of wind tunnel balances. The key differences between a water tunnel balance and a wind tunnel balance are the requirement for very high sensitivity since the loads are very low (typical normal force is 0.2 lbs), the need for water proofing the gage elements, and the small size required to fit into typical water tunnel models. Author

N95-14239*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
FOURTH HIGH ALPHA CONFERENCE, VOLUME 2
Jul. 1994 235 p Conference held at Edwards, CA, 12-14 Jul. 1994
(Contract(s)/Grant(s): RTOP-505-68-30)
(NASA-CP-10143-VOL-2; H-2007-VOL-2; NAS 1.55:10143-VOL-2)
Avail: CASI HC A11/MF A03

The goal of the Fourth High Alpha Conference, held at the NASA Dryden Flight Research Center on July 12-14, 1994, was to focus on the flight validation of high angle of attack technologies and provide an in-depth review of the latest high angle of attack activities. Areas that were covered include high angle of attack aerodynamics, propulsion and inlet dynamics, thrust vectoring, control laws and handling qualities, and tactical utility. For individual titles, see N95-14240 through N95-14250.

N95-14240*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
F-18 HIGH ALPHA RESEARCH VEHICLE: LESSONS LEARNED
ALBION H. BOWERS, VICTORIA A. REGENIE, and BRADLEY C. FLICK *In its* Fourth High Alpha Conference, Volume 2 15 p Jul. 1994
Avail: CASI HC A03/MF A03

The F-18 High Alpha Research Vehicle has proven to be a useful research tool with many unique capabilities. Many of these capabilities are to assist in characterizing flight at high angles of attack, while some provide significant research in their own right. Of these, the thrust vectoring system, the unique ability to rapidly reprogram flight controls, the reprogrammable mission computer, and a reprogrammable onboard excitation system have allowed an increased utility and versatility of the research being conducted. Because of this multifaceted approach to research in the high angle of attack regime, the capabilities of the F-18 High Alpha Research Vehicle were designed to cover as many high alpha technology bases as the program would allow. These areas include aerodynamics, controls, handling qualities, and propulsion.
Derived from text

N95-14241*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
DESIGN AND DEVELOPMENT OF AN F/A-18 INLET DISTORTION RAKE: A COST AND TIME SAVING SOLUTION
ANDREW J. YUHAS, RONALD J. RAY, RICHARD R. BURLEY, WILLIAM G. STEENKEN, LEON LECHTENBERG, and DON THORNTON *In its* Fourth High Alpha Conference, Volume 2 17 p Jul. 1994
Avail: CASI HC A03/MF A03

An innovative inlet total-pressure distortion measurement rake

has been designed and developed for the F/A-18 A/B/C/D aircraft inlet. The design was conceived by NASA and General Electric Aircraft Engines (Evendale, Ohio). This rake has been flight qualified and flown in the F-18 High Alpha Research Vehicle (HARV) at NASA Dryden Flight Research Center. The rake's eight-legged, one-piece wagon wheel design was developed at a reduced cost and offers reduced installation time compared with traditional designs. The rake features 40 dual measurement ports for both low- and high-frequency pressure measurements with the high-frequency transducer mounted at the port. The high-frequency transducer offers direct absolute pressure measurements from low frequency to the highest frequency of interest, thereby allowing the rake to be used during highly dynamic aircraft maneuvers. Outstanding structural characteristics are inherent to the design through its construction and use of lightweight materials.
Derived from text

N95-14242*# Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.
X-31 POST-STALL ENVELOPE EXPANSION AND TACTICAL UTILITY TESTING
DAVE CANTER *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 2 19 p Jul. 1994
Avail: CASI HC A03/MF A03

Technical and nontechnical lessons learned from the X-31 aircraft program are described in this viewgraph presentation. The tactical utility of high angle of attack flight and thrust vector control is discussed.
CASI

N95-14243*# Deutsche Aerospace A.G., Munich (Germany).
X-31 QUASI-TAILLESS FLIGHT DEMONSTRATION
PETER HUBER and HARVEY G. SCHELLENGER *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 2 14 p Jul. 1994
Avail: CASI HC A03/MF A03

The primary objective of the quasi-tailless flight demonstration is to demonstrate the feasibility of using thrust vectoring for directional control of an unstable aircraft. By using this low-cost, low-risk approach it is possible to get information about required thrust vector control power and deflection rates from an inflight experiment as well as insight in low-power thrust vectoring issues. The quasi-tailless flight demonstration series with the X-31 began in March 1994. The demonstration flight condition was Mach 1.2 at 37,500 feet. A series of basic flying quality maneuvers, doublets, bank to bank rolls, and wind-up-turns have been performed with a simulated 100% vertical tail reduction. Flight test and supporting simulation demonstrated that the quasi-tailless approach is effective in representing the reduced stability of tailless configurations. The flights also demonstrated that thrust vectoring could be effectively used to stabilize a directionally unstable configuration and provide control power for maneuver coordination.
Derived from text

N95-14244*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
X-31 HIGH ANGLE OF ATTACK CONTROL SYSTEM PERFORMANCE
PETER HUBER (Deutsche Aerospace A.G., Munich, Germany.) and PATRICIA SEAMOUNT *In its* Fourth High Alpha Conference, Volume 2 19 p Jul. 1994
Avail: CASI HC A03/MF A03

The design goals for the X-31 flight control system were: (1) level 1 handling qualities during post-stall maneuvering (30 to 70 degrees angle-of-attack); (2) thrust vectoring to enhance performance across the flight envelope; and (3) adequate pitch-down authority at high angle-of-attack. Additional performance goals are discussed. A description of the flight control system is presented, highlighting flight control system features in the pitch and roll axes and X-31 thrust vectoring characteristics. The high angle-of-attack envelope clearance approach will be described, including a brief explanation of analysis techniques and tools. Also, problems encountered during envelope expansion will be discussed. This presentation emphasizes control system solutions to problems encountered in envelope expansion. An essentially 'care free' envelope was cleared for the close-in-combat demonstrator phase. High angle-of-attack flying qualities maneuvers are currently being flown and evaluated. These results are compared with pilot opinions expressed during the close-in-combat program and with results obtained from the F-18 HARV for identical maneuvers. The status and preliminary results of these tests are discussed. Derived from text

N95-14245*# Lockheed Corp., Fort Worth, TX.
FLIGHT TEST RESULTS OF THE F-16 AIRCRAFT MODIFIED WITH THE AXISYMMETRIC VECTORING EXHAUST NOZZLE
PAUL D. ANNA and DAVID S. KIDMAN *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 2 15 p Jul. 1994
Avail: CASI HC A03/MF A03

The results of the envelope expansion phase of the F-16 Multi-Axis Thrust Vectoring (MATV) program are presented in viewgraph format. The objectives and test approach are presented followed by results of testing with the initial control law configuration. The revised flight control laws are discussed followed by test results with the revised control laws. Additional testing added to the program, nose chines, parameter identification maneuvers, and the extended range angle of attack cones are briefly discussed. Derived from text

N95-14246*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLIGHT VALIDATION OF GROUND-BASED ASSESSMENT FOR CONTROL POWER REQUIREMENTS AT HIGH ANGLES OF ATTACK
MARILYN E. OGBURN, HOLLY M. ROSS, JOHN V. FOSTER, JOSEPH W. PAHLE, CHARLES A. STERNBERG, RICARDO TRAVEN, JAMES B. LACKEY, and TROY D. ABBOTT *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 2 20 p Jul. 1994
Avail: CASI HC A03/MF A03

A review is presented in viewgraph format of an ongoing NASA/U.S. Navy study to determine control power requirements at high angles of attack for the next generation high-performance aircraft. This paper focuses on recent flight test activities using the NASA High Alpha Research Vehicle (HARV), which are intended to validate results of previous ground-based simulation studies. The purpose of this study is discussed, and the overall program structure, approach, and objectives are described. Results from two areas of investigation are presented: (1) nose-down control power requirements and (2) lateral-directional control power requirements. Selected results which illustrate issues and challenges that are being addressed in the study are discussed including test methodology, comparisons between simulation and flight, and general lessons learned. Derived from text

N95-14247*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH ANGLE OF ATTACK FLYING QUALITIES CRITERIA FOR LONGITUDINAL RATE COMMAND SYSTEMS
DAVID J. WILSON (McDonnell-Douglas Aerospace, Saint Louis, MO.), KEVIN D. CITURS (McDonnell-Douglas Aerospace, Saint Louis, MO.), and JOHN B. DAVIDSON *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 2 14 p Jul. 1994
Avail: CASI HC A03/MF A03

This study was designed to investigate flying qualities requirements of alternate pitch command systems for fighter aircraft at high angle of attack. Flying qualities design guidelines have already been developed for angle of attack command systems at 30, 45, and 60 degrees angle of attack, so this research fills a similar need for rate command systems. Flying qualities tasks that require post-stall maneuvering were tested during piloted simulations in the McDonnell Douglas Aerospace Manned Air Combat Simulation facility. A generic fighter aircraft model was used to test angle of attack rate and pitch rate command systems for longitudinal gross acquisition and tracking tasks at high angle of attack. A wide range of longitudinal dynamic variations were tested at 30, 45, and 60 degrees angle of attack. Pilot comments, Cooper-Harper ratings, and pilot induced oscillation ratings were taken

from five pilots from NASA, USN, CAF, and McDonnell Douglas Aerospace. This data was used to form longitudinal design guidelines for rate command systems at high angle of attack. These criteria provide control law design guidance for fighter aircraft at high angle of attack, low speed flight conditions. Additional time history analyses were conducted using the longitudinal gross acquisition data to look at potential agility measures of merit and correlate agility usage to flying qualities boundaries. This paper presents an overview of this research. Author (revised)

N95-14248*# Lockheed Corp., Fort Worth, TX.
VISTA/F-16 MULTI-AXIS THRUST VECTORING (MATV) CONTROL LAW DESIGN AND EVALUATION
W. D. ZWERNEMAN and B. G. ELLER *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 2 19 p Jul. 1994
Avail: CASI HC A03/MF A03

For the Multi-Axis Thrust Vectoring (MATV) program, a new control law was developed using multi-axis thrust vectoring to augment the aircraft's aerodynamic control power to provide maneuverability above the normal F-16 angle of attack limit. The control law architecture was developed using Lockheed Fort Worth's offline and piloted simulation capabilities. The final flight control laws were used in flight test to demonstrate tactical benefits gained by using thrust vectoring in air-to-air combat. Differences between the simulator aerodynamics data base and the actual aircraft aerodynamics led to significantly different lateral-directional flying qualities during the flight test program than those identified during piloted simulation. A 'dial-a-gain' flight test control law update was performed in the middle of the flight test program. This approach allowed for inflight optimization of the aircraft's flying qualities. While this approach is not preferred over updating the simulator aerodynamic data base and then updating the control laws, the final selected gain set did provide adequate lateral-directional flying qualities over the MATV flight envelope. The resulting handling qualities and the departure resistance of the aircraft allowed the 422nd_squadron pilots to focus entirely on evaluating the aircraft's tactical utility. Derived from text

N95-14249*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
MULTI-APPLICATION CONTROLS: ROBUST NONLINEAR MULTIVARIABLE AEROSPACE CONTROLS APPLICATIONS
DALE F. ENNS (Honeywell, Inc., Minneapolis, MN.), DANIEL J. BUGAJSKI (Honeywell, Inc., Minneapolis, MN.), JOHN CARTER, and BOB ANTONIEWICZ *In its* Fourth High Alpha Conference, Volume 2 26 p Jul. 1994
Avail: CASI HC A03/MF A03

This viewgraph presentation describes the general methodology used to apply Honywell's Multi-Application Control (MACH) and the specific application to the F-18 High Angle-of-Attack Research Vehicle (HARV) including piloted simulation handling qualities evaluation. The general steps include insertion of modeling data for geometry and mass properties, aerodynamics, propulsion data and assumptions, requirements and specifications, e.g. definition of control variables, handling qualities, stability margins and statements for bandwidth, control power, priorities, position and rate limits. The specific steps include choice of independent variables for least squares fits to aerodynamic and propulsion data, modifications to the management of the controls with regard to integrator windup and actuation limiting and priorities, e.g. pitch priority over roll, and command limiting to prevent departures and/or undesirable inertial coupling or inability to recover to a stable trim condition. The HARV control problem is characterized by significant nonlinearities and multivariable interactions in the low speed, high angle-of-attack, high angular rate flight regime. Systematic approaches to the control of vehicle motions modeled with coupled nonlinear equations of motion have been developed. This paper will discuss the dynamic inversion approach which explicity accounts for nonlinearities in the control design. Multiple control effectors (including aerodynamic control surfaces and thrust vectoring control) and sensors are used to control the motions of the vehicles in several degrees-of-freedom. Several maneuvers will be used to illustrate performance of MACH in the high angle-of-attack flight regime. Analytical methods for assessing the robust performance of the multivariable control system in the presence of math modeling uncertainty, disturbances, and commands have reached a high level of maturity. The structured singular value (mu) frequency response methodology is presented as a method for analyzing robust performance and the mu-synthesis method will be presented as a method for synthesizing a robust control system. The paper concludes with the author's expectations regarding future applications of robust nonlinear multivariable controls. Author (revised)

N95-14251*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
FOURTH HIGH ALPHA CONFERENCE, VOLUME
3 Jul. 1994 191 p *Conference held at Edwards, CA, 12-14 Jul. 1994*
(Contract(s)/Grant(s): RTOP-505-68-30)
(NASA-CP-10143-VOL-3; H-2007-VOL-3; NAS 1.55:10143-VOL-3)
Avail: CASI HC A09/MF A02

The goal of this conference was to focus on the flight validation of high-angle-of-attack technologies and provide an in-depth review of the latest high-angle-of-attack activities. Areas covered include: (1) high-angle-of-attack aerodynamics; (2) propulsion and inlet dynamics; (3) thrust vectoring; (4) control laws and handling qualities; (5) tactical utility; and (6) forebody controls. For individual titles, see N95-14252 through N95-14259.

N95-14252*# Naval Air Warfare Center, Patuxent River, MD.
NAVY AND THE HARV: HIGH ANGLE OF ATTACK TACTICAL UTILITY ISSUES
CHARLES A. STERNBERG, RICARDO TRAVEN, and JAMES B. LACKEY *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 3 19 p Jul. 1994
Avail: CASI HC A03/MF A02

This presentation will highlight results from the latest Navy evaluation of the HARV (March 1994) and focus primarily on the impressions from a piloting standpoint of the tactical utility of thrust vectoring. Issue to be addressed will be mission suitability of high AOA flight, visual and motion feedback cues associated with operating at high AOA, and the adaptability of a pilot to effectively use the increased control power provided by the thrust vectoring system. Derived from text

N95-14253*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPUTATIONAL ANALYSIS OF FOREBODY TANGENTIAL SLOT BLOWING
KEN GEE (MCAT Inst., Moffett Field, CA.), ROXANA M. AGOSTA-GREENMAN, YEHIA M. RIZK, LEWIS B. SCHIFF, and RUSSELL M. CUMMINGS *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 3 22 p Jul. 1994
Avail: CASI HC A03/MF A02

An overview of the computational effort to analyze forebody tangential slot blowing is presented. Tangential slot blowing generates side force and yawing moment which may be used to control an aircraft flying at high-angle-of-attack. Two different geometries are used in the analysis: (1) The High Alpha Research Vehicle; and (2) a generic chined forebody. Computations using the isolated F/A-18 forebody are obtained at full-scale wind tunnel test conditions for direct comparison with available experimental data. The effects of over- and under-blowing on force and moment production are analyzed. Time-accurate solutions using the isolated forebody are obtained to study the force onset timelag of tangential slot blowing. Computations using the generic chined forebody are obtained at experimental wind tunnel conditions, and the results compared with available experimental data. This computational analysis compliments the experimental results and provides a detailed understanding of the effects of tangential slot blowing on the flow field about simple and complex geometries. Derived from text

N95-14254*# Eidetics Aircraft, Inc., Torrance, CA.
F/A-18 AND F-16 FOREBODY VORTEX CONTROL, STATIC AND ROTARY-BALANCE RESULTS
BRIAN KRAMER and BROOKE SMITH *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 3 22 p Jul. 1994
Avail: CASI HC A03/MF A02

The results from research on forebody vortex control on both the F/A-18 and the F-16 aircraft will be shown. Several methods of forebody vortex control, including mechanical and pneumatic schemes, will be discussed. The wind tunnel data includes both static and rotary balance data for forebody vortex control. Time lags between activation or deactivation of the pneumatic control and when the aircraft experiences the resultant forces are also discussed. The static (non-rotating) forces and pressures are then compared to similar configurations tested in the NASA Langley and DTRC Wind Tunnel, the NASA Ames 80'x120' Wind Tunnel, and in flight on the High Angle of Attack Research Vehicle (HARV). Derived from text

N95-14255*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPARISON OF FULL-SCALE, SMALL-SCALE, AND CFD RESULTS FOR F/A-18 FOREBODY SLOT BLOWING
WENDY R. LANSER, LARRY A. MEYN, and KEVIN D. JAMES *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 3 19 p Jul. 1994
Avail: CASI HC A03/MF A02

It has been shown experimentally that forebody flow control devices provide a significant increase in yaw control for fighter aircraft at high angle-of-attack. This study presents comparisons of the various experimental and computational results for tangential slot blowing on the F/A-18 configuration. Experimental results are from the full-scale and 6 percent-scale model test and computational solutions are from both isolated forebody and and full aircraft configurations. The emphasis is on identifying trends in the variation of yawing moment with blowing-slot exit conditions. None of the traditional parameters (mass flow ratio, blowing momentum coefficient, velocity ratio) succeeded in collapsing all of the results into a common curve. Several factors may effect the agreement between the 6 percent- and full-scale results including Reynolds number effects, sensitivity of boundary layer transition from laminar to turbulent flow, and poor geometric fidelity, particularly of the blowing slot. The disagreement between the full-scale and computed yawing moments may be due to a mismatch in the slot exit conditions for the same mass flow ratio or aircraft configuration modeling. The general behavior of slot blowing on the 6 percent-scale and computational models is correct, but neither matches the full-scale results. Author

N95-14256*# McDonnell-Douglas Research Labs., Saint Louis, MO.
LOW-ENERGY PNEUMATIC CONTROL OF FOREBODY VORTICES
FREDERICK W. ROOS *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 3 16 p Jul. 1994
Avail: CASI HC A03/MF A02

This research will be exploring the prospect of employing bluntness, known to suppress the tendency toward asymmetry on slender forebodies, jointly with pneumatic manipulation as a system of forebody asymmetry control. The influences of jet location and direction, blowing rate, relative noise bluntness, angle of attack, and state of flow separation feeding the vortices (laminar vs. turbulent) will be evaluated. Derived from text

N95-14257*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PREPARATIONS FOR FLIGHT RESEARCH TO EVALUATE ACTUATED FOREBODY STRAKES ON THE F-18 HIGH-ALPHA RESEARCH VEHICLE
DANIEL G. MURRI, GAUTAM H. SHAH, and DANIEL J. DICARLO *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 3 20 p Jul. 1994
Avail: CASI HC A03/MF A02

As part of the NASA High-Angle-of-Attack Technology Program (HATP), flight tests are currently being conducted with a multi-axis thrust vectoring system applied to the NASA F-18 High Alpha Research Vehicle (HARV). A follow-on series of flight tests with the NASA F-18 HARV will be focusing on the application of actuated forebody strake controls. These controls are designed to provide increased levels of yaw control at high angles of attack where conventional aerodynamic controls become ineffective. The series of flight tests are collectively referred to as the Actuated Nose Strakes for Enhanced Rolling (ANSER) Flight Experiment. The development of actuated forebody strake controls for the F-18 HARV is discussed and a summary of the ground tests conducted in support of the flight experiment is provided. A summary of the preparations for the flight tests is also provided. Derived from text

N95-14258*# McDonnell-Douglas Corp., Saint Louis, MO.
INTEGRATION OF A MECHANICAL FOREBODY VORTEX CONTROL SYSTEM INTO THE F-15
RICHARD E. BOALBEY, KEVIN D. CITURS, WAYNE L. ELY, STEPHEN P. HARBAUGH, WILLIAM B. HOLLINGSWORTH, and RONALD L. PHILLIPS *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 3 20 p Jul. 1994
Avail: CASI HC A03/MF A02

The goal of the F-15 Forebody Vortex Control (FVC) program is to develop a production FVC system for the F-15. The system may consist of either a mechanically actuated device such as the strakes developed for the HARV program, or a pneumatic device such as the port blowing system being tested on the X-29. Both types of systems are being evaluated under this program. Background information on the F-15 and a description and overview of forebody vortex controls (FVC) will be presented. Derived from text

N95-14259*# Wright Lab., Wright-Patterson AFB, OH.
FLIGHT EVALUATION OF PNEUMATIC FOREBODY VORTEX CONTROL IN POST-STALL FLIGHT
LAWRENCE A. WALCHLI *In* NASA. Dryden Flight Research Center, Fourth High Alpha Conference, Volume 3 24 p Jul. 1994
Avail: CASI HC A03/MF A02

The following topics are discussed: (1) X-29 description; Vortex Flow Control (VFC) technology description; (3) X-29 VFC wind tunnel results (forebody only); (4) X-29 VFC wind tunnel results (full configuration yawing moment); (5) X-29 VFC wind tunnel results (full configuration C(sub n) with sideslip); (6) X-29VFC wind tunnel results (full configuration pitching moment); (7) VFC optimized nozzle details; (8) X-29 forebody nozzle configuration; (9) X-29 VFC system stored gas schematic; (10) X-29 VFC system stored gas installation; (11) VFC effectiveness at zero sideslip; (12) VFC effectiveness at 35 AOA with sideslip; (13) 'VFC Roll' at 40 AOA; (14) Effects of VFC on wing rock; (15) Integrated controls C(sub n) prediction; (16) Proposed F-15 with lateral control laws with active VFC; (17) Simulated F-15 roll performance with active VFC; (18) Simulated F-15 spin recovery with active VFC; (19) Test team restructuring; (20) testbed selection; (21) Simulation for risk reduction; (22) Benefits of high pressure system; and (23) Advanced weapon system integration. Derived from text

N95-14264# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
COMPUTATIONAL AERODYNAMICS BASED ON THE EULER EQUATIONS [L'AERODYNAMIQUE NUMERIQUE A PARTIR DES EQUATIONS D'EULER]
J. W. SLOOFF, ed. (National Aerospace Lab., Amsterdam, Netherlands.) and W. SCHMIDT, ed. (Deutsche Aerospace A.G., Munich, Germany.) Sep. 1994 250 p Original contains color illustrations (AGARD-AG-325; ISBN-92-836-1005-9) Copyright Avail: CASI HC A11/MF A03

A survey of the state of the art of Computational Aerodynamics

based on the Euler Equations is presented. For the major Euler Codes that are currently in use in the NATO countries, numerical schemes, algorithms, grid generation, physical and numerical aspects, as well as a wide range of applications are included. Background material required for understanding the physics modelled by the Euler Equations is also presented. Areas of application concentrate on numerical simulation of external flows about aerospace vehicles. Internal flows and turbomachinery applications are not extensively treated but touched upon where considered appropriate. Author

N95-14297*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A CARTESIAN, CELL-BASED APPROACH FOR ADAPTIVELY-REFINED SOLUTIONS OF THE EULER AND NAVIER-STOKES EQUATIONS

WILLIAM J. COIRIER and KENNETH G. POWELL Nov. 1994 16 p Presented at the 33rd Aerospace Sciences Meeting and Exhibit, Reno, NV, 9-12 Jan. 1995; sponsored by AIAA

(Contract(s)/Grant(s): RTOP 505-62-52)

(NASA-TM-106786; E-9241; NAS 1.15:106786; AIAA PAPER 95-0566) Copyright Avail: CASI HC A03/MF A01

A Cartesian, cell-based approach for adaptively-refined solutions of the Euler and Navier-Stokes equations in two dimensions is developed and tested. Grids about geometrically complicated bodies are generated automatically, by recursive subdivision of a single Cartesian cell encompassing the entire flow domain. Where the resulting cells intersect bodies, N-sided 'cut' cells are created using polygon-clipping algorithms. The grid is stored in a binary-tree structure which provides a natural means of obtaining cell-to-cell connectivity and of carrying out solution-adaptive mesh refinement. The Euler and Navier-Stokes equations are solved on the resulting grids using a finite-volume formulation. The convective terms are upwinded: a gradient-limited, linear reconstruction of the primitive variables is performed, providing input states to an approximate Riemann solver for computing the fluxes between neighboring cells. The more robust of a series of viscous flux functions is used to provide the viscous fluxes at the cell interfaces. Adaptively-refined solutions of the Navier-Stokes equations using the Cartesian, cell-based approach are obtained and compared to theory, experiment, and other accepted computational results for a series of low and moderate Reynolds number flows. Author

N95-14418*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AXIS SWITCHING AND SPREADING OF AN ASYMMETRIC JET: ROLE OF VORTICITY DYNAMICS

K. B. M. Q. ZAMAN Nov. 1994 18 p Presented at the 33rd Aerospace Sciences Meeting and Exhibit, Reno, NV, 9-12 Jan. 1995; sponsored by AIAA

(Contract(s)/Grant(s): RTOP 505-62-52)

(NASA-TM-106385; E-9230; NAS 1.15:106385; AIAA PAPER 95-0889) Copyright Avail: CASI HC A03/MF A01

The effects of vortex generators and periodic excitation on vorticity dynamics and the phenomenon of axis switching in a free asymmetric jet are studied experimentally. Most of the data reported are for a 3:1 rectangular jet at a Reynolds number of 450,000 and a Mach number of 0.31. The vortex generators are in the form of 'delta tabs', triangular shaped protrusions into the flow, placed at the nozzle exit. With suitable placement of the tabs, axis switching could be either stopped or augmented. Two mechanisms are identified governing the phenomenon. One, as described by previous researchers and referred to here as the omega(sub theta)-induced dynamics, is due to difference in induced velocities for different segments of a rolled up azimuthal vortical structure. The other, omega(sub x)-induced dynamics, is due to the induced velocities of streamwise vortex pairs in the flow. Both dynamics can be active in a natural asymmetric jet; the tendency for axis switching caused by the omega(sub theta)-induced dynamics may be, depending on the streamwise vorticity distribution, either resisted or enhanced by the omega(sub x)-induced dynamics. While this simple framework qualitatively explains the various observations made on axis switching, mechanisms actually in play may be much more complex. The two dynamics are not independent as the flow field is replete with both azimuthal and streamwise vortical structures which continually interact. Phase averaged flow field data for a periodically forced case, over a volume of the flow field, are presented and discussed in an effort to gain insight into the dynamics of these vortical structures. Author

N95-14445# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.

MISSILE AERODYNAMICS [L'AERODYNAMIQUE DES MISSILES]

Jun. 1994 341 p Special course held in Rhode-Saint-Genese, Belgium, 6-10 Jun. 1994 and in Ankara, Turkey, 13-17 Jun. 1994; sponsored by AGARD and VKI

(AGARD-R-804; ISBN-92-835-0752-5) Copyright Avail: CASI HC A15/MF A03

Lecture notes for the AGARD Fluid Dynamics Panel (FDP) Special Course on 'Missile Aerodynamics' have been assembled in this report. The aim and scope of this course was to present the current state of the art on specific topics of tactical missile aerodynamics. Specifically, topics and methods covered include: Aeromechanical Design of Modern Missiles, Semi-empirical Predictive Tools, Lateral Jet Control, High Angle of Attack Aerodynamics, Analysis and Modelling of Missile Infrared Radiation, Navier-Stokes Computations for Complete Missile Configurations, and Navier-Stokes and Euler Computations for Supersonic Air Intakes. The material assembled in this report was prepared under the combined sponsorship of the AGARD Fluid Dynamics Panel, the Consultant and Exchange Program of AGARD, and the von Karman Institute (VKI) for Fluid Dynamics. For individual titles, see N95-14446 through N95-14452.

N95-14446# Deutsche Aerospace A.G., Munich (Germany). Missile Systems Div.

AEROMECHANICAL DESIGN OF MODERN MISSILES

P. HENNIG and P. G. LACAU *In* AGARD, Missile Aerodynamics 76 p Jun. 1994

Copyright Avail: CASI HC A05/MF A03

The changes in the political and strategic situation in the world, especially in Europe, result in new kinds of military scenarios and in different approaches to well-known scenarios. In combination with technological advances and with new mathematical and physical solutions for system component design and for improvements in system performance this leads to a request for advanced and new types of missiles with corresponding design goals and criteria. From such more general demands associated with the overall system design new requirements for the aerodynamical and aeromechanical design goals can be derived in correspondence. Advanced experimental and theoretical tools support the project aerodynamicist in coping with these new problems. Examples for the demands for new missile types and for the new system requirements are given. The most important aeromechanical work packages in the design procedure of modern missiles are identified and methods to get solutions sufficient for qualitative answers in early project phases are presented. Author

N95-14447# Naval Surface Warfare Center, Dahlgren, VA. Weapons Systems Dept.

ENGINEERING CODES FOR AEROPREDICTION: STATE-OF-THE-ART AND NEW METHODS

FRANK G. MOORE *In* AGARD, Missile Aerodynamics 82 p Jun. 1994

Copyright Avail: CASI HC A05/MF A03

This paper discusses the pros and cons of numerical, semiempirical, and empirical aeroprediction codes. It then summarizes many of the more popular approximate analytical methods used in state-of-the-art (SOTA) semiempirical aeroprediction codes. It also summarizes some recent new nonlinear semiempirical methods that allow more accurate calculation of static aerodynamics on complete missile configurations

to higher angles of attack. Results of static aerodynamic calculations on complete missile configurations compared to wind tunnel data are shown for several configurations at various flight conditions. Calculations show the new nonlinear methods being far superior to some of the former linear technology when used at angles of attack greater than about 15 degrees. Author

N95-14450# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
HIGH ANGLE OF ATTACK AERODYNAMICS
P. CHAMPIGNY *In* AGARD, Missile Aerodynamics 19 p Jun. 1994
Copyright Avail: CASI HC A03/MF A03

The demand for continually increased performance of missiles and aircraft leads to considering flight at very high angles of attack where control is very difficult. This is mainly due to the shedding of asymmetric vortices from the forebody, producing side forces even at zero sideslip. The purpose of this paper is not to make a review of missile aerodynamics at high angle of attack, but to focus on an understanding of the phenomena which give rise to asymmetric vortices, from an experimental as well as a theoretical point of view. Author

N95-14451# Army Research Lab., Aberdeen Proving Ground, MD. Propulsion and Flight Div.
NAVIER-STOKES PREDICTIONS OF MISSILE AERODYNAMICS
PAUL WEINACHT and JUBARAJ SAHU *In* AGARD, Missile Aerodynamics 48 p Jun. 1994
Copyright Avail: CASI HC A03/MF A03

This paper discusses the application of Navier-Stokes computational methods to the prediction of the aerodynamics of missile configurations. The governing equations, turbulence models, and numerical approaches used to solve these equations are briefly described. The paper focuses mainly on aerodynamic coefficient prediction. Static and dynamic aerodynamic derivative prediction methods and applications are presented for axisymmetric and finned bodies and comparisons are made with experimental data. Results of validation studies are also presented for the purpose of demonstrating the accuracy as well as potential shortcomings of these techniques. The paper also discusses the application of Navier-Stokes methods in the prediction of base flow. Application of these techniques to unpowered, base bleed, and powered configurations is shown. Author

N95-14452# *Aerospatiale, Verrieres-L-Buisson (France).*
COMPUTATION OF SUPERSONIC AIR-INTAKES
R. G. LACAU, P. GARNERO, and F. GAIBLE *In* AGARD, Missile Aerodynamics 21 p Jun. 1994
Copyright Avail: CASI HC A03/MF A03

The aim of this paper is to present how some CFD tools can be used to compute external and internal flowfields involved in the design of supersonic air-intakes. These tools help the designer to better understand flow phenomena, to determine favorable intake locations, and to predict air-intake performances such as pressure recovery and mass flow ratio. As supersonic intakes are mainly used on ramjet missiles, we limit this paper to ramjet air-intakes. After a brief overview of the existing types of air-intakes, we describe the way their performances are quantified. Then we present the CFD tools used to evaluate air-intake characteristics. Finally, selected applications of these tools demonstrate how a comprehensive study of air-intake may be achieved through CFD. Both external and internal flowfield computations are presented, which allows predictions of air-intake performances. Derived from text

N95-14612*# MCAT Inst., San Jose, CA.
NUMERICAL SIMULATION OF THE SOFIA FLOWFIELD Annual Report
STEPHEN P. KLOTZ Jul. 1994 75 p Original contains color illustrations
(Contract(s)/Grant(s): NCC2-636)
(NASA-CR-197025; NAS 1.26:197025) Avail: CASI HC A04/MF A01; 1 functional color page

This report provides a concise summary of the contribution of computational fluid dynamics (CFD) to the SOFIA (Stratospheric Observatory for Infrared Astronomy) project at NASA Ames and presents results obtained from closed- and open-cavity SOFIA simulations. The aircraft platform is a Boeing 747SP and these are the first SOFIA simulations run with the aircraft empennage included in the geometry database. In the open-cavity run the telescope is mounted behind the wings. Results suggest that the cavity markedly influences the mean pressure distribution on empennage surfaces and that 110-140 decibel (db) sound pressure levels are typical in the cavity and on the horizontal and vertical stabilizers. A strong source of sound was found to exist on the rim of the open telescope cavity. The presence of this source suggests that additional design work needs to be performed in order to minimize the sound emanating from that location. A fluid dynamic analysis of the engine plumes is also contained in this report. The analysis was part of an effort to quantify the degradation of telescope performance resulting from the proximity of the port engine exhaust plumes to the open telescope bay. Author

N95-14613*# MCAT Inst., San Jose, CA.
CONTROL OF UNSTEADY SEPARATED FLOW ASSOCIATED WITH THE DYNAMIC STALL OF AIRFOILS Annual Report
M. C. WILDER 31 Jul. 1994 69 p Original contains color illustrations
(Contract(s)/Grant(s): NCC2-637)
(NASA-CR-197024; NAS 1.26:197024; MCAT-94-20) Avail: CASI HC A04/MF A01; 1 functional color page

A unique active flow-control device is proposed for the control of unsteady separated flow associated with the dynamic stall of airfoils. The device is an adaptive-geometry leading-edge which will allow controlled, dynamic modification of the leading-edge profile of an airfoil while the airfoil is executing an angle-of-attack pitch-up maneuver. A carbon-fiber composite skin has been bench tested, and a wind tunnel model is under construction. A baseline parameter study of compressible dynamic stall was performed for flow over an NACA 0012 airfoil. Parameters included Mach number, pitch rate, pitch history, and boundary layer tripping. Dynamic stall data were recorded via point-diffraction interferometry and the interferograms were analyzed with in-house developed image processing software. A new high-speed phase-locked photographic image recording system was developed for real-time documentation of dynamic stall. Author

N95-14614*# MCAT Inst., San Jose, CA.
NUMERICAL SIMULATION OF THE FLOW ABOUT THE F-18 HARV AT HIGH ANGLE OF ATTACK Annual Report
SCOTT M. MURMAN Aug. 1994 7 p Original contains color illustrations
(Contract(s)/Grant(s): NCC2-729)
(NASA-CR-197023; NAS 1.26:197023; MCAT-94-11) Avail: CASI HC A02/MF A01; 2 functional color pages

As part of NASA's High Alpha Technology Program, research has been aimed at developing and extending numerical methods to accurately predict the high Reynolds number flow about the NASA F-18 High Alpha Research Vehicle (HARV) at large angles of attack. The HARV aircraft is equipped with a bidirectional thrust vectoring unit which enables stable, controlled flight through 70 deg angle of attack. Currently, high-fidelity numerical solutions for the flow about the HARV have been obtained at alpha = 30 deg, and validated against flight-test data. It is planned to simulate the flow about the HARV through alpha = 60 deg, and obtain solutions of the same quality as those at the lower angles of attack. This report presents the status of work aimed at extending the HARV computations to the extreme angle of attack range. Derived from text

N95-14646# Kossel (Horst), Shrewsbury, MA.
ACTIVATED BUOYANCY PROPULSION = PARADOX POWER (TM)
HORST KOSSEL *In* Huntsville Association of Technical Societies, TABES 1994: 10th Annual Technical and Business Exhibition and

Symposium 7 p 1994
(TABES PAPER 94-619) Avail: CASI HC A02/MF A04

The PARADOX POWER(tm) concept recognizes molecular activity/heat of all fluids as an unlimited source of clean kinetic energy, accessible to do 'work' within the lower atmosphere and open water. By expending minimal energy to selectively subtract from the molecular impulse (pressure) on a surface of a macroscopic body, acceleration is provided by momentum transfer to the normal (opposite) surface, directly by ambient pressure. Energy from a separate source is used to increase the parallel velocity of microscopic size particles, within the invisible Attached Ionized Boundary Layer (U.S. Pat. Appl. No. 106,867). Controllable, super efficient vehicle operation results, doubling microscopic oscillation velocity increases the atmospheric propulsive force four times; deceleration functions similarly. Molecular oscillation by rapidly reversing alternating current, causing an imbalance, provides clean, quiet, controlled 'buoyancy' propulsion. Author

N95-14803*# Georgia Inst. of Tech., Atlanta, GA. School of Aerospace Engineering.
NUMERICAL STUDY OF THE EFFECTS OF ICING ON VISCOUS FLOW OVER WINGS Final Report
L. N. SANKAR Oct. 1994 156 p
(Contract(s)/Grant(s): NAG3-768)
(NASA-CR-197102; NAS 1.26:197102) Avail: CASI HC A08/MF A02

An improved hybrid method for computing unsteady compressible viscous flows is presented. This method divides the computational domain into two zones. In the outer zone, the unsteady full-potential equation (FPE) is solved. In the inner zone, the Navier-Stokes equations are solved using a diagonal form of an alternating-direction implicit (ADI) approximate factorization procedure. The two zones are tightly coupled so that steady and unsteady flows may be efficiently solved. Characteristic-based viscous/inviscid interface boundary conditions are employed to avoid spurious reflections at that interface. The resulting CPU times are less than 60 percent of that required for a full-blown Navier-Stokes analysis for steady flow applications and about 60 percent of the Navier-Stokes CPU times for unsteady flows in non-vector processing machines. Applications of the method are presented for a rectangular NACA 0012 wing in low subsonic steady flow at moderate and high angles of attack, and for an F-5 wing in steady and unsteady subsonic and transonic flows. Steady surface pressures are in very good agreement with experimental data and are essentially identical to Navier-Stokes predictions. Density contours show that shocks cross the viscous/inviscid interface smoothly, so that the accuracy of full Navier-Stokes equations can be retained with a significant savings in computational time. Author

N95-14878*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH-SPEED RESEARCH: 1994 SONIC BOOM WORKSHOP: ATMOSPHERIC PROPAGATION AND ACCEPTABILITY STUDIES
DAVID A. MCCURDY, ed. Oct. 1994 222 p The 3rd workshop was held in Hampton, VA, 1-3 Jun. 1994
(Contract(s)/Grant(s): RTOP 537-03-21-03)
(NASA-CP-3279; L-17434; NAS 1.55:3279) Avail: CASI HC A10/MF A03

The workshop proceedings include papers on atmospheric propagation and acceptability studies. Papers discussing atmospheric effects on the sonic boom waveform addressed several issues. It has long been assumed that the effects of molecular relaxation are adequately accounted for by assuming that a steady state balance between absorption and nonlinear wave steepening exists. It was shown that the unsteadiness induced by the nonuniform atmosphere precludes attaining this steady state. Further, it was shown that the random atmosphere acts as a filter, effectively filtering out high frequency components of the distorted waveform. Several different propagation models were compared, and an analysis of the sonic boom at the edge of the primary carpet established that the levels there are bounded. Finally, a discussion of the levels of the sonic boom below the sea surface was presented. For individual titles, see N95-14879 through N95-14892.

N95-14880*# Texas Univ., Austin, TX. Dept. of Mechanical Engineering.
EFFECT OF STRATIFICATION AND GEOMETRICAL SPREADING ON SONIC BOOM RISE TIME
ROBIN O. CLEVELAND, MARK F. HAMILTON, and DAVID T. BLACKSTOCK *In* NASA. Langley Research Center, High-Speed Research: 1994 Sonic Boom Workshop: Atmospheric Propagation and Acceptability Studies p 19-38 Oct. 1994
Avail: CASI HC A03/MF A03

The purpose of our investigation is to determine the effect of unsteadiness (not associated with turbulence) on rise time. The unsteadiness considered here is due to (1) geometrical spreading, (2) stratification, which includes variation in density, temperature, and relative humidity, and (3) N shaped waveform. A very general Burgers equation, which includes all these effects, is the propagation model for our study. The equation is solved by a new computational algorithm in which all the calculations are done in the time domain. The present paper is a progress report in which some of the factors contributing to unsteadiness are studied, namely geometrical spreading and variation in relative humidity. The work of Pierce and Kang, which motivated our study, is first reviewed. We proceed with a discussion of the Burgers equation model and the algorithm for solving the equation. Some comparison tests to establish the validity of the algorithm are presented. The algorithm is then used to determine the distance required for a steady-state shock, on encountering an abrupt change in relative humidity, to reach a new steady state based on the new humidity. It is found that the transition distance for plane shocks of amplitude 70 Pa is about 4 km when the change in relative humidity is 10 percent. Shocks of amplitude 140 Pa require less distance. The effect of spherical and cylindrical spreading is also considered. We demonstrate that a spreading shock wave never reaches steady state and that its rise time will be less than the equivalent steady state shock. Finally we show that an N wave has a slightly shorter rise time than a step shock of the same amplitude. Author

N95-14894# Pennsylvania State Univ., University Park, PA. Dept. of Aerospace Engineering.
WAKE TURBULENCE
BARNES W. MCCORMICK *In* AGARD, Flight in an Adverse Environment 15 p Nov. 1994
Copyright Avail: CASI HC A03/MF A02

Wake turbulence is a misnomer. Turbulence implies a random process whereas the term 'wake turbulence' refers to the hazard posed to smaller airplanes by the ordered, rotational flow in the trailing vortex systems behind larger airplanes. This lecture begins by examining the relationship of aircraft size, geometry and operating conditions to the strength of an aircraft's trailing vortex system. Next, the velocity field initially induced close behind the generating airplane by its trailing vortex system is defined. This is followed by a discussion of the various ways in which a vortex system can dissipate and the many factors which affect the dissipation. In particular, the effects of atmospheric turbulence, ground proximity and vortex bursting on the ensuing behavior of the vortex system are considered. The paper continues with a study of the dynamics of an aircraft encountering the wake of a larger airplane. The degree to which an aircraft is threatened by a given vortex system of known characteristics is analyzed and the hazard posed by a given vortex system to a following aircraft quantified. Finally, the paper concludes with recommendations on possible ways to alleviate the safety and operational problems associated with wake turbulence. Author

N95-15319# Naval Postgraduate School, Monterey, CA.
LOW-SPEED WIND TUNNEL TESTING OF THE NPS AND NASA AMES MACH 6 OPTIMIZED WAVERIDER M.S. Thesis
MARK E. CEDRUN 16 Jun. 1994 106 p
(AD-A283585) Avail: CASI HC A06/MF A02

Low-speed wind tunnel tests were conducted to determine the subsonic aerodynamic characteristics of an optimized supersonic (Mach 6) conical-flow waverider designed for a deck-launched intercept mission. These tests are part of the continuing waverider research being conducted by the Naval Postgraduate School and the NASA Ames Research Center. The tests consisted of performing Alpha and Beta sweeps, at different dynamic pressures, with a 15 inch aluminum waverider model in the NPS low-speed wind tunnel. Force and moment data were then collected using a six-degree-of-freedom sting balance. Coefficients of lift, drag and pitch were calculated from the data and compared to theory and existing waverider subsonic aerodynamic performance data. Flow visualization using tufts was also done. The results of the experiments show that waverider exhibits high lift characteristics at positive angles of attack. The design also compares favorably with both subsonic thin airfoil theory and the results of the delta wing and subsonic waverider analysis done by Vanhoy. However, flow visualization showed that vortex bursting occurred at a dynamic pressure of 12.11bf at +/-15 degrees angle of attack. Based upon the data collected in this analysis, the development of an actual waverider aircraft using the NPS/NASA Ames waverider design as a baseline is a plausible endeavor. DTIC

N95-15465 Wright Lab., Wright-Patterson AFB, OH.
PRESSURE MEASUREMENTS ON AN F/A-18 TWIN VERTICAL TAIL IN BUFFETING FLOW. VOLUME 2: STEADY AND UNSTEADY RMS PRESSURE DATA Final Report
CHRIS PETTIT, DANSEN BROWN, MICHAEL BANFORD, and ED PENDLETON 1 Aug. 1994 383 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A281581; WL-TM-94-3065-VOL-2) Avail: CASI HC A17

Buffeting pressure measurements were made on the vertical tail surface of a full scale F/A-18 aircraft model in the National Full Scale Aerodynamics Complex at NASA Ames Research Center. Test variables included aircraft angle-of-attack, aircraft sideslip angle, and dynamic pressure. Accelerometers were used to obtain vertical tail accelerations. Pressure transducers were mounted on the starboard vertical tail. Steady and unsteady pressures were obtained. Unsteady pressure data were reduced to PSD and CSD forms. Both steady and unsteady RMS pressure coefficients are also presented. Volume 1 contains the general description of the model, the test program, and highlights of the reduced data. Volume 2 contains steady and unsteady RMS data. Volume 3 contains unsteady PSD results. Volume 4 contains unsteady CSD results. DTIC

N95-15762*# California Polytechnic State Univ., San Luis Obispo, CA. Dept. of Aeronautical Engineering.
NUMERICAL DESIGN OF ADVANCED MULTI-ELEMENT AIRFOILS Final Report
DONOVAN L. MATHIAS and RUSSELL M. CUMMINGS Oct. 1994 105 p
(Contract(s)/Grant(s): NCC2-813)
(NASA-CR-197135; NAS 1.26:197135) Avail: CASI HC A06/MF A02

The current study extends the application of computational fluid dynamics to three-dimensional high-lift systems. Structured, overset grids are used in conjunction with an incompressible Navier-Stokes flow solver to investigate flow over a two-element high-lift configuration. The computations were run in a fully turbulent mode using the one-equation Baldwin-Barth turbulence model. The geometry consisted of an unswept wing which spanned a wind tunnel test section. Flows over full and half-span Fowler flap configurations were computed. Grid resolution issues were investigated in two dimensional studies of the flapped airfoil. Results of the full-span flap wing agreed well with experimental data and verified the method. Flow over the wing with the half-span was computed to investigate the details of the flow at the free edge of the flap. The results illustrated changes in flow streamlines, separation locations, and surface pressures due to the vortex shed from the flap edge. Author

N95-15852*# NYMA, Inc., Brook Park, OH. Engineering Services Div.
RESONANT INTERACTION OF A LINEAR ARRAY OF SUPERSONIC RECTANGULAR JETS: AN EXPERIMENTAL STUDY Final Report
GANESH RAMAN and RAY TAGHAVI Cleveland, OH NASA Nov. 1994 25 p Presented at the 33rd Aerospace Sciences Meeting and Exhibit, 9-12 Jan. 1994; sponsored by the AIAA
(Contract(s)/Grant(s): NAS3-27186; RTOP 537-02-22)
(NASA-CR-195398; E-9128; NAS 1.26:195398) Copyright Avail: CASI HC A03/MF A01

This paper examines a supersonic multi jet interaction problem that we believe is likely to be important for mixing enhancement and noise reduction in supersonic mixer-ejector nozzles. We demonstrate that it is possible to synchronize the screech instability of four rectangular jets by precisely adjusting the inter jet spacing. Our experimental data agrees with a theory that assumes that the phase-locking of adjacent jets occurs through a coupling at the jet lip. Although the synchronization does not change the frequency of the screech tone, its amplitude is augmented by 10 dB. The synchronized multi jets exhibit higher spreading than the unsynchronized jets, with the single jet spreading the least. We compare the nearfield noise of the four jets with synchronized screech to the noise of the sum of four jets operated individually. Our noise measurements reveal that the more rapid mixing of the synchronized multi jets causes the peak jet noise source to move up stream and to radiate noise at larger angles to the flow direction. Based on our results, we believe that screech synchronization is advantageous for noise reduction internal to a mixer-ejector nozzle, since the noise can now be suppressed by a shorter acoustically lined ejector. Author

N95-15853*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN APPROACH FOR DYNAMIC GRIDS
JOHN W. SLATER, MENG-SING LIOU, and RICHARD G. HINDMAN Nov. 1994 11 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by the AIAA
(Contract(s)/Grant(s): NGT-50441; RTOP 505-62-52)
(NASA-TM-106774; E-9124-1; NAS 1.15:106774; AIAA PAPER 94-0319) Avail: CASI HC A03/MF A01

An approach is presented for the generation of two-dimensional, structured, dynamic grids. The grid motion may be due to the motion of the boundaries of the computational domain or to the adaptation of the grid to the transient, physical solution. A time-dependent grid is computed through the time integration of the grid speeds which are computed from a system of grid speed equations. The grid speed equations are derived from the time-differentiation of the grid equations so as to ensure that the dynamic grid maintains the desired qualities of the static grid. The grid equations are the Euler-Lagrange equations derived from a variational statement for the grid. The dynamic grid method is demonstrated for a model problem involving boundary motion, an inviscid flow in a converging-diverging nozzle during startup, and a viscous flow over a flat plate with an impinging shock wave. It is shown that the approach is more accurate for transient flows than an approach in which the grid speeds are computed using a finite difference with respect to time of the grid. However, the approach requires significantly more computational effort. Author

N95-15912*# Toledo Univ., OH.
ENHANCED CAPABILITIES AND UPDATED USERS MANUAL FOR AXIAL-FLOW TURBINE PRELIMINARY SIZING CODE TURBAN Final Report
ARTHUR J. GLASSMAN Nov. 1994 18 p
(Contract(s)/Grant(s): NAG3-1165; RTOP 505-69-50)
(NASA-CR-195405; E-9252; NAS 1.26:195405) Avail: CASI HC A03/MF A01

Several modifications have been made to the axial-flow turbine preliminary sizing code TURBAN. Turbine cooling has been added to the analysis. New alternative input options allow direct specification of

stage reaction, stage work factor, and stage work split. The Reynolds number loss dependency was modified and an internal calculation of air viscosity was added. A complete description of input and output along with sample cases are included. Author

03
AIR TRANSPORTATION AND SAFETY

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

A95-61733
CERAMIC BLANKET REDUCES MAINTENANCE COSTS
Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 9 September 1993 p. 11-12
(BTN-94-EIX94461290278) Copyright

In 1981, removable fire shield blankets were developed. The blanket is attached on the reverser 'hot side' to provide fire protection and prevent thermal stress, in compliance with FAA regulations. These ceramic blankets are still in use, and their application has expanded. The blanket reduces maintenance costs. EI

N95-14179# National Inst. of Standards and Technology, Gaithersburg, MD. Building and Fire Research Lab.
RISK ANALYSIS FOR THE FIRE SAFETY OF AIRLINE PASSENGERS
R. L. SMITH Jun. 1994 40 p
(Contract(s)/Grant(s): DTFA03-92-Z-00018)
(PB94-194065; NISTIR-5441) Avail: CASI HC A03/MF A01

The purpose of this report is to describe the National Institute of Standards and Technology's work to date relating to the general methodology being developed for the project Risk Analysis for the Fire Safety of Airline Passengers and the software being used to facilitate this methodology. The approach selected involved the use of influence diagrams. Therefore, a brief discussion of influence diagrams is given. The status of their application to the water mist system for passenger planes is given and the overall approach to carrying out the project is described. An example is included that shows how the process works, but the case is fictional, not intended to be realistic. NTIS

N95-14199# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
THE PRINCIPLES OF FLIGHT TEST ASSESSMENT OF FLIGHT-SAFETY-CRITICAL SYSTEMS IN HELICOPTERS [LES PRINCIPES DE L'EVALUATION, DANS LE CADRE DES ESSAIS EN VOL, DES SYSTEMES INDISPENSABLES A LA SECURITE DE VOL DES HELICOPTERES]
J. D. L. GREGORY Aug. 1994 29 p Flight Test Techniques Series
(AGARD-AG-300-VOL-12; ISBN-92-836-1001-6) Copyright Avail: CASI HC A03/MF A01

Modern helicopters usually incorporate many engineering systems (including pilot-aiding systems such as autostabilizers and flight directors) which are essential to the safe and effective use of the helicopter. Where the helicopter can be endangered by failure of a system (or of one of its units), that system is termed flight-safety-critical. In general, the use of those systems should not incur a higher probability of hazard to the helicopter than that considered acceptable from considerations of structural or mechanical failure. In assessing the suitability of a helicopter for its intended mission(s), it has become increasingly important to consider the effects of the various systems provided. In particular, assessments of the implications of systems performance and failures derived from calculation and ground test should be validated by flight tests. This paper seeks to establish the general principles applicable to the testing in flight of any flight-safety-critical system, with emphasis on certification rather than system development. It does not deal with the testing of particular systems, but it is hoped that readers will find the principles described readily applicable to specific cases. This document has been sponsored by the Flight Mechanics Panel of AGARD. Author (revised)

N95-14350# Federal Aviation Administration, Atlantic City, NJ.
PROCEEDINGS OF THE FAA INSPECTION PROGRAM AREA REVIEW Final Report
CHRISTOPHER SMITH Jul. 1994 922 p Review held in Ames, IA, 5-7 Apr. 1994
(AD-A283849; DOT/FAA/CT-94/64) Avail: CASI HC A99/MF A10

This publication is a compendium of the Proceedings, of the FAA Inspection Program Are Review Presentations given at the Center for Aviation Systems Reliability held at Iowa State University at Ames, Iowa on April 5-7, 1994. DTIC

N95-14893# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Vehicle Integration Panel.
FLIGHT IN AN ADVERSE ENVIRONMENT [LE VOL EN ENVIRONNEMENT HOSTILE]
Nov. 1994 161 p Lecture series held in Brunswick, Germany, 7-8 Nov. 1994, in Lisbon, Portugal, 10-11 Nov. 1994, and in Atlantic City, NJ, 15-16 Nov. 1994
(AGARD-LS-197; ISBN-92-836-1006-7) Copyright Avail: CASI HC A08/MF A02

The environment in which an airplane must operate is a major cause of aircraft accidents. This lecture series focuses on specific aspects of the environment, both natural and man-made, which are the major contributors to these accidents as follows: (1) wake turbulence and the generation of trailing vortex systems; (2) the results of an extensive flight test program concerning winter storms off the east coast of Canada including effect on aircraft operations; (3) electromagnetic effects including electrical discharge properties, in-flight test program, in-flight lightning models and lightning simulation techniques; (4) response of an aircraft to wind shear and methods of detection and quantifying this natural hazard; (5) heavy rain effects on aircraft systems performances in the light of full scale and model tests; (6) measurements of atmospheric turbulence, treatment of aircraft response to random turbulence and discrete gusts. For individual titles, see N95-14894 through N95-14900.

N95-14897*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ICING: ACCRETION, DETECTION, PROTECTION
JOHN J. REINMANN *In* AGARD, Flight in an Adverse Environment 27 p Nov. 1994
Copyright Avail: CASI HC A03/MF A02

The global aircraft industry and its regulatory agencies are currently involved in three major icing efforts: ground icing; advanced technologies for in-flight icing; and tailplane icing. These three major icing topics correspondingly support the three major segments of any aircraft flight profile: takeoff; cruise and hold; and approach and land. This lecture addressess these three topics in the same sequence as they appear in flight, starting with ground deicing, followed by advanced technologies for in-flight ice protection, and ending with tailplane icing. Derived from text

N95-14898# Woodfield (Alan A.), Bedford (England).
WIND SHEAR AND ITS EFFECTS ON AIRCRAFT
ALAN A. WOODFIELD *In* AGARD, Flight in an Adverse Environment 31 p Nov. 1994
Copyright Avail: CASI HC A03/MF A02

Wind shear has been responsible for several major accidents and many incidents during landing and take off. In aviation terms, wind changes that cause flight path deviations (wind shear) are mainly those occurring over distances between about 150 and 3000m, i.e. approximately 3 to 40 sec. at approach speeds. General characteristics of

many forms of wind shear are described together with measured data on the probability of meeting headwind shears of different magnitudes. This is followed by analysis of the basic response of aircraft to both horizontal wind changes and downdrafts, and discussion of aircraft sensitivity to wind shear. Several recorded examples of wind shear in both normal operational and accident scenarios are presented. The relevance of different ways of quantifying wind shear severity is examined, including a calculation of height loss that can be used when a wind shear is fully defined, and the 'F' factor, which is used with reactive wind shear measuring systems. Some insight into the probabilities of false or missed warnings with each system is derived using the measured probability data. A brief outline is given of the relevant characteristics of different wind shear prediction and detection systems. The lecture concludes with a study of the ways in which pilots can be trained and assisted to survive most wind shear encounters and, hopefully, avoid those which could be catastrophic. It is concluded that, given appropriate training and aircraft systems, it is possible to survive encounters with nearly all those wind shears that caused fatal accidents in previous years. New predictive detection systems offer the possibility to warn an aircraft before it attempts to penetrate those extremely rare wind shears that are beyond its performance capability. Author

N95-14899*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HEAVY RAIN EFFECTS
R. EARL DUNHAM, JR. *In* AGARD, Flight in an Adverse Environment 17 p Nov. 1994
Copyright Avail: CASI HC A03/MF A02

This paper summarizes the current state of knowledge of the effect of heavy rain on airplane performance. Although the effects of heavy rain on airplane systems and engines are generally known, only *recently has the potential aerodynamic effect of heavy rain been* recognized. In 1977 the United States Federal Aviation Administration (FAA) conducted a study of 25 aircraft accidents and incidents which *occurred between 1964 and 1976 in which low-altitude wind shear could* have been a contributing factor. Of the 25 cases (23 approach or landing and 2 take-off) in the study, ten cases had occurred in a rain environment, and in five cases these were classified as intense or heavy rain encounters. These results led to the reconsideration of high-intensity, short-duration rainfall as a potential weather-related aircraft safety *hazard, particularly in the take-off and/or approach phases of flight.* Author

N95-14916# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: OVERSPEED AND LOSS OF POWER ON BOTH ENGINES DURING DESCENT AND POWER-OFF EMERGENCY, LANDING SIMMONS AIRLINES, INC., D/B/A, AMERICAN EAGLE FLIGHT 3641, N349SB FALSE RIVER AIR PARK, NEW ROADS, LOUSIANA, 1 FEBRUARY 1994
27 Sep. 1994 80 p
Avail: CASI HC A05/MF A01

This report explains the emergency landing of American Eagle flight 3641, a Saab 340B airplane, at False River Air Park, New Roads, Louisiana, on February 1, 1994. The safety issues in the report focused on the safety hazards involved with the inflight operation of propellers in the beta mode in airplanes for which such operation is prohibited. The Safety Board reiterated Safety Recommendation A-94-62, which is intended to prevent the in-flight beta operation unless the airplane is certified for such use. Author

N95-15066# National Transportation Safety Board, Washington, DC.
ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA: US AIR CARRIER OPERATIONS, CALENDAR YEAR 1992
15 Sep. 1994 72 p
Avail: CASI HC A04/MF A01

This publication presents the record of aviation accidents involving revenue operations of U.S. Air Carriers including Commuter Air Carriers and On Demand Air Taxis for calendar year 1992. The report is divided into three major sections according to the federal regulations under which the flight was conducted - 14 CFR 121, Scheduled 14 CFR 135, or Nonscheduled 14 CFR 135. In each section of the report tables are presented to describe the losses and characteristics of 1992 accidents to enable comparison with prior years. Author

N95-15439 Midwest Research Inst., Kansas City, MO.
DEVELOPMENT OF ANTI-ICING TECHNOLOGY
R. R. BLACKBURN, E. J. MCGRANE, C. C. CHAPPELOW, D. W. HARWOOD, and E. J. FLEEGE Apr. 1994 497 p See also PB253268, PB271250, PB88-233705 and PB88-233713 Prepared in cooperation with Minnesota Dept. of Transportation, Duluth, MN
(Contract(s)/Grant(s): DOT-SHRP-H-208A)
(PB94-195369; SHRP-H-385; ISBN-0-309-05761-2) Copyright Avail: Issuing Activity

Scandinavian and other European countries have shown that applying a chemical freezing-point depressant on a highway pavement prior to, or very quickly after, the start of frozen participation minimizes the formation of an ice-pavement bond. Nine state highway agencies conducted anti-icing experiments when possible during the 1991-92 and 1992-93 winters. These tests were used to develop a better understanding of both the conditions under which anti-icing will be effective and how to conduct anti-icing efficiently to ensure the greatest success. Prewetted salt and liquid chemicals were used during the anti-icing experiments. The project also involved evaluating specialized equipment for applying controlled quantities of solid, prewetted or liquid chemicals at minimum application rates required for effective anti-icing treatment. NTIS

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A95-61739
EVOLUTION OF A NOSE-WHEEL STEERING SYSTEM
CHARLES A. SMITH Vickers, Inc., Los Angeles, CA Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 6 June 1993 p. 23-25
(BTN-94-EIX94461047056) Copyright

A digital nose-wheel steering system is used to control the McDonnell Douglas T-45 aircraft during takeoff and landing as well as low-speed taxiing and parking. Author (EI)

A95-61740
ELECTRORHEOLOGICALLY CONTROLLED LANDING GEAR
ZHENG LOU, ROBERT D. ERVIN, FRANK E. FILISKO, and CHRISTOPHER B. WINKLER Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 6 June 1993 p. 17-22
(BTN-94-EIX94461047055) Copyright

When using an electrorheological (ER) fluid with a yield stress of 7 kPa, the energy absorption efficiency of an ER-controlled landing gear can reach almost 100% at various sink rates. Author (EI)

A95-62633
THE EFFECT OF ROTATING LOADS SUSPENDED UNDER A HELICOPTER ON THEIR AMPLITUDE-FREQUENCY CHARACTERISTICS
B. F. TYURIN Akademiya GA, Saint Peterburg (Russia), S. V. SIPAROV, E. S. STELMAKOV, and K. A. NOVOZHILOV Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 81-84 In RUSSIAN

(BTN-94-EIX94461407959) Copyright

The twisting of a load on the outer suspension of a helicopter is regarded as a way to provide its transportation stability during the flight. Basic physics of the load stabilization is discussed. The experimental research results have been presented to determine amplitude-frequency characteristics and aerodynamic coefficients of rotating loads. The loads have the form of a parallelepiped and a ring cylinder. Three factors affect the stabilization of a rotating load. They are: the gyroscopic effect, symmetrization of the load shape, and mismatch in oscillation frequencies. EI

N95-13703*# Universities Space Research Association, Columbia, MD.

VIPER

L. E. PAUL GILBERT, CASSIE BERRY, DANA LAMBORN, JACK MURPHY, and CHRIS OKELLY 8 Dec. 1993 19 p

(Contract(s)/Grant(s): NASW-4435)

(NASA-CR-197191; NAS 1.26:197191; F93-2B-0R15) Avail: CASI HC A03/MF A01

A Viper aircraft was redesigned with a new airfoil and engine to verify if improvements can be made to the baseline configuration. The two major redesigning processes were: replacing the baseline aircraft's NACA 652-415 airfoil with an NLF 0414 Natural Laminar Flow airfoil, and the baseline aircraft's Lycoming 0-235 engine with a Teledyne Continental GR-36 rotary combustion engine. As a result of these changes: (1) the Viper aircraft becomes smaller in most respects (gross weight, wing platform area, and horizontal tail area); (2) overall drag of the aircraft decreased (due to reduction in area and the reduced drug of the new airfoil); (3) cruise velocity, the maximum rate of climb at sea level, and takeoff distance (but not landing distance) decreased; and (4) cost increased. Although the overall drag decreased, the performance remained about the same due to the reduced horsepower available from the Teledyne Continental engine. CASI

N95-13981 Federal Aviation Administration, Kansas City, MO. Aircraft Certification Service.

FATIGUE EVALUATION OF EMPENNAGE, FORWARD WING, AND WINGLETS/TIP FINS ON PART 23 AIRPLANES Final Technical Report

15 Feb. 1994 64 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(PB94-196813; FAA/ACE-100-01) Avail: Issuing Activity (National Technical Information Service (NTIS))

This report provides technical guidance for complying with the fatigue evaluation requirements of Part 23 (small and commuter category airplanes) of the Federal Aviation Regulations, Section 23.572, pertaining to empennage, forward wing, and winglets/tip fins. Detailed procedures are described for developing empennage repeated loads using published airplane center-of-gravity normal acceleration spectra in conjunction with basic airplane data. An alternate approach that eliminates calculating applied loads uses empirically derived stress equations from measured flight strain survey data, coupled with the airplane center-of-gravity normal acceleration spectra and proposed airplane usage data. NTIS

N95-14102# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.

IDENTIFICATION OF DYNAMIC SYSTEMS. VOLUME 3: APPLICATIONS TO AIRCRAFT. PART 2: NONLINEAR ANALYSIS AND MANOEUVRE DESIGN [L'IDENTIFICATION DES SYSTEMES DYNAMIQUES: APPLICATIONS AUX AERONEFS. TITRE 2: L'ANALYSE NON-LINEAIRE ET LA CONCEPTION DE LA MANOEUVRE]

J. A. MULDER (Technische Univ., Delft, Netherlands.), J. K. SRIDHAR (Technische Univ., Delft, Netherlands.), and J. H. BREEMAN (National Aerospace Lab., Amsterdam, Netherlands.) May 1994 213 p Flight Test Techniques Series

(AGARD-AG-300-VOL-3-PT-2; ISBN-92-835-0748-7) Copyright Avail: CASI HC A10/MF A03

This AGARDograph is a sequel to the previous AGARDographs published in the AGARD Flight Test Techniques Series, Volume 2 on 'Identification of Dynamic Systems' and Volume 3 on 'Identification of Dynamic Systems - Applications to Aircraft - Part 1: The Output Error Approach' both written by R.E. Maine and K.W. Iliff. The intention of the present document is to cover some of those areas which were either absent or only briefly mentioned in those volumes. These areas are Flight Path Reconstruction, Nonlinear Model Identification, Optimal Input Design and Flight Test Instrumentation. The present approach to identification is rather different from that presented in the earlier AGARDographs in the sense that the identification problem is decomposed into a state estimation and a parameter identification part. This approach is referred to as the Two-Step Method (TSM), although one will find other names like Estimation Before Modelling (EBM) in the literature. It will be shown in the present AGARDograph that this approach has significant practical advantages over methods which no attempt is made to decompose the joint parameter-state estimation problem. The two-step method is generally applicable to flight vehicles such as fixed wing aircraft and rotorcraft which are equipped with state of the art inertial reference systems. The theoretical developments in the present AGARDograph will be illustrated with examples of a flight test program with the De Havilland DHC-2 Beaver aircraft, the experimental aircraft of the Delft University of Technology which has been used for almost two decades to test new ideas in the science of aircraft parameter identification. Author

N95-14205# Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.

ADD A DIMENSION TO YOUR ANALYSIS OF THE HELICOPTER LOW AIRSPEED ENVIRONMENT

HERMAN KOLWEY 1994 30 p

(AD-A283982) Avail: CASI HC A03/MF A01

We have long strived to better define the low airspeed relative wind limits of the helicopter and also to define the helicopter performance in a 3-dimensional (3-D) format. These concepts were first presented in an AHS paper in 1977 also published as NAVAIRTESTCEN Technical Memorandum TM 77-2 RW of 29 April 1977. Recent analysis of the low airspeed environment for purposes of defining deficiencies and evaluating an Unanticipated Right Yaw (URY) or Loss of Tail Rotor Effectiveness (LTE) problem have developed a new method of reducing and presenting critical azimuth test data. A new method of reducing test data was presented to the Society of Flight Test Engineers in a 1992 paper and involved the automatic handling of test data along with including the oscillatory component of the trim point. In our opinion, presentation formats were more logical than the classical methods of presentation of critical azimuth data, but they were still presented in a 2-dimensional (2-D) format. Dispersion data on the plot gave indications of the third dimension of workload as has been presented by the Army in their reports, but still on a 2-D plot. The location of interference effects could be determined by looking at six or seven 2-D plots of the type presented in the prior paper. DTIC

N95-14306# Loral Systems, Inc., Orlando, FL. Adst Program Office.

ADVANCED DISTRIBUTED SIMULATION TECHNOLOGY ADVANCED ROTARY WING AIRCRAFT. STUDY COMPARING APPROACHES TO MODELING THE ARWA MAIN ROTOR

ROGER BRANSON 18 Mar. 1994 19 p

(Contract(s)/Grant(s): N61339-91-D-0001)

(AD-A280824; ADST/TR-94-003280) Avail: CASI HC A03/MF A01

The Advanced Distributed Simulation Technology (ADST) Advanced Rotary Wing Aircraft (ARWA) study comparing approaches to modeling the ARWA main rotor provides details of technical approaches for both a blade element model and a rotor disk model to simulate the flying qualities of the ARWA simulation system. A background of aeromodeling and discussion of the technical and cost merits for both approaches is provided. DTIC

N95-14469*# Rockwell International Corp., El Segundo, CA.
EXTRACTING A REPRESENTATIVE LOADING SPECTRUM FROM RECORDED FLIGHT DATA
ANTHONY G. DENYER *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 225-240 Sep. 1994
Avail: CASI HC A03/MF A04

One of the more important ingredients when computing the life of a structure is the loading environment. This paper describes the development of an aircraft loading spectrum that closely matches the service experience, thus allowing a more accurate assessment of the structural life. The paper outlines the flight loads data collection system, the procedures developed to compile and interpret the service records and the techniques used to define a spectrum suitable for structural life analysis. The areas where the procedures were tailored to suit the special situation of the USAF B-1B bomber are also discussed. The results of the methodology verification, achieved by comparing the generated spectra with the results of strain gage monitoring during service operations, are also presented. Author

N95-14481*# Aeronautical Systems Div., Wright-Patterson AFB, OH.
CHALLENGES FOR THE AIRCRAFT STRUCTURAL INTEGRITY PROGRAM
JOHN W. LINCOLN *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 409-423 Sep. 1994
Avail: CASI HC A03/MF A04

Thirty-six years ago the United States Air Force established the USAF Aircraft Structural Integrity Program (ASIP) because flight safety had been degraded by fatigue failures of operational aircraft. This initial program evolved, but has been stable since the issuance of MIL-STD-1530A in 1975. Today, the program faces new challenges because of a need to maintain aircraft longer in an environment of reduced funding levels. Also, there is increased pressure to reduce cost of the acquisition of new aircraft. It is the purpose of this paper to discuss the challenges for the ASIP and identify the changes in the program that wil meet these challenges in the future. Author

N95-14486*# Academy of Sciences (USSR), Moscow (USSR). Central Aerohydrodynamic Inst.
ADVANCED METHOD AND PROCESSING TECHNOLOGY FOR COMPLICATED SHAPE AIRFRAME PART FORMING
P. V. MIODUSHEVSKY and G. A. RAJEVSKAYA *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 497-503 Sep. 1994
Avail: CASI HC A02/MF A04

Slow deformation modes of forming give considerably higher residual fatigue life of the airframe part. It has experimentally proven that fatigue life of complicated shape integral airframe panels made of high strength aluminum alloys is significantly increased after creep deformation process. To implement the slow deformation mode forming methods, universal automated equipment was developed. Multichannel forming systems provide high accuracy of airframe part shape eliminating residual stresses and spring effect. Forming process multizone control technology was developed and experimentally proved that static/fatigue properties of formed airframe parts are increased. Author

N95-14604*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GRAPHICAL USER INTERFACE FOR THE NASA FLOPS AIRCRAFT PERFORMANCE AND SIZING CODE
THOMAS M. LAVELLE and BRIAN P. CURLETT Oct. 1994 39 p
(Contract(s)/Grant(s): RTOP 505-69-50)
(NASA-TM-106649; E-8957; NAS 1.15:106649) Avail: CASI HC A03/MF A01

XFLOPS is an X-Windows/Motif graphical user interface for the aircraft performance and sizing code FLOPS. This new interface simplifies entering data and analyzing results, thereby reducing analysis time and errors. Data entry is simpler because input windows are used for each of the FLOPS namelists. These windows contain fields to input the variable's values along with help information describing the variable's function. Analyzing results is simpler because output data are displayed rapidly. This is accomplished in two ways. First, because the output file has been indexed, users can view particular sections with the click of a mouse button. Second, because menu picks have been created, users can plot engine and aircraft performance data. In addition, XFLOPS has a built-in help system and complete on-line documentation for FLOPS. Author

N95-14794*# Rockwell International Corp., Downey, CA. Space Systems Div.
REQUIREMENTS REPORT FOR SSTO VERTICAL TAKE-OFF AND HORIZONTAL LANDING VEHICLE
H. S. GREENBERG 4 Nov. 1994 156 p
(Contract(s)/Grant(s): NCC1-193; NCC2-9003; NCC8-39)
(NASA-CR-197029; NAS 1.26:197029; SSD94D0217B) Avail: CASI HC A08/MF A02

This document describes the detailed design requirements and design criteria to support Structures/TPS Technology development for SSTO winged vehicle configurations that use vertical take-off and horizontal landing and delivers 25,000 lb payloads to a 220 nm circular orbit at an inclination of 51.6 degrees or 40,000 lb payloads to a 150 nm circular orbit at a 28.5 degree inclination. Derived from text

N95-14849# Naval Postgraduate School, Monterey, CA.
ARTIFICIAL NEURAL NETWORK MODELING OF DAMAGED AIRCRAFT M.S. Thesis
CLIFFORD A. BRUNGER Mar. 1994 109 p
(AD-A283227) Avail: CASI HC A06/MF A02

Aircraft design and control techniques rely on the proper modeling of the aircraft's equations of motion. Many of the variables used in these equations are aerodynamic coefficients which are obtained from scale models in wind tunnel tests. In order to model damaged aircraft, every aerodynamic coefficient must be determined for every possible damage mechanism in every flight condition. Designing a controller for a damaged aircraft is particularly burdensome because knowledge of the effect of each damage mechanism on the model is required before the controller can be designed. Also, a monitoring system must be employed to decide when and how much damage has occurred in order to reconfigure the controller. Recent advances in artificial intelligence have made parallel distributed processors (artificial neural networks) feasible. Modeled on the human brain, the artificial neural network's strength lies in its ability to generalize from a given model. This thesis examines the robustness of the artificial neural network as a model for damaged aircraft. DTIC

N95-14852*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SPATIAL AWARENESS COMPARISONS BETWEEN LARGE-SCREEN, INTEGRATED PICTORIAL DISPLAYS AND CONVENTIONAL EFIS DISPLAYS DURING SIMULATED LANDING APPROACHES
RUSSELL V. PARRISH, ANTHONY M. BUSQUETS, STEVEN P. WILLIAMS, and DEAN E. NOLD Oct. 1994 25 p Prepared in cooperation with Army Communications-Electronics Command, Fort Monmouth, NJ
(Contract(s)/Grant(s): RTOP 505-64-53-03; DA PROJ. 1L1-62211-A-47-A)
(NASA-TP-3467; L-17356; NAS 1.60:3467; CECOM-TR-94-E-1) Avail: CASI HC A03/MF A01

An extensive simulation study was performed to determine and compare the spatial awareness of commercial airline pilots on simulated landing approaches using conventional flight displays with their awareness using advanced pictorial 'pathway in the sky' displays. Sixteen commercial airline pilots repeatedly made simulated complex

microwave landing system approaches to closely spaced parallel runways with an extremely short final segment. Scenarios involving conflicting traffic situation assessments and recoveries from flight path offset conditions were used to assess spatial awareness (own ship position relative the the desired flight route, the runway, and other traffic) with the various display formats. The situation assessment tools are presented, as well as the experimental designs and the results. The results demonstrate that the integrated pictorial displays substantially increase spatial awareness over conventional electronic flight information systems display formats. Author

N95-14909*# Mississippi State Univ., State College, MS. Computational Fluid Dynamics Lab.

PROPULSION/AIRFRAME INTERFERENCE FOR DUCTED PROPFAN ENGINES WITH GROUND EFFECT Final Report, Mar. 1993 - Feb. 1995

ABDOLLAH ARABSHAHI and RAMESH PANKAJAKSHAN 11 Nov. 1994 17 p Prepared in cooperation with NSF, Washington, DC

(Contract(s)/Grant(s): NAG1-226)

(NASA-CR-197110; NAS 1.26:197110) Avail: CASI HC A03/MF A01

The advanced propfan propulsion systems design of the next-generation subsonic transport aircraft has been of interest to many airline companies in the past several years. This is due to the studies which indicate that an efficient ducted propfan engine technology offers a significant reduction in aircraft fuel consumption. However, because of the geometric complexity of the configuration, one challenge is the integration of the ducted propfan engine with the airframe so that aerodynamic interference effects frequently encountered near the nacelle can be minimized, or perhaps, optimized. To understand this interaction phenomenon better, it is desirable to have a reliable and efficient computational tool that can predict propeller effects on the flowfield around complex configurations. Derived from text

N95-15451 RAND Corp., Santa Monica, CA.

THE F-16 MULTINATIONAL STAGED IMPROVEMENT PROGRAM: A CASE STUDY OF RISK ASSESSMENT AND RISK MANAGEMENT

FRANK CAMM 1993 123 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): F49620-91-C-0003)

(AD-A281706; RAND/N-3619-AF) Avail: CASI HC A06

The F-16 Multinational Staged Improvement Program (MSIP) is the development program that the F-16 program has used to move beyond the F-16A/B. Its primary product has been the F-16C/D, an aircraft whose design evolves over time as new technological capabilities become available or attractive to incorporate in its design. MSIP is the program that F-16C/D developers have used to introduce these capabilities over time. The prime contractor for the F-16, General Dynamics, and the F-16 System Program Office (SPO) formally initiated the program in 1980. This study examines MSIP, giving special attention to means of assessing and managing the risks associated with system development. It is one of seven case studies conducted by RAND for the Air Force to examine the Air Force's management of risk in development programs during the 1980's. DTIC

N95-15742*# Universities Space Research Association, Columbia, MD.

THE ALUMINUM FALCON: A LOW COST MODERN COMMERCIAL TRANSPORT

MARK BRYANT, ESTELA HERNANDEZ, GREGORY KING, ALEX CHOUA LOR, JANA MUSSER, DEANNE TRIGS, and SUSAN YEE 6 Jun. 1994 109 p

(Contract(s)/Grant(s): NASW-4435)

(NASA-CR-197180; NAS 1.26:197180) Avail: CASI HC A06/MF A02

The American Institute of Aeronautics and Astronautics (AIAA) released a Request For Proposal (RFP) in the form of an undergraduate design competition for a 153 passenger jet transport with a range of 3,000 nautical miles. The primary requirement for this aircraft was low cost, both in acquisition and operation, with a technology availability date of the year 2000. This report presents the Non-Solo Design Group's response to the RFP, the Aluminum Falcon (AF-1). Non-Solo's approach to development was to take the best elements of seven individual preliminary designs, then combine and refine them. The resulting aircraft meets or exceeds all requirements of both the RFP and the Federal Aviation Administration (FAA). Highlights include a revolutionary wing planform, known as an M-wing, which offers many advantages over a conventional aft swept wing. For example, the M-wing lessens the travel in the aircraft center of gravity caused by fuel being stored in the wing. It also reduces the amount of torque imposed on the center wing box because more of the lifting load acts near the fuselage joint, rather than behind it. In essence, the M-wing offers the best of both worlds: using a forward swept wing root places the aerodynamic center of the wing further forward and allows the landing gear to be placed without the use of a yahudi. At the same time, with the outboard section swept backward the tip retains an amount of aeroelastic dampening that is lost on a completely forward swept wing. The result is a wing which has many advantages of a straight, unswept wings without the severe compressibility effects at high Mach numbers. Other highlights include judicious use of composites, giving recognition to the importance of weight and its effect on aircraft cost and performance, and an advanced passenger entertainment system which can be used as a source of revenue for the airlines. This aircraft meets the low-cost doctrine with an acquisition cost of $29 million and a direct operating cost of 3.5 cents per seat mile. The AF-1 incorporates new ideas with existing technology to result in an aircraft that will retain market viability well into the next century. Author

N95-15815# Army Test and Evaluation Command, Aberdeen Proving Ground, MD.

TEST OPERATION PROCEDURE (TOP): VIBRATION TESTING OF HELICOPTER EQUIPMENT Final Report

26 Aug. 1994 42 p

(AD-A284433; TOP-7-3-531) Avail: CASI HC A03/MF A01

This TOP provides guidelines and procedures for helicopter vibration calibration and measurements. Guides are provided for vibration frequencies and magnitudes to be expected. Procedures are developed for transducer selection and placement, instrumentation system design, and data collection. Emphasis is placed on use of piezoelectric accelerometers for vibration measurement and tape recorders for data storage. Step-by-step procedures are provided for accelerometer sensitivity measurement and calibration, instrumentation system adjustments and calibrations, and data collection and handling. DTIC

N95-15821 Technische Hochschule, Aachen (Germany). Inst. fuer Mechanik.

PREDICTION OF ROTOR-BLADE DEFORMATIONS DUE TO UNSTEADY AIRLOADS Interim Report No. 1, May 1994 - Jun. 1995

J. BALLMANN and S. SCHLECHTRIEM 31 Jul. 1994 9 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): N68171-94-C-9068)

(AD-A284467; R/D-7213-AN-01) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

SOFIA, a computer code for aeroelastic computations, was applied to predict the rotor blade deformations due to unsteady airloads caused by blade-vortex interaction (BVI) and to investigate appropriate control movements to minimize vibration and noise. The computation of the unsteady, compressible, inviscid flow about rotor-blades uses an Euler CFD code, while a quasi one-dimensional structural solver is used to compute the deformation of the rotor blades. DTIC

06
AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A95-61741
ON-BOARD AVIONICS MAINTENANCE
Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 6 June 1993 p. 13-15
(BTN-94-EIX94461047054) Copyright

As avionics standards evolve, there is increasing interaction between technology and the line mechanic and, at the same time, less emphasis on the line mechanic as the knowledge base for maintenance information. Author (EI)

N95-14518* National Aeronautics and Space Administration. Ames *Research Center, Moffett Field, CA.*
AIRCRAFT MANEUVER ENVELOPE WARNING SYSTEM
Patent
COURTLAND C. BIVENS, inventor (to NASA), JOEL M. ROSADO, inventor (to NASA), and BURNETT LEE, inventor (to NASA) 25 Oct. 1994 9 p Filed 16 Mar. 1993
(NASA-CASE-ARC-11953-1; US-PATENT-5,359,326; US-PATENT-APPL-SN-032067; US-PATENT-CLASS-340-971; US-PATENT-CLASS-340-945; US-PATENT-CLASS-340-978; INT-PATENT-CLASS-G01C-21/00) Avail: US Patent and Trademark Office

A maneuver envelope warning system for an aircraft having operating limits, operating condition sensors and an indicator driver. The indicator driver has a plurality of visual indicators. The indicator driver determines a relationship between sensed operating conditions and the operating limits; such as, a ratio therebetween. The indicator driver illuminates a number of the indicators in proportion to the determined relationship. The position of the indicators illuminated represents to a pilot in an easily ascertainable manner whether the operational conditions are approaching operational limits of the aircraft, and the degree to which operational conditions lie within or exceed operational limits. Author

N95-15392 *Naval Surface Warfare Center, Dahlgren, VA.*
ELECTROMAGNETIC REVERBERATION CHARACTERISTICS OF A LARGE TRANSPORT AIRCRAFT
Final Report
MICHAEL O. HATFIELD, GUSTAV J. FREYER, D. M. JOHNSON, and CHARLES L. FARTHING Jul. 1994 95 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A282923; NSWCDD/TR-93/339) Avail: CASI HC A05

A demonstration test to investigate the reverberation characteristics of the avionics bay and cockpit of a typical commercial aircraft was conducted on a decommissioned Boeing 707-720B aircraft. The aircraft, located at the Aerospace Maintenance and Regeneration Center, Davis Monthan Air Force Base, Arizona, had a significant fraction of its electronics equipment remaining in the avionics bay and cockpit and the passenger compartment was essentially intact. A simulated avionics box was placed in an equipment rack and a trace on an internal circuit board was monitored. The simulated avionics box was also tested in the Naval Surface Warfare Center, Dahlgren Division (NSWCDD) mode stirred chamber (MSC). The avionics bay and cockpit were internally excited from 100 MHz to 18 GHz using a pair of horn and wire antennas placed in several locations. Aluminum foil tuners, each 2 x 2 ft, were located in the avionics bay and the cockpit. The internal electromagnetic environment was measured by a horn and a wire antenna placed successively in several locations in the avionics bay and cockpit. Limited measurements of the local ambient environment, both external to the aircraft and within the aircraft, were obtained for the FM band (88 to 108 MHz) and the VHF/UHF bands (100 MHz to 1 GHz). Cavity losses were characterized by comparing the received power to the input power. The cavity loss for the avionics bay was about 15 dB greater than the loss in the NSWCDD MSC. The loss for the cockpit was about 12 dB greater than the NSWCDD MSC. The observed stirring ratios (ratio of maximum received signal to minimum received signal at a particular frequency as the tuner rotates) were generally less than 10 dB up to about 800 MHz. DTIC

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.

A95-61727
TRENT ENGINE DEVELOPMENT
STUART BIRCH Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 12 December 1993 p. 30-32
(BTN-94-EIX94461290507) Copyright

The design, development and certification of a new civil aero engine by Rolls-Royce is described. The new three-shaft turbofan engine, called the Trent, is scheduled to fly in 1994, with an in-service date of January 1955. It combines both proven and advanced technology, including hollow, diffusion bonded, and superplastically formed fan blades. EI

A95-61732
FOIL BEARINGS FOR GAS TURBINE ENGINES
Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 9 September 1993 p. 15-19
(BTN-94-EIX94461290279) Copyright

Various design factors are considered which affect a foil bearing's dynamic stiffness and damping characteristics. It is shown that optimizing a foil bearing can have a significant effect on the stability of a typical rotor in the hot end of an auxilliary power unit or gas turbine. This is a necessary tool to ensure successful integration and production transition of high-temperature foil bearings into gas turbine engines. EI

A95-61736
SMALL GAS TURBINES IN THE 21ST CENTURY
Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 8 August 1993 p. 17-20
(BTN-94-EIX94461290241) Copyright

Today's small gas turbine engines have five times the power at about the same weight and half the fuel consumption of the early engines. In addition, the reliability and durability of today's engines are at least five time better. Modifications to the cycles of small gas turbines can produce significant improvements in power density and fuel consumption. EI

A95-61737
TURBOFAN PROPULSION SIMULATOR
Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 8 August 1993 p. 11-16
(BTN-94-EIX94461290240) Copyright

An ultra-high-bypass turbofan propulsion simulator (UPS) is used to evaluate fan aero performance, source noise and acoustic treatment effectiveness, high-angle-of-attack inlet fan operability performance, and aeromechanics. The UPS is a pneumatically powered single-shaft, ducted-fan-engine model propulsion simulator. It can accommodate fans of a nominal 0.6 m tip diameter. EI

A95-62264
ON PROFILING A CAM OF AN AXIAL AVIATION DIESEL ENGINE BY PERIODIC SPLINES
A. A. RYZHOV NPP Motor, Ufa (Russia) and YU. S. SHATALOV

Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 28-33 In RUSSIAN
(BTN-94-EIX94461407946) Copyright

A method has been developed to construct a profile, based on a two-parametric periodic spline, with continuous up to the second order derivatives along the turn angle. The spline should be selected so that the inertia force of the rod be a continuous function; the force acting on the rod should have a minimal amplitude and be positive. An example calculation is given. EI

A95-62638
PROFILING OF THE WORKING SURFACE OF ELECTRODES-TOOLS FOR CIRCLE ELECTROCHEMICAL DIMENSIONAL TREATMENT OF COMPRESSOR BLADES
YU. M. VAKHITOV KazNIID, Kazan (Russia), V. F. GERASIMOV, A. I. ALMAN, and A. KH. KARIMOV Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 100-103 In RUSSIAN
(BTN-94-EIX94461407964) Copyright

Compressor blades of advanced aviation engines should be manufactured according to the first-second classes of accuracy of the standard 102571-86. The blades mentioned cannot be manufactured using the traditional technology. The paper offers a method to profile electrodes for the electrochemical dimensional treatment of blades of gas turbine engines. The test results have been presented. EI

N95-14645# Spectra Research Systems, Inc., Huntsville, AL.
A GRAPHICAL USER INTERFACE FOR DESIGN AND ANALYSIS OF AIR BREATHING PROPULSION SYSTEMS
CHARLES P. DEPLACHETT and RICHARD K. STEINBERG *In* Huntsville Association of Technical Societies, TABES 1994: 10th Annual Technical and Business Exhibition and Symposium 7 p 1994 Sponsored by Army Missile Command
(TABES PAPER 94-616) Avail: CASI HC A02/MF A04

Existing air breathing propulsion engine analysis software requires extensive training to use. Therefore, a need exists for a user friendly computer simulation which is capable of analyzing air breathing propulsion cycles quickly and efficiently. Human factors studies have been performed for real-time interactive computer displays for DOD systems. The technologies resulting from these real-time display designs are being used to produce an optimal graphical user interface (GUI) which will provide a means for interactive design and/or modification of air breathing propulsion systems. Author

N95-15329# Naval Postgraduate School, Monterey, CA.
COMBUSTION EFFICIENCY IN A DUAL-INLET SIDE-DUMP RAMJET COMBUSTOR M.S. Thesis
MARTIN W. DEPPE Jun. 1994 50 p
(AD-A283564) Avail: CASI HC A03/MF A01

A dual, axially-in-line, side-dump, liquid-fueled ramjet combustor was designed and tested with varying fuel-air ratios, atomizer types, and air distributions between the two inlets. Particle size distributions produced by the atomizers were measured at the inlet duct plane. When operated in a contra-flow direction, all of the atomizers produced excellent atomization with a Sauter mean diameter less than 14 microns. The dual, in-line inlets provided improved flammability limits and combustion efficiencies at lean fuel-air ratios when compared to single side-dump performance. Direct injection of approximately 20 percent of the fuel flow into the dome region was found to provide improved lean flammability limits for the single side-dump, but was not required with the dual inlets. The fuel distribution in the inlet duct required for good flammability limits and combustion efficiency was opposite to that required to prevent pressure oscillations, indicating that a dump plane aero-grid will often be necessary. A dump angle of 45 deg resulted in lower than desired combustion efficiencies, apparently due to poor mixing with the air from the aft inlet. DTIC

N95-15683# Purdue Univ., West Lafayette, IN. Research Foundation.
GAS TURBINE PREDIFFUSER-COMBUSTOR PERFORMANCE DURING OPERATION WITH AIR-WATER MIXTURE Interim Report, 10 May 1992 - 20 Aug. 1993
P. LAING and S. N. B. MURTHY Aug. 1994 139 p
(Contract(s)/Grant(s): FAA-92-G-002)
(DOT/FAA/CT-93/52; M/FAA/002-93-1) Avail: CASI HC A07/MF A02

In a continuing effort to establish performance changes due to water ingestion into an aircraft gas turbine engine and possible design improvements, an experimental investigation was performed with a model gas turbine prediffuser-combustor sector utilizing a number of mixture and flow conditions in a tunnel operating with a two-phase, air-liquid film-droplet mixture. For given entry conditions into the prediffuser (which can be related to the exit conditions of the core compressor in a bypass engine, and, therefore, also to ingestion conditions at the engine face) the two main issues are (1) the amount of water entering the primary zone of the combustor, and (2) the local reduction in temperature, flame-water interactions, and the vitiation caused by the vaporizing of water. Flow visualization and estimates of water flow and droplet size in the primary zone have been undertaken under cold flow conditions. The amount of water entering the primary zone has been found to be a complex function of (1) the air-water mixture conditions at entry to the prediffuser, and (2) the effects of gravity on the flowfield for given geometry of the prediffuser-combustor, and the flow split between the primary and the coolant streams in the combustor. Combustion tests have been carried out to establish the effects on performance, occurrence of flameout, and recoverability of combustor exit temperature by enhancement of one or both of the fuel equivalence ratio and the oxygen content of air. It was tentatively concluded that the observed effects of the presence of water are a result of the interactive effects of heat transfer to water, vitiation by water vapor on combustion, and the total heat release in the primary zone. the latter being the dominant factor in stabilizing the flame with a large increase in combustor exit temperature, as found in the tests with the addition of both fuel and oxygen to a given burning mixture. Author

08
AIRCRAFT STABILITY AND CONTROL

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

A95-62631
LOCAL-OPTIMAL CONTROL OF A FLYING VEHICLE, WITH FINAL STATE OPTIMIZED
V. I. SMAGIN TGU, Tomsk (Russia) Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 74-76 In RUSSIAN
(BTN-94-EIX94461407957) Copyright

The problem of the horizontal gliding of a flying vehicle at the height given is solved by an algorithm and by the numerical optimization of the terminal criterion. The algorithm is designed for the local-optimal control of a moving point. The control mechanism is formed as a nonlinear feedback. An equation for the movement of a flying vehicle in the longitudinal plane has been given. It is meant that the flying vehicle is landing in the atmosphere. EI

N95-14343 Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Computer Science.
COMPUTING QUANTITATIVE CHARACTERISTICS OF FINITE-STATE REAL-TIME SYSTEMS
S. CAMPOS, E. CLARKE, W. MARRERO, and M. MINEA 4 May 1994 23 p *Limited Reproducibility: More than 20% of this document may be*

affected by microfiche quality
(Contract(s)/Grant(s): MDA972-90-C-0035)
(AD-A282839; CMU-CS-94-147) Avail: CASI HC A03

Current methods for verifying real-time systems are essentially decision procedures that establish whether the system model satisfies a given specification. We present a general method for computing quantitative information about finite-state real-time systems. We have developed algorithms that compute exact bounds on the delay between two specified events and on the number of occurrences of an event in any given interval. This technique allows us to determine performance measures such as schedulability, response time, and system load. Our algorithms produce more detailed information than traditional methods. This information leads to a better understanding of system behavior, in addition to determining its correctness. We also show that our technique can be extended to a more general representation of real-time systems, namely, timed transition graphs. The algorithms presented in this paper have been incorporated into the SMV model checker and used to verify a model of an aircraft control system. The results obtained demonstrate that our method can be successfully applied in the verification of real-time system designs DTIC

N95-14448# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
LATERAL JET CONTROL FOR TACTICAL MISSILES
P. CHAMPIGNY and R. G. LACAU *In* AGARD, Missile Aerodynamics 57 p Jun. 1994
Copyright Avail: CASI HC A04/MF A03

The aim of this paper is to give a survey of lateral jets as control system of tactical missiles. The paper is divided into four parts. The first part gives a brief analysis of new control requirements pertaining to tactical missiles, presents the advantages of lateral jet control, and describes two types of applications for missiles designed and developed by Aerospatiale-Missiles. The first example relates to the ground/surface-to-air missile ASTER which has antimissile capability; the second example concerns the antitank missile ERYX. The second part presents in detail the phenomenological aspects of lateral jets and the influence of various flow parameters and missile geometry on control system performance. The third part describes some wind-tunnel testing problems. The fourth and last part is dedicated to computation for valuation and understanding of the aerodynamic interactions.
Derived from text

N95-14815# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
A SIMULINK ENVIRONMENT FOR FLIGHT DYNAMICS AND CONTROL ANALYSIS: APPLICATION TO THE DHC-2 BEAVER. PART 1: IMPLEMENTATION OF A MODEL LIBRARY IN SIMULINK. PART 2: NONLINEAR ANALYSIS OF THE BEAVER AUTOPILOT (Diskette Supplement) M.S. Thesis
MARC O. RAUW Sep. 1993 265 p Diskette supplement: 3.5-inch DSDD
(NONP-NASA-SUPPL-DK-94-28027) Avail: CASI SET A19 (HC,DK)

The design of advanced Automatic Aircraft Control Systems (AACS's) can be improved upon considerably if the designer can access all models and tools required for control system design and analysis through a graphical user interface, from within one software environment. This MSc-thesis presents the first step in the development of such an environment, which is currently being done at the Section for Stability and Control of Delft University of Technology, Faculty of Aerospace Engineering. The environment is implemented within the commercially available software package MATLAB/SIMULINK. The report consists of two parts. Part 1 gives a detailed description of the AACS design environment. The heart of this environment is formed by the SIMULINK implementation of a nonlinear aircraft model in block-diagram format. The model has been worked out for the old laboratory aircraft of the Faculty, the DeHavilland DHC-2 'Beaver', but due to its modular structure, it can easily be adapted for other aircraft. Part 1 also describes MATLAB programs which can be applied for finding steady-state trimmed-flight conditions and for linearization of the aircraft model, and it shows how the built-in simulation routines of SIMULINK have been used for open-loop analysis of the aircraft dynamics. Apart from the implementation of the models and tools, a thorough treatment of the theoretical backgrounds is presented. Part 2 of this report presents a part of an autopilot design process for the 'Beaver' aircraft, which clearly demonstrates the power and flexibility of the AACS design environment from part 1. Evaluations of all longitudinal and lateral control laws by means of nonlinear simulations are treated in detail. A floppy disk containing all relevant MATLAB programs and SIMULINK models is provided as a supplement.
Author (revised)

N95-14900# Technische Univ., Brunswick (Germany). Inst. of Flight Guidance and Control.
TURBULENCE: ENGINEERING MODELS, AIRCRAFT RESPONSE
MANFRED SWOLINSKY *In* AGARD, Flight in an Adverse Environment 20 p Nov. 1994
Copyright Avail: CASI HC A03/MF A02

This paper covers problems of flight in a turbulent atmosphere. A realistic simulation of aircraft behavior in turbulent air requires different engineering models. On one hand, this means a mathematical description of random turbulence or short scale gusts. For simple problems, a computation of the turbulence velocity vector only at the trajectory of the aircraft is sufficient. In cases of detailed investigations, the generation of a 3-dimensional spatial turbulence field is necessary. Additional real time requirements imply special approaches, such as the realization of a matrix wind model. On the other hand the description of the interaction between turbulence or short scale gusts and aircraft may require complex aerodynamic models especially if the gust scale and the aircraft scale are in the same order of magnitude. The presented multi point or lifting surface models consider the wind vector at several points along the wing span under real time constraints. Based on simulation results and flight test data, the dynamic aircraft response is discussed. Single gust effects are demonstrated by examples of cross flights through the updraft of a powerplant cooling tower. Author

09
RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A95-61735
FLIGHT SIMULATION
Aerospace Engineering (Warrendale, Pennsylvania) (ISSN 0736-2536) vol. 13, no. 8 August 1993 p. 21-24
(BTN-94-EIX94461290242) Copyright

To keep pace with advancing aeronautical technologies, the capability for dynamically simulating high-quality flight on the ground is needed. Ground simulation is a critical step in the process of air vehicle development. The Combined Acceleration Flight Simulator (CAFS) will fulfill that requirement. EI

N95-13687# Wright Lab., Wright-Patterson AFB, OH.
DEVELOPMENTS IN LASER-BASED DIAGNOSTICS FOR WIND TUNNELS IN THE AEROMECHANICS DIVISION: 1987-1992 Final Report, Jan. 1987 - Dec. 1992
LINDA G. SMITH, MARK S. MAURICE, CHARLES TYLER, JOHN D. SCHMISSEUR, and GEORGE L. SEIBERT May 1994 107 p
(Contract(s)/Grant(s): AF PROJ. 2404)
(AD-A283011; WL-TR-94-3054) Avail: CASI HC A06/MF A02

The Aero-Diagnostics Research Section of the Aeromechanics Division develops and advances laser-based diagnostic techniques for

use in a variety of subsonic through hypersonic wind tunnel facilities. These include laser velocimetry, laser induced fluorescence, Rayleigh scattering, phase shift holographic interferometry, and chemiluminescence. The purpose of this report is to bring the reader up to date on the status of these and other techniques under development in the Aeromechanics Division at the Wright Laboratory. DTIC

N95-14415* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRPLANE TAKEOFF AND LANDING PERFORMANCE MONITORING SYSTEM Patent
DAVID B. MIDDLETON, inventor (to NASA), RAGHAVACHARI SRIVATSAN, inventor (to NASA), and LEE H. PERSON, JR., inventor (to NASA) 4 Oct. 1994 28 p Filed 6 Apr. 1993 Continuation of abandoned US-Patent-Appl-SN-755248, filed 5 Sep. 1991 which is a continuation-in-part of US-Patent-Appl-SN-192562, filed 11 May 1988 which is a continuation-in-part of US-Patent-Appl-SN-082766, filed 6 Aug. 1987
(NASA-CASE-LAR-14745-2-SB; US-PATENT-5,353,022; US-PATENT-APPL-SN-045337; US-PATENT-APPL-SN-755248; US-PATENT-APPL-SN-192562; US-PATENT-APPL-SN-082766; US-PATENT-CLASS-340-959; US-PATENT-CLASS-73-178T; US-PATENT-CLASS-364-427; INT-PATENT-CLASS-G08B-21/00) Avail: US Patent and Trademark Office

The invention is a real-time takeoff and landing performance monitoring system for an aircraft which provides a pilot with graphic and metric information to assist in decisions related to achieving rotation speed (VR) within the safe zone of a runway, or stopping the aircraft on the runway after landing or take-off abort. The system processes information in two segments: a pretakeoff segment and a real-time segment. One-time inputs of ambient conditions and airplane configuration information are used in the pretakeoff segment to generate scheduled performance data. The real-time segment uses the scheduled performance data, runway length data and transducer measured parameters to monitor the performance of the airplane throughout the takeoff roll. Airplane acceleration and engine-performance anomalies are detected and annunciated. A novel and important feature of this segment is that it updates the estimated runway rolling friction coefficient. Airplane performance predictions also reflect changes in head wind occurring as the takeoff roll progresses. The system provides a head-down display and a head-up display. The head-up display is projected onto a partially reflective transparent surface through which the pilot views the runway. By comparing the present performance of the airplane with a continually predicted nominal performance based upon given conditions, performance deficiencies are detected by the system and conveyed to pilot in form of both elemental information and integrated information.
Official Gazette of the U.S. Patent and Trademark Office

N95-15328# Systems Control Technology, Inc., Arlington, VA.
VERTICAL FLIGHT TERMINAL OPERATIONAL PROCEDURES. A SUMMARY OF FAA RESEARCH AND DEVELOPMENT Final Report
RAYMOND H. MATTHEWS Jul. 1994 53 p
(Contract(s)/Grant(s): DTFA01-87-C-00014)
(AD-A283550; SCT-92-RR-9; DOT/FAA/RD-94/24) Avail: CASI HC A04/MF A01

Common-carrier operations by helicopters are becoming increasingly routine. Prospects for their future utilization are promising as the variety of uses continues to grow and public acceptance expands. The Federal Aviation Administration (FAA) and industry are working to more fully integrate vertical flight vehicles in to the National Airspace System (NAS). Rotorcraft, including tiltrotor, tiltwing, and helicopters, are unique and each offers potential benefits that may provide relief to the delay problems being experienced throughout the NAS. Before these advantages can be fully exploited, a myriad of untested areas must be explored through research and development (R and D) activities to prove their viability. One important area is safety in terminal area operations. Safety includes such diversified subjects as approach and departure procedures, one-engine-inoperative (OEI) operations, loss of engine during critical flight phases, and landing site qualifications and capabilities. Pilot qualification, training of pilots and ground service personnel, precision approach glideslope angles, obstruction avoidance, etc., are also important safety concerns. Some of these topics have been addressed, others are currently under investigation, while others are still in the planning stages. DTIC

10
ASTRONAUTICS

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

A95-62259
SOFT LANDING ON THE SLOPE SURFACE OF A LANDING VEHICLE WITH AN AIR SHOCK-ABSORBER OF FORCED PRESSURIZATION
S. S. KOMAROV UGATU, Ufa (Russia) and N. I. MISKAKTIN Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 3-9 In RUSSIAN
(BTN-94-EIX94461407941) Copyright

Based on the solution of the optimization problem, the stability of a spacecraft landing is estimated. The spacecraft is equipped with a conical pressurized shock-absorber. Dynamics of spacecraft landing with an air shock-absorber of forced pressurization has been investigated. The flat movement of a device with a soft foundation has been studied. The foundation changes its shape, due to the contact with the landing platform. EI

A95-62657
VARIATIONS OF PERTURBATIONS IN PERIGEE HEIGHT WITH ECCENTRICITY FOR ARTIFICIAL EARTH'S SATELLITES DUE TO AIR DRAG
Y. E. HELALI Helwan Institute of Astronomy and Geophysics, Cairo, Egypt and H. M. BASURAH K.A.A.U., Jeddah, Saudia Arabia Earth, Moon, and Planets (ISSN 0167-9295) vol. 64, no. 2 February 1994 p. 133-137
(HTN-95-40013) Copyright

The variations of perturbations in perigee distance for different values of the orbital eccentricity for artificial Earth's satellites due to air drag have been studied. The analytical solution of deriving these perturbations, using the TD model (Total Density) have been applied, (Helali; 1987). The theory is valid for altitudes ranging from 200 to 500 km above the Earth's surface and for solar 10.7 cm flux. Numerical examples are given to illustrate the variations of the perturbations in perigee distance with changing eccentricity (e less than 0.2). A stronge perturbations in the perigee distance have been shown when the eccentricity in the range 0.001 less than e less than 0.05, especially for perigee distance 200 km. Author (Hemer)

N95-13718*# MCAT Inst., Moffett Field, CA.
SCIENCE OBJECTIVES AND PERFORMANCE OF A RADIOMETER AND WINDOW DESIGN FOR ATMOSPHERIC ENTRY EXPERIMENTS
ROGER A. CRAIG, WILLIAM C. DAVY, and ELLIS E. WHITING *In its* Planetary Entry Experiments 41 p Jul. 1994
Avail: CASI HC A03/MF A02

The Radiative Heating Experiment, RHE, aboard the Aeroassist Flight Experiment, AFE, (now cancelled) was to make in-situ measurements of the stagnation region shock layer radiation during an aerobraking

maneuver from geosynchronous to low earth orbit. The measurements were to provide a data base to help develop and validate aerothermodynamic computational models. Although cancelled, much work was done to develop the science requirements and to successfully meet RHE technical challenges. This paper discusses the RHE scientific objectives and expected science performance of a small sapphire window for the RHE radiometers. The spectral range required was from 170 to 900 nm. The window size was based on radiometer sensitivity requirements including capability of on-orbit solar calibration. Author

N95-14089*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SIMULATION OF SHUTTLE LAUNCH G FORCES AND ACOUSTIC LOADS USING THE NASA AMES RESEARCH CENTER 20G CENTRIFUGE
T. L. SHAW, J. M. CORLISS, D. P. GUNDO, G. M. MULENBURG, G. A. BREIT, and J. B. GRIFFITH *In* NASA. Goddard Space Flight Center, Eighteenth Space Simulation Conference: Space Mission Success Through Testing p 349-371 Nov. 1994
Avail: CASI HC A03/MF A04

The high cost and long times required to develop research packages for space flight can often be offset by using ground test techniques. This paper describes a space shuttle launch and reentry simulating using the NASA Ames Research Center's 20G centrifuge facility. The combined G-forces and acoustic environment during shuttle launch and landing were simulated to evaluate the effect on a payload of laboratory rates. The launch G force and acoustic profiles are matched to actual shuttle launch data to produce the required G-forces and acoustic spectrum in the centrifuge test cab where the rats were caged on a free-swinging platform. For reentry, only G force is simulated as the aero-acoustic noise is insignificant compared to that during launch. The shuttle G-force profiles of launch and landing are achieved by programming the centrifuge drive computer to continuously adjust centrifuge rotational speed to obtain the correct launch and landing G forces. The shuttle launch acoustic environment is simulated using a high-power, low-frequency audio system. Accelerometer data from STS-56 and microphone data from STS-1 through STS-5 are used as baselines for the simulations. This paper provides a description of the test setup and the results of the simulation with recommendations for follow-on simulations. Author

N95-14096*# Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (Germany).
THERMOACOUSTIC ENVIRONMENTS TO SIMULATE REENTRY CONDITIONS
GERHARD BAYERDOERFER *In* NASA. Goddard Space Flight Center, Eighteenth Space Simulation Conference: Space Mission Success Through Testing p 441-450 Nov. 1994 Sponsored by BMFT
Avail: CASI HC A02/MF A04

Aerothermal environments as encountered during the reentry of spaceplanes or during the cruise of hypersonic aircrafts represent complex loading conditions for the external structures of those vehicles. In order to shield against the aerodynamic heating a special Thermal Protection System (TPS) is required which is designed as a light weight structure to reduce the weight penalty. TPS is therefore vulnerable to vibroacoustic fatigue caused by the pressure fluctuations of the environment. Because of the complex interactions between the loading forces and the resulting structural response which make an analytical treatment difficult and in order to provide means for fatigue testing IABG has designed and built a thermoacoustic facility which recently became operational. The facility is capable to produce surface temperatures up to 1.300 C at sound pressure levels up to 160 dB. This paper describes the design of the facility, some operational test work it also deals with problems associated with the facility instrumentation. Author

N95-14162*# Fairchild Space Co., Germantown, MD. Communications, Data Handling, and Power Systems.
EVOLUTIONARY TELEMETRY AND COMMAND PROCESSOR (TCP) ARCHITECTURE
JOHN R. SCHNEIDER *In* Research Inst. for Computing and Information Systems, RICIS Symposium 1992: Mission and Safety Critical Systems Research and Applications 20 p 30 Oct. 1992
Avail: CASI HC A03/MF A03

A low cost, modular, high performance, and compact Telemetry and Command Processor (TCP) is being built as the foundation of command and data handling subsystems for the next generation of satellites. The TCP product line will support command and telemetry requirements for small to large spacecraft and from low to high rate data transmission. It is compatible with the latest TDRSS, STDN and SGLS transponders and provides CCSDS protocol communications in addition to standard TDM formats. Its high performance computer provides computing resources for hosted flight software. Layered and modular software provides common services using standardized interfaces to applications thereby enhancing software re-use, transportability, and interoperability. The TCP architecture is based on existing standards, distributed networking, distributed and open system computing, and packet technology. The first TCP application is planned for the 94 SDIO SPAS 3 mission. The architecture enhances rapid tailoring of functions thereby reducing costs and schedules developed for individual spacecraft missions. Author (revised)

N95-14282*# Texas Univ., Austin, TX. Center for Space Research.
PRECISION ORBIT DETERMINATION OF ALTIMETRIC SATELLITES
C. K. SHUM, JOHN C. RIES, and BYRON D. TAPLEY *In* NASA. Goddard Space Flight Center, Satellite Laser Ranging in the 1990s: Report of the 1994 Belmont Workshop p 65-70 Nov. 1994
Avail: CASI HC A02/MF A02

The ability to determine accurate global sea level variations is important to both detection and understanding of changes in climate patterns. Sea level variability occurs over a wide spectrum of temporal and spatial scales, and precise global measurements are only recently possible with the advent of spaceborne satellite radar altimetry missions. One of the inherent requirements for accurate determination of absolute sea surface topography is that the altimetric satellite orbits be computed with sub-decimeter accuracy within a well defined terrestrial reference frame. SLR tracking in support of precision orbit determination of altimetric satellites is significant. Recent examples are the use of SLR as the primary tracking systems for TOPEX/Poseidon and for ERS-1 precision orbit determination. The current radial orbit accuracy for TOPEX/Poseidon is estimated to be around 3-4 cm, with geographically correlated orbit errors around 2 cm. The significance of the SLR tracking system is its ability to allow altimetric satellites to obtain absolute sea level measurements and thereby provide a link to other altimetry measurement systems for long-term sea level studies. SLR tracking allows the production of precise orbits which are well centered in an accurate terrestrial reference frame. With proper calibration of the radar altimeter, these precise orbits, along with the altimeter measurements, provide long term absolute sea level measurements. The U.S. Navy's Geosat mission is equipped with only Doppler beacons and lacks laser retroreflectors. However, its orbits, and even the Geosat orbits computed using the available full 40-station Tranet tracking network, yield orbits with significant north-south shifts with respect to the IERS terrestrial reference frame. The resulting Geosat sea surface topography will be tilted accordingly, making interpretation of long-term sea level variability studies difficult. Author (revised)

N95-14639*# Auburn Univ., AL. Space Power Inst.
HYPERVELOCITY IMPACT TEST FACILITY: A GUN FOR HIRE
CALVIN R. JOHNSON, M. F. ROSE, D. C. HILL, S. BEST, T. CHALOUPKA, G. CRAWFORD, M. CRUMPLER, and B. STEPHENS *In* Huntsville Association of Technical Societies, TABES 1994: 10th Annual Technical and Business Exhibition and Symposium 7 p 1994 (Contract(s)/Grant(s): NAG1-1329; DNA001-90-C-0127)
(TABES PAPER 94-605) Avail: CASI HC A02/MF A04

An affordable technique has been developed to duplicate the types of impacts observed on spacecraft, including the Shuttle, by use of a certified Hypervelocity Impact Facility (HIF) which propels particu-

lates using capacitor driven electric gun techniques. The fully operational facility provides a flux of particles in the 10-100 micron diameter range with a velocity distribution covering the space debris and interplanetary dust particle environment. HIF measurements of particle size, composition, impact angle and velocity distribution indicate that such parameters can be controlled in a specified, tailored test designed for or by the user. Unique diagnostics enable researchers to fully describe the impact for evaluating the 'targets' under full power or load. Users regularly evaluate space hardware, including solar cells, coatings, and materials, exposing selected portions of space-qualified items to a wide range of impact events and environmental conditions. Benefits include corroboration of data obtained from impact events, flight simulation of designs, accelerated aging of systems, and development of manufacturing techniques. Author (revised)

N95-14653*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
BUILDING COMPLEX SIMULATIONS RAPIDLY USING MATRIX(X): THE SPACE STATION REDESIGN
C. K. CARRINGTON *In* Huntsville Association of Technical Societies, TABES 1994: 10th Annual Technical and Business Exhibition and Symposium 7 p 1994
(TABES PAPER 94-632) Avail: CASI HC A02/MF A04

MSFC's quick response to the Space Station redesign effort last year required the development of a computer simulation to model the attitude and station-keeping dynamics of a complex body with rotating solar arrays in orbit around the Earth. The simulation was written using a rapid-prototyping graphical simulation and design tool called MATRIX(x) and provided the capability to quickly remodel complex configuration changes by icon manipulation using a mouse. The simulation determines time-dependent inertia properties, and models forces and torques from gravity-gradient, solar radiation, and aerodynamic disturbances. Surface models are easily built from a selection of beams, plates, tetrahedrons, and cylinders. An optimization scheme was written to determine the torque equilibrium attitudes that balance gravity-gradient and aerodynamic torques over an orbit, and propellant-usage estimates were determined. The simulation has been adapted to model the attitude dynamics for small spacecraft. Author

N95-14850 Naval Postgraduate School, Monterey, CA.
EVALUATION OF ENERGY-SINK STABILITY CRITERIA FOR DUAL-SPIN SPACECRAFT M.S. Thesis
VINCENT M. ORTIZ Jun. 1994 152 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A283228) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The nutational stability of a dual-spin, quasi-rigid, axisymmetric spacecraft containing a driven rotor is analyzed. The purpose is to examine a revised energy-sink stability theory that properly accounts for the energy contribution of the motor. An inconsistency in the development disproves the existing energy-sink theory's assumption that the motor of the system contributes exactly enough energy to offset the frictional losses between the rotor and the platform. Using the concept of core energy, the revised stability criteria for a dual-spin, quasi-rigid, axisymmetric spacecraft containing a driven rotor is derived. An expression for nutation angle as a function of core energy over time is then determined. Numerical simulations are used to verify the revised energy-sink stability theory. The dual-spin, quasi-rigid, axisymmetric system presented by D. L. Mingori was chosen for the simulation. Equations for angular momentum and total energy were necessary to validate the numerical simulation and confirm aspects of the revised energy-sink stability theory. These equations are derived from the first principles of dynamics and are included in the analysis. An explicit relationship for core energy as a function of time does not exist. Various models postulating core energy are presented and analyzed. The numerical simulations of the computed nutation angles as a function of the postulated core energy compare well with the actual nutation angles of the system to confirm the revised energy-sink stability criteria. DTIC

N95-14363# Lockheed Aeronautical Systems Co., Marietta, GA.
THERMALLY STABLE ORGANIC POLYMERS Interim Technical Report, 1 Feb. 1993 - 15 May 1994
R. H. BOSCHAN, MATTHEW MARROCCO, and JAMES MCGRATH 1 Jun. 1994 19 p
(Contract(s)/Grant(s): DAAL03-92-C-0021)
(AD-A281380; LG94ER0099; ARO-30357.1-MS) Avail: CASI HC A03/MF A01

Environmentally durable high temperature polymer matrix resins are critical in the design of near-term high performance supersonic aircraft. Currently available 6F based polymers are thermally stable, but are expensive and difficult to process into void-free laminates. 3F polymers have demonstrated equivalent thermal stability and processability, but are amenable to more facile, environmentally acceptable synthetic procedures. In the current program, semi-interpenetrating polymer network (SIPN) blends of ethynyl and phenylethynyl terminated 3F polymers have been formulated and evaluated. A series of test panels were fabricated, using dielectric monitoring procedures, from a 1:1 3F SIPN blend of phthalic anhydride terminated thermoplastic 3F oligomer with a phenylethynyl terminated thermosetting 3F oligomer. Solution prepregging techniques were used to prepare IM7 fiber prepreg tape. The void content of these laminates was somewhat higher than acceptable, probably due to the high melt viscosity. DTIC

N95-14409# Aeronautical Research Labs., Melbourne (Australia).
RESIDUAL STRENGTH OF COMPOSITES WITH MULTIPLE IMPACT DAMAGE
J. J. PAUL, S. C. GALEA, and R. JONES Mar. 1994 27 p
(AD-A284230; ARL-RR-13; DODA-AR-008-383) Avail: CASI HC A03/MF A01

In recent years the issue of damage interaction, with particular emphasis on multi-site damage, has been of concern to the aircraft industry. Whilst most attention focused on fuselage lap joints, related problems occur in composite structures which are subjected to multiple impact damage. This paper reveals that, for the cases of multiple impact damage in composite structures investigated, little interaction between damaged regions was observed. Thus a simple repair methodology, previously developed for single impact damaged structures, was applied. This methodology was verified via a coupon test program and an experimental evaluation of two damaged F/A-18 horizontal stabilators. DTIC

N95-14465*# Lehigh Univ., Bethlehem, PA. Dept. of Mechanical Engineering and Mechanics.
CORROSION AND CORROSION FATIGUE OF AIRFRAME ALUMINUM ALLOYS
G. S. CHEN, M. GAO, D. G. HARLOW, and R. P. WEI *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 157-173 Sep. 1994
(Contract(s)/Grant(s): FAA-92-G-0006)
Avail: CASI HC A03/MF A04

Localized corrosion and corrosion fatigue crack nucleation and growth are recognized as degradation mechanisms that effect the durability and integrity of commercial transport aircraft. Mechanically based understanding is needed to aid the development of effective methodologies for assessing durability and integrity of airframe components. As a part of the methodology development, experiments on pitting corrosion, and on corrosion fatigue crack nucleation and early growth from these pits were conducted. Pitting was found to be associated with constituent particles in the alloys and pit growth often involved coalescence of individual particle-nucleated pits, both laterally and in depth. Fatigue cracks typically nucleated from one of the larger pits that formed by a cluster of particles. The size of pit at which fatigue crack nucleates is a function of stress level and fatigue loading

frequency. The experimental results are summarized, and their implications on service performance and life prediction are discussed.
Author

N95-14482*# Utah Univ., Salt Lake City, UT.
THE EFFECTS OF PITTING ON FATIGUE CRACK NUCLEATION IN 7075-T6 ALUMINUM ALLOY
LI MA and DAVID W. HOEPPNER *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 425-440 Sep. 1994 Sponsored by Boeing Commercial Airplane Co.
Avail: CASI HC A03/MF A04

A high-strength aluminum alloy, 7075-T6, was studied to quantitatively evaluate chemical pitting effects of its corrosion fatigue life. The study focused on pit nucleation, pit growth, and fatigue crack nucleation. Pitting corrosion fatigue experiments were conducted in 3.5 percent NaCl aqueous solution under constant amplitude sinusoidal loading at two frequencies, 5 and 20 Hz. Smooth and unnotched specimens were used in this investigation. A video recording system was developed to allow in situ observation of the surface changes of the specimens during testing. The results indicated that pitting corrosion considerably reduces the fatigue strength by accelerating fatigue crack nucleation. A metallographic examination was conducted on the specimens to evaluate the nature of corrosion pits. First, the actual shapes of the corrosion pits were evaluated by cross-sectioning the pits. Secondly, the relation between corrosion pits and microstructure was also investigated. Finally, the possibility of another corrosion mechanism that might be involved in pitting was explored in this investigation. The fractography of the tested specimens showed that corner corrosion pits were responsible for fatigue crack nucleation in the material due to the associated stress concentration. The pits exhibited variance of morphology. Fatigue life for the experimental conditions appeared to be strongly dependent on pitting kinetics and the crack nucleation stage.
Author

N95-14920*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE CHARACTERIZATION OF WIDESPREAD FATIGUE DAMAGE IN FUSELAGE STRUCTURE
ROBERT S. PIASCIK, SCOTT A. WILLARD, and MATTHEW MILLER Sep. 1994 16 p
(Contract(s)/Grant(s): RTOP 538-02-10-01)
(NASA-TM-109142; NAS 1.15:109142) Avail: CASI HC A03/MF A01

The characteristics of widespread fatigue damage (WSFD) in fuselage riveted structure were established by detailed nondestructive and destructive examinations of fatigue damage contained in a full size fuselage test article. The objectives of this were to establish an experimental data base for validating emerging WSFD analytical prediction methodology and to identify first order effects that contribute to fatigue crack initiation and growth. Detailed examinations were performed on a test panel containing four bays of a riveted lap splice joint. The panel was removed from a full scale fuselage test article after receiving 60,000 full pressurization cycles. The results of in situ examinations document the progression of fuselage skin fatigue crack growth through crack linkup. Detailed tear down examinations and fractography of the lap splice joint region revealed fatigue crack initiation sites, crack morphology, and crack linkup geometry. From this large data base, distributions of crack size and locations are presented and discussions of operative damage mechanisms are offered.
Author

N95-15415 Pratt and Whitney Aircraft, West Palm Beach, FL. Government Engines and Space Propulsion.
FATIGUE IN SINGLE CRYSTAL NICKEL SUPERALLOYS
D. P. DELUCA and CHARLES ANNIS 15 Oct. 1993 30 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): N00014-91-C-0124)
(AD-A282917; FR2198-20) Avail: CASI HC A03

This program investigates the seemingly unusual behavior of single crystal airfoil materials. The fatigue initiation processes in single crystal (SC) materials are significantly more complicated and involved than fatigue initiation and subsequent behavior of a (single) macrocrack in conventional, isotropic, materials. To understand these differences is the major goal of this project.
DTIC

12 ENGINEERING

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

A95-61720
DISCRETE SHAPE SENSITIVITY EQUATIONS FOR AERODYNAMIC PROBLEMS
GENE J. W. HOU Old Dominion Univ., Norfolk, VA, ARTHUR C. TAYLOR, and VAMSHI M. KORIVI International Journal for Numerical Methods in Eng ineering (ISSN 0029-5981) vol. 37, no. 13 July 15, 1994 p. 2251-2266 refs
(BTN-94-EIX94451393721) Copyright

This paper presents a part of such an effort to develop a sensitivity analysis methodology that enables the sensitivity equations to be implemented into existing CFD codes with minimal code modification. The methodology is based upon a pre-elimination procedure which accounts for consistently linearized boundary conditions. Formulations of both the direct differentiation and the adjoint variable methods will be presented in the paper.
Author (revised by EI)

A95-61795
NEW STRATEGY COMBINING BACKWARD INFERENCE WITH FORWARD INFERENCE IN MONITORING AND DIAGNOSING TECHNIQUES FOR HYDRODYNAMIC BEARING-ROTOR SYSTEMS
YOU-YUN ZHANG Xi'an Jiaotong Univ., Xian (China) and YOU-BAI XIE Wear (ISSN 0043-1648) vol. 173, no. 1-2 April 1994 p. 31-37 refs
(BTN-94-EIX94331336949) Copyright

A new strategy for the techniques of monitoring and diagnosing hydrodynamic bearing-rotor systems is recommended in this paper. The strategy integrates the traditional technique of spectrum and statistics analysis (backward inference) with the application of knowledge and information of rotor-bearing dynamics and tribology (forward inference). This strategy has been used to develop a monitoring and diagnosing system for rotating machinery and examples of the successful application of the system are given.
Author (EI)

A95-62265
ON CALCULATED MODELS FOR IMPELLERS OF CENTRIFUGAL COMPRESSORS
S. K. CHERNIKOV KFTI, Kazan (Russia), S. V. KULAGIN, and E. V. KASUMOV Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 33-38 In RUSSIAN refs
(BTN-94-EIX94461407947) Copyright

A variety of calculated schemes for impellers of centrifugal compressors has been analysed. It has been shown that the assessment of the stress-deformed state of the impeller leads to significant errors, if the mutual effects of its elements are ignored. To calculate the impeller of the compressor, the finite element method was used. In order to simplify the problem, a concept of cyclic symmetry was introduced.
EI

A95-62267
HEAT TRANSFER IN THE FLOW-THROUGH PART OF AXIAL COMPRESSORS
V. I. LOKAJ KGTU, Kazan (Russia), A. G. KARIMOVA, and L. B. SHIGIN Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 43-47 In RUSSIAN refs (BTN-94-EIX94461407949) Copyright

If no valid data on the temperature state of heat stressed units are available, it is impossible to assess the strength reserves of pieces. Also, it is impossible, in this case, to develop efficient cooling systems and systems for controlling radial clearances. That's why the paper presents experimental results, showing heat transfer on the surface of the blade profile and on the end surfaces of the interblade channel of flat compressor lattices. Dependences, considering the effect of geometric and regime parameters on heat transfer, have been obtained. EI

A95-62625
INVESTIGATION OF HEAT TRANSFER IN A ROTATING RING GAP WITH THE AXIAL FLOW OF A COOLANT DURING THE ROTATION OF THE CENTRAL SHAFT
N. N. SALOV SPI, Sevastopol, (Ukraine) Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 51-54 In RUSSIAN refs (BTN-94-EIX94461407951) Copyright

Heat transfer of a cylindrical surface inside a rotating ring gap of the rotor of a turbine rocket engine has been experimentally studied. The rotor is of the disc-drum type. The studies were conducted with the axial flow of a coolant and with variations of the rotational speed and changes in the direction of rotation of the central shaft. The test results have been generalized on the basis of the similarity theory. Test data on the opposite rotation of the shaft and gap are in good agreement with dependences obtained. EI

A95-62627
MECHANISM AND TECHNOLOGICAL PARTICULAR FEATURES OF THERMOMAGNETIC HARDENING
S. M. BOROVSKIJ UGATU, Ufa (Russia) and V. S. MUKHIN Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 60-63 In RUSSIAN (BTN-94-EIX94461407953) Copyright

The particular features of mechanism associated with piece hardening of gas-turbine engines are analyzed. This mechanism is connected with the change of conditions for phase equilibrium and kinetics of transformations. It is important to estimate the nature of the formation of new ferromagnetic centers at phase transitions, when permanent, pulsed, or periodic magnetic fields act. Two factors should be taken into account: the power effect of the magnetic field and the increase of 'magnetic segregation' of a source nonferromagnetic matrix. EI

N95-13665*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPUTATIONAL ANALYSIS IN SUPPORT OF THE SSTO FLOWPATH TEST
BEVERLY S. DUNCAN (NYMA, Inc., Brook Park, OH.) and CHARLES J. TREFNY Oct. 1994 24 p
(Contract(s)/Grant(s): NAS3-27186; RTOP 505-70-59)
(NASA-TM-106757; E-9179; NAS 1.15:106757) Avail: CASI HC A03/MF A01

A synergistic approach of combining computational methods and experimental measurements is used in the analysis of a hypersonic inlet. There are four major focal points within this study which examine the boundary layer growth on a compression ramp upstream of the cowl lip of a scramjet inlet. Initially, the boundary layer growth on the NASP Concept Demonstrator Engine (CDE) is examined. The follow-up study determines the optimum diverter height required by the SSTO Flowpath test to best duplicate the CDE results. These flow field computations are then compared to the experimental measurements and the mass average Mach number is determined for this inlet. Author

N95-13892*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
NUMERICAL MODELING OF A CRYOGENIC FLUID WITHIN A FUEL TANK
DONALD S. GREER Washington Oct. 1994 15 p Presented at the Second Thermal Structures Conference, Charlottesville, VA, 18-21 Oct. 1994
(Contract(s)/Grant(s): RTOP 505-70-63)
(NASA-TM-4651; H-2029; NAS 1.15:4651) Copyright Avail: CASI HC A03/MF A01

The computational method developed to study the cryogenic fluid characteristics inside a fuel tank in a hypersonic aircraft is presented. The model simulates a rapid draining of the tank by modeling the ullage vapor and the cryogenic liquid with a moving interface. A mathematical transformation was developed and applied to the Navier-Stokes equations to account for the moving interface. The formulation of the numerical method is a transient hybrid explicit-implicit technique where the pressure term in the momentum equations is approximated to first order in time by combining the continuity equation with an ideal equation of state. Author

N95-14127# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.
TURBOMACHINERY DESIGN USING CFD [LA CONCEPTION DES TURBOMACHINES PAR L'AERODYNAMIQUE NUMERIQUE]
May 1994 251 p Lecture series held in OH, 24-25 May 1994, in Ankara, Turkey, 6-7 Jun. 1994, and in Munich, Germany, 9-10 Jun. 1994 Original contains color illustrations
(AGARD-LS-195; ISBN-92-835-0749-5) Copyright Avail: CASI HC A12/MF A03

Computational Fluid Dynamics (CFD) has become a major design tool for designers of turbomachinery. The progress in this area is fast, and the use of 3-D methods is becoming increasingly applicable to the design process. This Lecture Series will include: (1) Computational methods for preliminary design and geometry definitions; (2) Methods for computing through-flows, blade-to-blade flows and geometry generation; (3) Optimization strategies; (4) Designing in three dimensions; (5) Code validation, mesh influence on solution accuracy; (6) Turbulence and transition modelling; (7) Comparison of time averaged flow solvers and 3-D unsteady CFD codes; (8) Industrial use of CFD and the points of view of the designers. For individual titles, see N95-14128 through N95-14136.

N95-14128# Sulzer Innotec A.G., Winterthur (Switzerland). Fluid Dynamics Lab.
COMPUTATIONAL METHODS FOR PRELIMINARY DESIGN AND GEOMETRY DEFINITION IN TURBOMACHINERY
M. V. CASEY *In* AGARD, Turbomachinery Design Using CFD 22 p May 1994
Copyright Avail: CASI HC A03/MF A03

A review of the turbomachinery preliminary design process is given with particular emphasis on axial and radial compressors. The review covers the selection of machine type, mean-line analysis and correlations, stagestacking calculations and the use of design charts and optimization techniques to find optimum values for design parameters. A comparison is made between the most successful correlations for endwall losses in axial compressors to highlight the different approaches that are possible. The preliminary design process provides an initial definition of the skeletal geometry of the blading and the annulus of the turbomachine. Turbomachinery design systems are then based on design by analysis, whereby the blading is assessed using CFD codes and is iteratively refined. A numerically based parametric blade geometry definition system makes the use of CFD considerably more effective. Examples of modern turbomachinery geometry definition methods involving Bezier surfaces and B-splines are described. Author

N95-14129# General Electric Co., Cincinnati, OH. Aircraft Engines Div.
ELEMENTS OF A MODERN TURBOMACHINERY DESIGN SYSTEM
IAN K. JENNIONS *In* AGARD, Turbomachinery Design Using CFD 22 p May 1994
Copyright Avail: CASI HC A03/MF A03

The aerodynamic design system at GE Aircraft Engines (GEAE) consists of many parts: throughflow, secondary flow, geometry generators, blade-to-blade and fully three-dimensional (3D) analysis. This paper describes each of these elements and discusses optimization and computer architecture issues. Emphasis is placed on those areas in which the company is thought to have special capability. Author

N95-14130# Cambridge Univ., Cambridge (England). Dept. of Engineering.
DESIGNING IN THREE DIMENSIONS
J. D. DENTON *In* AGARD, Turbomachinery Design Using CFD 14 p May 1994
Copyright Avail: CASI HC A03/MF A03

This lecture advocates the direct use of three-dimensional flow calculations for turbomachinery design. The limitations of the usual quasi-three dimensional approach are discussed and it is shown that fully 3D calculations overcome the modelling limitations inherent in them. Fully 3D calculations also avoid the need to iterate between throughflow and blade to blade calculations. This leads to fewer routine operations (e.g. data transfers) being needed during the design process and hence more efficient use of the designer's time. With a flexible geometrical package, able to generate blade sections and transfer their geometry directly to a 3D data set, changes of stage geometry can be made in minutes. An outline of such a package is given. Modern 3D calculation methods, Ref(11), enable complete stage solutions. with adequate accuracy for design purposes, to be obtained in the order of I hour on a workstation. Hence several design iterations per day can be easily be performed for a single stage of a machine. An example used to design a very high pressure ratio (3:1) axial fan is given and discussed. Author (revised)

N95-14132# Pratt and Whitney Aircraft, East Hartford, CT.
UNSTEADY FLOWS IN TURBINES: IMPACT ON DESIGN PROCEDURE
O. P. SHARMA, R. H. NI, and S. TANRIKUT *In* AGARD, Turbomachinery Design Using CFD 27 p May 1994 Original *contains color illustrations*
Copyright Avail: CASI HC A03/MF A03

The impact of recent research activities in unsteady flows and flow simulation methods used in the turbine design process are outlined. Results from a number of experimental investigations are described to quantify the effect of unsteadiness on the time-averaged flows in turbines. Results from numerical simulations, obtained by using 3-D unsteady Computational Fluid Dynamics (CFD) codes, are also shown to indicate that some of the unsteady flow features can be fairly accurately predicted. An overall discussion is presented to distinguish flow parameters that can be modeled with existing steady CFD codes, from those that require unsteady codes. Author

N95-14133# Sulzer Innotec A.G., Winterthur (Switzerland). Fluid Dynamics Lab.
THE INDUSTRIAL USE OF CFD IN THE DESIGN OF TURBOMACHINERY
M. V. CASEY *In* AGARD, Turbomachinery Design Using CFD 24 p May 1994
Copyright Avail: CASI HC A03/MF A03

The numerical simulation of the internal flowfield now plays a major role in all turbomachinery aerodynamic designs, from aero-engines to hydraulic turbines and pumps. With the help of CFD codes an experienced designer is able to produce more adventurous, better engineered and more clearly understood designs more rapidly at lower cost. This paper reviews the use of CFD as an engineering tool in modern turbomachinery design from the standpoint of a turbomachinery designer. Particular attention is given to the current limitations with regard to performance prediction. The necessary engineering criteria used by turbomachinery designers to overcome these limitations and to assess the weak points of their designs using CFD flowfield computations are discussed. Examples of the application of these general aerodynamic design criteria to most classes of turbomachines using a variety of different CFD codes are given. Author

N95-14134# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France). Div. Recherches et Etudes Avancees.
NEW METHODS, NEW METHODOLOGY: ADVANCED CFD IN THE SNECMA TURBOMACHINERY DESIGN PROCESS
CHRISTOPHE VUILLEZ and BERTRAND PETOT *In* AGARD, Turbomachinery Design Using CFD 26 p May 1994 Original contains color illustrations
Copyright Avail: CASI HC A03/MF A03

CFD tools represent a significant source of improvements in the design process of turbomachinery components, leading to higher performances, cost and cycle savings as well as lower associated risks. Such methods are the backbone of compressor and turbine design methodologies at Snecma. In the 80's, the use of 3D Euler solvers was a key factor in designing fan blades with very high performance level. Counter rotating high speed propellers designed with this methodology reached measured performances very close to their ambitious objective from the first test series. In the late 80's and the beginning of the 90's, new, more powerful methods were rapidly developed and are now commonly used in the design process: a quasi-3D, compressible, transonic inverse method; quasi-3D and 3D Navier-Stokes solvers; 3D unsteady Euler solvers. As an example, several hundred 3D Navier-Stokes computations are run yearly for the design of low and high pressure compressor and turbine blades. In addition to their modelling capabilities, the efficient use of such methods in the design process comes from their close integration in the global methodology and from an adequate exploitation environment. Their validation, their calibration, and the correlations between different levels of modelling are of critical importance to an actual improvement in design know-how. The integration of different methods in the design process is described. Several examples of application illustrate their practical utilization. Comparisons between computational results and test results show their capabilities as well as their present limitations. The prospects linked to new developments currently under way are discussed. Author

N95-14135# General Electric Co., Cincinnati, OH. Aircraft Engines Div.
THE ROLE OF CFD IN THE DESIGN PROCESS
IAN K. JENNIONS *In* AGARD, Turbomachinery Design Using CFD 34 p May 1994
Copyright Avail: CASI HC A03/MF A03

Over the last decade the role played by CFD codes in turbomachinery design has changed remarkably. While convergence/ stability or even the existence of unique solutions was discussed fervently ten years ago, CFD codes now form a valuable part of an overall integrated design system and have caused us to re-think much of what we do. The geometric and physical complexities addressed have also evolved, as have the number of software houses competing with in-house developers to provide solutions to daily design problems. This paper reviews how GE Aircraft Engines (GEAE) uses CFD in the turbomachinery design process and examines many of the issues faced in successful code implementation. Author

N95-14136# Technische Univ., Munich (Germany).
AERO DESIGN OF TURBOMACHINERY COMPONENTS: CFD IN COMPLEX SYSTEMS
KLAUS BROICHHAUSEN *In* AGARD, Turbomachinery Design Using CFD 23 p May 1994
Copyright Avail: CASI HC A03/MF A03

The importance of CFD in the design of turbocomponents is no

longer a matter of discussion. Since the fundamental publications of Wu and the first successful attempts to determine the potential 2D flow in blade rows the position of computational fluid dynamics in the design of jet-engine turbocomponents has increased continuously. This mainly has been driven by the two factors 'time' and 'cost'. As a result the design engineer of today can rely on a mature set of numerical approaches for the aerodynamic optimization of turbomachines. This design system is structured differently in the specific companies. Generally, however, an inverse correlation between the complexity of the problem and the complexity of the numerical approach can be observed: The most complex problems rely on relatively simple codes with a big portion of empiricism and vice versa. An overview of the design problems and the application of computational methods is given. Author

N95-14139*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SPIRAL MICROSTRIP ANTENNA WITH RESISTANCE Patent Application
DAVID G. SHIVELY, inventor (to NASA) 28 Jun. 1994 20 p
(NASA-CASE-LAR-15088-1; NAS 1.71:LAR-15088-1; US-PATENT-APPL-SN-269268) Avail: CASI HC A03/MF A01

The present invention relates to microstrip antennas, and more particularly to wide bandwidth spiral antennas with resistive loading. A spiral microstrip antenna having resistor element embedded in each of the spiral arms is provided. The antenna is constructed using a conductive back plane as a base. The back plane supports a dielectric slab having a thickness between one-sixteenth and one-quarter of an inch. A square spiral, having either two or four arms, is attached to the dielectric slab. Each arm of the spiral has resistor elements thereby dissipating an excess energy not already emitted through radiation. The entire configuration provides a thin, flat, high gain, wide bandwidth antenna which requires no underlying cavity. The configuration allows the antenna to be mounted conformably on an aircraft surface. NASA

N95-14183*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
BASE PASSIVE POROSITY FOR DRAG REDUCTION Patent Application
STEVEN X. S. BAUER, inventor (to NASA) and RICHARD M. WOOD, inventor (to NASA) 19 Oct. 1994 13 p
(NASA-CASE-LAR-15246-1; NAS 1.71:LAR-15246-1; US-PATENT-APPL-SN-327061) Avail: CASI HC A03/MF A01

A device for controlling drag on a ground vehicle is presented. The device consists of a porous skin mounted on the trailing surface of the ground vehicle. The porous skin may be separated from the vehicle surface by a distance of at least two times the boundary layer formed on the surface. Alternately, the trailing surface of the ground vehicle may be porous. The device minimizes the strength of the separation in the base and wake regions of the ground vehicle, thus reducing drag. NASA

N95-14201# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
A SELECTION OF EXPERIMENTAL TEST CASES FOR THE VALIDATION OF CFD CODES, VOLUME 1 [RECUEIL DE CAS D'ESSAI EXPERIMENTAUX POUR LA VALIDATION DES CODES DE L'AERODYNAMIQUE NUMERIQUE]
Aug. 1994 152 p See also 95N-17846 and diskette supplement AGARD-AR-303-Suppl
(AGARD-AR-303-VOL-1; ISBN-92-836-1002-4) Copyright Avail: CASI HC A08/MF A02

This report presents the results of a study by Working Group 14 of the AGARD Fluid Dynamics Panel. This group was formed to establish an accessible, detailed experimental data base for the validation of Computational Fluid Dynamics (CFD) codes. The thirty nine test cases that are documented cover the subsonic, transonic, and supersonic flow regimes and five classes of geometries. Included in the five classes of geometries are: two dimensional airfoils; three dimensional wings, designed for predominantly attached flow conditions; slender bodies, typical of missile type configurations; delta wings, characterized by a conical type of vortex flow; and complex configurations, either in a geometrical sense or because of complicated flow interactions. The report is presented in two volumes. Volume 1 provides a review of the theoretical and experimental requirements, a general introduction and summary of the test cases, and recommendations for the future. Volume 2 contains detailed information on the test cases. The relevant data of all test cases has been compiled on floppy disks, which can be obtained through National Centers. Author

N95-14299*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HYPERSONIC ENGINE LEADING EDGE EXPERIMENTS IN A HIGH HEAT FLUX, SUPERSONIC FLOW ENVIRONMENT
HERBERT J. GLADDEN and MATTHEW E. MELIS Oct. 1994 13 p Presented at the Winter Annual Meeting, Chicago, IL, 6-11 Nov. 1994; sponsored by the ASME Original contains color illustrations
(Contract(s)/Grant(s): RTOP 505-62-52)
(NASA-TM-106742; E-9152; NAS 1.15:106742) Avail: CASI HC A03/MF A01; 2 functional color pages

A major concern in advancing the state-of-the-art technologies for hypersonic vehicles is the development of an aeropropulsion system capable of withstanding the sustained high thermal loads expected during hypersonic flight. Three aerothermal load related concerns are the boundary layer transition from laminar to turbulent flow, articulating panel seals in high temperature environments, and strut (or cowl) leading edges with shock-on-shock interactions. A multidisciplinary approach is required to address these technical concerns. A hydrogen/oxygen rocket engine heat source has been developed at the NASA Lewis Research Center as one element in a series of facilities at national laboratories designed to experimentally evaluate the heat transfer and structural response of the strut (or cowl) leading edge. A recent experimental program conducted in this facility is discussed and related to cooling technology capability. The specific objective of the experiment discussed is to evaluate the erosion and oxidation characteristics of a coating on a cowl leading edge (or strut leading edge) in a supersonic, high heat flux environment. Heat transfer analyses of a similar leading edge concept cooled with gaseous hydrogen is included to demonstrate the complexity of the problem resulting from plastic deformation of the structures. Macro-photographic data from a coated leading edge model show progressive degradation over several thermal cycles at aerothermal conditions representative of high Mach number flight. Author

N95-14351# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
EFFECT OF SURFACE ROUGHNESS ON LOCAL FILM COOLING EFFECTIVENESS AND HEAT TRANSFER COEFFICIENTS Ph.D. Thesis
DOUGLAS N. BARLOW Aug. 1994 297 p
(AD-A283854; AFIT/CI/CIA-94-033D) Avail: CASI HC A13/MF A03

In high temperature gas turbine engines, the life cycle of the hot section is extremely dependent on accurate design prediction of component temperature distribution. Particular attention must be paid to the film cooling performance of the first stage turbine stator vanes where the highest heat loads are encountered. Recent investigations have determined during operation the smooth surface of high pressure turbine vanes become rough due to corrosion, oxidation and particulate impact. A transient experimental method has been developed to obtain both local heat transfer and cooling effectiveness information downstream of a row of film cooling holes on a rough flat plate. This investigation provides information on the effects of roughness on film cooling heat transfer for a Reynolds number and dimensionless boundary layer momentum thickness which match conditions applicable to the pressure side of the first stage turbine vane of the Pratt and Whitney F-100-PW229 engine. Data for film cooling on rough surfaces are extremely limited in the literature. However, comparison with the available data is made. DTIC

N95-14405 Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.

COMPOSITE WAVEFORM GENERATION FOR EMP AND LIGHTNING DIRECT-DRIVE TESTING

C. M. GRAVES, JR. (United International Engineering, Inc., Waldorf, MD.) and S. J. FRAZIER 1994 110 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A284159) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

An integral portion of electromagnetic transient (EMT) testing is the survivability assessment. The ultimate goal of the survivability assessment is to establish the margin of survivability for the system under test. The margin of survivability is the ratio of system strength to anticipated stress. Within the EMP (electromagnetic pulses) community, the anticipated stress reflects the responses induced by the simulated EMP environment and extrapolated to the Bell Laboratory's Generalized High-Altitude EMP Waveform; the system strength reflects the stress level required to upset or damage the system under test. One key approach to determine system strength is direct-drive testing. Direct-drive testing involves re-injecting amplified versions of the maximum response waveform at each test point until an operational upset occurs or an accepted drive level is attained. The maximum response waveforms are acquired by measuring defined test points for various simulated EMP environments with the system under test in various orientations and operational configurations. DTIC

N95-14453*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FAA/NASA INTERNATIONAL SYMPOSIUM ON ADVANCED STRUCTURAL INTEGRITY METHODS FOR AIRFRAME DURABILITY AND DAMAGE TOLERANCE

CHARLES E. HARRIS, ed. Sep. 1994 506 p Symposium held in Hampton, VA, 4-6 May 1994 Sponsored by NASA, Washington and FAA

(Contract(s)/Grant(s): RTOP 538-02-10-01)

(NASA-CP-3274-PT-1; L-17432-PT-1; NAS 1.55:3274-PT-1) Avail: CASI HC A22/MF A04

International technical experts in durability and damage tolerance of metallic airframe structures were assembled to present and discuss recent research findings and the development of advanced design and analysis methods, structural concepts, and advanced materials. The symposium focused on the dissemination of new knowledge and the peer-review of progress on the development of advanced methodologies. Papers were presented on: structural concepts for enhanced durability, damage tolerance, and maintainability; new metallic alloys and processing technology; fatigue crack initiation and small crack effects; fatigue crack growth models; fracture mechanics failure, criteria for ductile materials; structural mechanics methodology for residual strength and life prediction; development of flight load spectra for design and testing; and advanced approaches to resist corrosion and environmentally assisted fatigue. For individual titles, see N95-14454 through N95-14486.

N95-14454*# Engineering Software Research and Development, Inc., Saint Louis, MO.

ELASTIC-PLASTIC MODELS FOR MULTI-SITE DAMAGE

RICARDO L. ACTIS and BARNA A. SZABO *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 1-16 Sep. 1994

(Contract(s)/Grant(s): NAG9-622)

Avail: CASI HC A03/MF A04

This paper presents recent developments in advanced analysis methods for the computation of stress site damage. The method of solution is based on the p-version of the finite element method. Its implementation was designed to permit extraction of linear stress intensity factors using a superconvergent extraction method (known as the contour integral method) and evaluation of the J-integral following an elastic-plastic analysis. Coarse meshes are adequate for obtaining accurate results supported by p-convergence data. The elastic-plastic analysis is based on the deformation theory of plasticity and the von Mises yield criterion. The model problem consists of an aluminum plate with six equally spaced holes and a crack emanating from each hole. The cracks are of different sizes. The panel is subjected to a remote tensile load. Experimental results are available for the panel. The plasticity analysis provided the same limit load as the experimentally determined load. The results of elastic-plastic analysis were compared with the results of linear elastic analysis in an effort to evaluate how plastic zone sizes influence the crack growth rates. The onset of net-section yielding was determined also. The results show that crack growth rate is accelerated by the presence of adjacent damage, and the critical crack size is shorter when the effects of plasticity are taken into consideration. This work also addresses the effects of alternative stress-strain laws: The elastic-ideally-plastic material model is compared against the Ramberg-Osgood model. Author

N95-14455*# United Technologies Research Center, East Hartford, CT.

SMALL CRACK TEST PROGRAM FOR HELICOPTER MATERIALS

BAL ANNIGERI and GEORGE SCHNEIDER *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 17-32 Sep. 1994

(Contract(s)/Grant(s): F09603-89-G-0096)

Avail: CASI HC A03/MF A04

Crack propagation tests were conducted to determine crack growth behavior in five helicopter materials for surface cracks between 0.005 to 0.020 inches in depth. Constant amplitude tests were conducted at stress ratios R equals 0.1 and 0.5, and emphasis was placed on near threshold data (i.e., 10-8 to 10-6 inches/cycle). Spectrum tests were conducted using a helicopter spectrum. The test specimen was an unnotched tension specimen, and cracks were initiated from a small EDM notch. An optical/video system was used to monitor crack growth. The material for the test specimens was obtained from helicopter part forgings. Testing was conducted at stresses below yield to reflect actual stresses in helicopter parts. Author

N95-14456*# Purdue Univ., West Lafayette, IN. School of Aeronautics and Astronautics.

BENDING EFFECTS OF UNSYMMETRIC ADHESIVELY BONDED COMPOSITE REPAIRS ON CRACKED ALUMINUM PANELS

CORY ARENDT and C. T. SUN *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 33-48 Sep. 1994

(Contract(s)/Grant(s): AF PROJ. 1397)

Avail: CASI HC A03/MF A04

The bending effects of unsymmetrically bonded composite repairs on cracked aluminum panels were quantified using a plate linear finite element model. Stress intensity factors and strain energy release rates were obtained from the model twice, once with out-of-plane displacement suppressed and another time without these restrictions. Several configurations were examined, crack growth stability was identified, and the effect of a debond was considered. The maximum stress intensity factor was also analyzed. Previous work by other authors was found to underpredict the bending effect. Author

N95-14457*# Textron Specialty Materials, Lowell, MA.

EVALUATION OF BONDED BORON/EPOXY DOUBLERS FOR COMMERCIAL AIRCRAFT ALUMINUM STRUCTURES

BRUCE BELASON, PAUL RUTHERFORD, MATTHEW MILLER, and SHREERAM RAJ *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 49-60 Sep. 1994

Avail: CASI HC A03/MF A04

An 18 month laboratory test and stress analysis program was conducted to evaluate bonded boron/epoxy doublers for repairing

cracks on aluminum aircraft structures. The objective was to obtain a core body of substantiating data which will support approval for use on commercial transports of a technology that is being widely used by the military. The data showed that the doublers had excellent performance. Author

N95-14458*# Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

INSPECTING FOR WIDESPREAD FATIGUE DAMAGE: IS PARTIAL DEBONDING THE KEY?

JOHN BREWER *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 61-70 Sep. 1994
Avail: CASI HC A02/MF A04

Experimental and analytical results indicate that cracks can initiate, grow, and coalesce more rapidly in fuselage lap joints that have experienced partial or complete debonding. Computational analysis in this paper shows that stress concentrations and stress intensity factors at the rivet holes are far less severe when the bond is intact. Debonding hastens the initiation of widespread fatigue cracks and significantly increases crack growth rate. Thus, debonded regions serve as "breeding grounds" for widespread fatigue damage. Therefore, the effectiveness of lap joint inspection programs may be enhanced if detailed inspections are focused on areas in which debonding has been detected. Author

N95-14460*# FractuResearch, Inc., Galena, OH.

TESTING AND ANALYSIS OF FLAT AND CURVED PANELS WITH MULTIPLE CRACKS

DAVID BROEK, DAVID Y. JEONG, and DOUGLAS THOMSON *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 85-98 Sep. 1994
Avail: CASI HC A03/MF A04

An experimental and analytical investigation of multiple cracking in various types of test specimens is described in this paper. The testing phase is comprised of a flat unstiffened panel series and curved stiffened and unstiffened panel series. The test specimens contained various configurations for initial damage. Static loading was applied to these specimens until ultimate failure, while loads and crack propagation were recorded. This data provides the basis for developing and validating methodologies for predicting linkup of multiple cracks, progression to failure, and overall residual strength. The results from twelve flat coupon and ten full scale curved panel tests are presented. In addition, an engineering analysis procedure was developed to predict multiple crack linkup. Reasonable agreement was found between predictions and actual test results for linkup and residual strength for both flat and curved panels. The results indicate that an engineering analysis approach has the potential to quantitatively assess the effect of multiple cracks in the arrest capability of an aircraft fuselage structure. Author

N95-14461*# Israel Aircraft Industries Ltd., Tashan (Israel). Engineering Center.

PROBABILISTIC INSPECTION STRATEGIES FOR MINIMIZING SERVICE FAILURES

ABRAHAM BROT *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 99-109 Sep. 1994
Avail: CASI HC A03/MF A04

The INSIM computer program is described which simulates the 'limited fatigue life' environment in which aircraft structures generally operate. The use of INSIM to develop inspection strategies which aim to minimize service failures is demonstrated. Damage-tolerance methodology, inspection thresholds and customized inspections are simulated using the probability of failure as the driving parameter. Author

N95-14464*# Defence Research Agency, Farnborough, Hampshire (England).

A METHOD OF CALCULATING THE SAFE FATIGUE LIFE OF COMPACT, HIGHLY-STRESSED COMPONENTS

ARTHUR W. CARDICK and VERA J. PIKE *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 145-156 Sep. 1994
Avail: CASI HC A03/MF A04

This paper describes a method which has been developed for estimating the safe fatigue life of compact, highly-stressed and inaccessible components for aeroplanes and helicopters of the Royal Air Force. It is explained why the Design Requirements for British Military Aircraft do not favor the use of a damage-tolerance approach in these circumstances. Author

N95-14466*# Stevens Inst. of Tech., Hoboken, NJ. Dept. of Mechanical Engineering.

COMPUTATIONAL PREDICTIVE METHODS FOR FRACTURE AND FATIGUE

J. CORDES, A. T. CHANG, N. NELSON, and Y. KIM *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 175-192 Sep. 1994
Avail: CASI HC A03/MF A04

The damage-tolerant design philosophy as used by aircraft industries enables aircraft components and aircraft structures to operate safely with minor damage, small cracks, and flaws. Maintenance and inspection procedures insure that damages developed during service remain below design values. When damage is found, repairs or design modifications are implemented and flight is resumed. Design and redesign guidelines, such as military specifications MIL-A-83444, have successfully reduced the incidence of damage and cracks. However, fatigue cracks continue to appear in aircraft well before the design life has expired. The F16 airplane, for instance, developed small cracks in the engine mount, wing support, bulk heads, the fuselage upper skin, the fuel shelf joints, and along the upper wings. Some cracks were found after 600 hours of the 8000 hour design service life and design modifications were required. Tests on the F16 plane showed that the design loading conditions were close to the predicted loading conditions. Improvements to analytic methods for predicting fatigue crack growth adjacent to holes, when multiple damage sites are present, and in corrosive environments would result in more cost-effective designs, fewer repairs, and fewer redesigns. The overall objective of the research described in this paper is to develop, verify, and extend the computational efficiency of analysis procedures necessary for damage tolerant design. This paper describes an elastic/plastic fracture method and an associated fatigue analysis method for damage tolerant design. Both methods are unique in that material parameters such as fracture toughness, R-curve data, and fatigue constants are not required. The methods are implemented with a general-purpose finite element package. Several proof-of-concept examples are given. With further development, the methods could be extended for analysis of multi-site damage, creep-fatigue, and corrosion fatigue problems. Author

N95-14467*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

INFLUENCE OF CRACK HISTORY ON THE STABLE TEARING BEHAVIOR OF A THIN-SHEET MATERIAL WITH MULTIPLE CRACKS

D. S. DAWICKE (Analytical Services and Materials, Inc., Hampton, VA.), J. C. NEWMAN, JR., M. A. SUTTON, and B. E. AMSTUTZ *In its* FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 193-212 Sep. 1994
Avail: CASI HC A03/MF A04

Fracture tests were conducted on 2.3mm thick, 305mm wide sheets of 2024-T3 aluminum alloy with from one to five collinear cracks. The cracks were introduced (crack history) into the specimens by three methods: saw cutting, fatigue precracking at a low stress range, and fatigue precracking at a high stress range. For the single crack tests, the

initial crack history influenced the stress required for the onset of stable crack growth and the first 10mm of crack growth. The effect on failure stress was about 4 percent or less. For the multiple crack tests, the initial crack history was shown to cause differences of more than 20 percent in the link-up stress and 13 percent in failure stress. An elastic-plastic finite element analysis employing the CTOA fracture criterion was used to predict the fracture behavior of the single and multiple crack tests. The numerical predictions were within 7 percent of the observed link-up and failure stress in all the tests. Author

N95-14468*# Rutgers Univ., Piscataway, NJ. Federal Aviation Administration for Computational Modeling of Aircraft Structures.

STUDY OF MULTIPLE CRACKS IN AIRPLANE FUSELAGE BY MICROMECHANICS AND COMPLEX VARIABLES

MITSUNORI DENDA and Y. F. DONG *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 213-223 Sep. 1994

Avail: CASI HC A03/MF A04

Innovative numerical techniques for two dimensional elastic and elastic-plastic multiple crack problems are presented using micromechanics concepts and complex variables. The simplicity and the accuracy of the proposed method will enable us to carry out the multiple-site fatigue crack propagation analyses for airplane fuselage by incorporating such features as the curvilinear crack path, plastic deformation, coalescence of cracks, etc. Author

N95-14470*# Utah Univ., Salt Lake City, UT. Quality and Integrity Design Engineering Center.

THE ROLE OF FRETTING CORROSION AND FRETTING FATIGUE IN AIRCRAFT RIVET HOLE CRACKING Status Report

CHARLES B. ELLIOTT, III, MARK MOESSER, and DAVID W. HOEPPNER *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 241-246 Sep. 1994 (Contract(s)/Grant(s): FAA-92-G-0004; FAA-93-G-0068)

Avail: CASI HC A02/MF A04

Personnel in the Quality and Integrity Design Engineering Center (QIDEC) at the University of Utah are working under a two year grant from the FAA to better understand the role of fretting corrosion and fretting fatigue in aircraft rivet hole cracking. The current program follows a one year grant program which was completed in 1993. This paper provides a status report on the results of these grant programs. Recent effort has been focused on developing basic fretting fatigue models which consider variation in the coefficient of friction with time and location within the fretting interface. This is a very important characteristic of the QIDEC model because coefficient of friction varies significantly during the fretting fatigue process. Copies of QIDEC documents discussed in this paper can be obtained by contacting the authors. Author

N95-14473*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

DEVELOPMENT OF THE NASA/FLAGRO COMPUTER PROGRAM FOR ANALYSIS OF AIRFRAME STRUCTURES

R. G. FORMAN, V. SHIVAKUMAR, and J. C. NEWMAN, JR. *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 277-288 Sep. 1994

Avail: CASI HC A03/MF A04

The NASA/FLAGRO (NASGRO) computer program was developed for fracture control analysis of space hardware and is currently the standard computer code in NASA, the U.S. Air Force, and the European Agency (ESA) for this purpose. The significant attributes of the NASGRO program are the numerous crack case solutions, the large materials file, the improved growth rate equation based on crack closure theory, and the user-friendly promptive input features. In support of the National Aging Aircraft Research Program (NAARP); NASGRO is being further developed to provide advanced state-of-the-art capability for damage tolerance and crack growth analysis of aircraft structural problems, including mechanical systems and engines. The project currently involves a cooperative development effort by NASA, FAA, and ESA. The primary tasks underway are the incorporation of advanced methodology for crack growth rate retardation resulting from spectrum loading and improved analysis for determining crack instability. Also, the current weight function solutions in NASGRO or nonlinear stress gradient problems are being extended to more crack cases, and the 2-d boundary integral routine for stress analysis and stress-intensity factor solutions is being extended to 3-d problems. Lastly, effort is underway to enhance the program to operate on personal computers and work stations in a Windows environment. Because of the increasing and already wide usage of NASGRO, the code offers an excellent mechanism for technology transfer for new fatigue and fracture mechanics capabilities developed within NAARP. Author

N95-14475*# Northwestern Univ., Evanston, IL. School of Engineering and Applied Science.

FATIGUE RELIABILITY METHOD WITH IN-SERVICE INSPECTIONS

H. H. HARKNESS, M. FLEMING, B. MORAN, and T. BELYTSCHKO *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 307-326 Sep. 1994 Sponsored in part by National Inst. for Standards and Technology and FAA

Avail: CASI HC A03/MF A04

The first reliability method (FORM) has traditionally been applied in a fatigue reliability setting to one inspection interval at a time, so that the random distribution of crack lengths must be recharacterized following each inspection. The FORM presented here allow each analysis to span several inspection periods without explicit characterization of the crack length distribution upon each inspection. The method thereby preserves the attractive feature of FORM in that relatively few realizations in the random variable space need to be considered. Examples are given which show that the present methodology gives estimates which are in good agreement with Monte Carlo simulations and is efficient even for complex components. Author

N95-14476*# Federal Aviation Administration, Cambridge, MA. Research and Special Programs Administration.

NONLINEAR BULGING FACTOR BASED ON R-CURVE DATA

DAVID Y. JEONG and PIN TONG *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 327-338 Sep. 1994

Avail: CASI HC A03/MF A04

In this paper, a nonlinear bulging factor is derived using a strain energy approach combined with dimensional analysis. The functional form of the bulging factor contains an empirical constant that is determined using R-curve data from unstiffened flat and curved panel tests. The determination of this empirical constant is based on the assumption that the R-curve is the same for both flat and curved panels. Author

N95-14479*# Washington Univ., Seattle, WA. Dept. of Mechanical Engineering.

AXIAL CRACK PROPAGATION AND ARREST IN PRESSURIZED FUSELAGE

M. KOSAI, A. SHIMAMOTO, C.-T. YU, S. I. WALKER, A. S. KOBAYASHI, and P. TAN *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 375-392 Sep. 1994

(Contract(s)/Grant(s): FAA-92-G-0005)

Avail: CASI HC A03/MF A04

The crack arrest capability of a tear strap in a pressurized precracked fuselage was studied through instrumented axial rupture tests of small scale models of an idealized fuselage. Upon pressurization, rapid crack propagation initiated at an axial through crack along the

stringer and immediately kinked due to the mixed modes 1 and 2 state caused by the one-sided opening of the crack flap. The diagonally running crack further turned at the tear straps. Dynamic finite element analysis of the rupturing cylinder showed that the crack kinked and also ran straight in the presence of a mixed mode state according to a modified two-parameter crack kinking criterion. Author

N95-14480*# Georgia Inst. of Tech., Atlanta, GA. School of Mechanical Engineering.

FRACTURE MECHANICS VALIDITY LIMITS

DENNIS M. LAMBERT and HUGO A. ERNST *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 393-407 Sep. 1994

Avail: CASI HC A03/MF A04

Fracture behavior is characteristics of a dramatic loss of strength compared to elastic deformation behavior. Fracture parameters have been developed and exhibit a range within which each is valid for predicting growth. Each is limited by the assumptions made in its development: all are defined within a specific context. For example, the stress intensity parameters, K, and the crack driving force, G, are derived using an assumption of linear elasticity. To use K or G, the zone of plasticity must be small as compared to the physical dimensions of the object being loaded. This insures an elastic response, and in this context, K and G will work well. *Rice's J-integral has been used beyond* the limits imposed on K and G. J requires an assumption of nonlinear elasticity, which is not characteristic of real material behavior, but is thought to be a reasonable approximation if unloading is kept to a minimum. As well, the constraint cannot change dramatically (typically, the crack extension is limited to ten-percent of the initial remaining ligament length). Rice, et al investigated the properties required of J-type parameters, J(sub x), and showed that the time rate, dJ(sub x)/dt, must not be a function of the crack extension rate, da/dt. Ernst devised *the modified-J parameter, J(sub M), that meets this criterion. J(sub M)* correlates fracture data to much higher crack growth than does J. Ultimately, a limit of the validity of J(sub M) is anticipated, and this has been estimated to be at a crack extension of about 40-percent of the initial remaining ligament length. None of the various parameters can be expected to describe fracture in an environment of gross plasticity, in which case the process is better described by deformation parameters, e.g., stress and strain. In the current study, various schemes to identify the onset of the plasticity-dominated behavior, i.e., the end of fracture mechanics validity, are presented. Each validity limit parameter is developed in detail, and then data is presented and the various schemes for establishing a limit of the validity are compared. The selected limiting parameter is applied to a set of fracture data showing the improvement of correlation gained. Author (revised)

N95-14484*# Southwest Research Inst., San Antonio, TX.

ANALYSIS OF SMALL CRACK BEHAVIOR FOR AIRFRAME APPLICATIONS

R. C. MCCLUNG, K. S. CHAN, S. J. HUDAK, JR., and D. L. DAVIDSON *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 463-479 Sep. 1994 Sponsored in part by AFOSR; AFWAL; ARO; and ONR

Avail: CASI HC A03/MF A04

The small fatigue crack problem is critically reviewed from the perspective of airframe applications. Different types of small cracks-microstructural, mechanical, and chemical-are carefully defined and relevant mechanisms identified. Appropriate analysis techniques, including both rigorous scientific and practical engineering treatments, are briefly described. Important materials data issues are addressed, including increased scatter in small crack data and recommended small crack test methods. Key problems requiring further study are highlighted. Author

N95-14485*# Boeing Co., Seattle, WA.

FULL-SCALE TESTING AND ANALYSIS OF FUSELAGE STRUCTURE

M. MILLER, M. L. GRUBER, K. E. WILKINS, and R. E. WORDEN *In* NASA. Langley Research Center, FAA/NASA International Symposium on Advanced Structural Integrity Methods for Airframe Durability and Damage Tolerance p 481-496 Sep. 1994

Avail: CASI HC A03/MF A04

This paper presents recent results from a program in the Boeing Commercial Airplane Group to study the behavior of cracks in fuselage *structures. The goal of this program is to improve methods for analyzing* crack growth and residual strength in pressurized fuselages, thus improving new airplane designs and optimizing the required structural inspections for current models. The program consists of full-scale experimental testing of pressurized fuselage panels in both wide-body and narrow-body fixtures and finite element analyses to predict the results. The finite element analyses are geometrically nonlinear with material and fastener nonlinearity included on a case-by-case basis. The analysis results are compared with the strain gage, crack growth, *and residual strength data from the experimental program. Most of the* studies reported in this paper concern the behavior of single or multiple cracks in the lap joints of narrow-body airplanes (such as 727 and 737 commercial jets). The phenomenon where the crack trajectory is curved creating a 'flap' and resulting in a controlled decompression is discussed. Author

N95-14556*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CHARACTERIZATION OF ANNULAR TWO-PHASE GAS-LIQUID FLOWS IN MICROGRAVITY

W. SCOTT BOUSMAN (Houston Univ., TX.) and JOHN B. MCQUILLEN *In its* Second Microgravity Fluid Physics Conference p 227-232 Aug. 1994

(Contract(s)/Grant(s): NAG3-510)

Avail: CASI HC A02/MF A04; 2 functional color pages

A series of two-phase gas-liquid flow experiments were developed to study annular flows in microgravity using the NASA Lewis Learjet. A test section was built to measure the liquid film thickness around the perimeter of the tube permitting the three dimensional nature of the gas-liquid interface to be observed. A second test section was used to measure the film thickness, pressure drop and wall shear stress in *annular microgravity two-phase flows. Three liquids were studied to* determine the effects of liquid viscosity and surface tension. The result of this study provide insight into the wave characteristics, pressure drop and droplet entrainment in microgravity annular flows. Author

N95-14563*# Carnegie-Mellon Univ., Pittsburgh, PA.

TRANSPORT PHENOMENA IN STRATIFIED MULTI-FLUID FLO W IN THE PRESENCE AND ABSENCE OF GRAVITY

NORMAN CHIGIER, MIN XU, DAVID SQUARER, and NASSER RASHIDNIA *In* NASA. Lewis Research Center, Second Microgravity Fluid Physics Conference p 273-278 Aug. 1994

Avail: CASI HC A02/MF A04; 2 functional color pages

An experiment is being conducted to study the effects of buoyancy on planar stratified flows. A wind tunnel has been designed and constructed to generate planar flows with separate heating for the top and bottom planar air jets emerging from slot nozzles separated by an insulating splitter plate. The objective is to generate planar jet flows with well defined and well controlled velocity and temperature profiles. Magnitudes of velocity and temperature will be varied separately in each flow for both laminar and turbulent flow conditions. Both stably and unstably stratified flows will be studied by changing the temperature distributions in each air stream. This paper reports on the design of the apparatus and initial measurements of velocity and turbulence made by laser Doppler velocimetry. Author

N95-14617*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENTAL/ANALYTICAL APPROACH TO UNDERSTANDING MISTUNING IN A TRANSONIC WIND TUNNEL COMPRESSOR

TERI KAISER, REED S. HANSEN, NHAN NGUYEN, ROY W. HAMPTON, DOUG MUZZIO, MLADEN K. CHARGIN, ROY GUIST, KEN HAMM, and LEN WALKER Jun. 1994 16 p

(NASA-TM-108833; A-94104; NAS 1.15:108833) Avail: CASI HC A03/MF A01

This paper will briefly set forth some of the basic tenets of mistuned rotating bladed-disk assemblies. The experience with an existing three stage compressor in a transonic wind tunnel will be documented. The manner in which the theoretical properties manifest themselves in this non-ideal compressor will be described. A description of mistuning behaviors that can and cannot be accurately substantiated will be discussed. Author

N95-14658 Naval Postgraduate School, Monterey, CA. Dept. of Mechanical Engineering.

SPECTRAL ANALYSIS OF VORTEX/FREE-SURFACE INTERACTION M.S. Thesis

GLENN D. HOFERT Jun. 1994 73 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A283210) Avail: CASI HC A04

The unsteady flow phenomena resulting from the interaction of vorticity with a free surface has been investigated through the use of a three-color Laser Doppler-Velocimeter. The vorticity field was provided by a single tip vortex generated by an airfoil, placed in the test section of a recirculating water tunnel at a suitable angle of attack. All of the statistical quantities of flow such as turbulence and Reynolds stresses and in particular the spectrum of the fluctuations have been measured and analyzed. The results have shown that the free surface redistributes part or all of the normal turbulent kinetic energy into streamwise and spanwise components. Furthermore, the energy spectra have also shown that there exists an energy gradient on the free surface, on either side of the vertical passing through the original vortex. It is believed that the scars observed on the free surface are a consequence of the matching of the Bragg wave length with the wave length of the surface signatures within a particular spectrum. DTIC

N95-14879*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN OPTICAL TECHNIQUE FOR EXAMINING AIRCRAFT SHOCK WAVE STRUCTURES IN FLIGHT

LEONARD M. WEINSTEIN *In its* High-Speed Research: 1994 Sonic Boom Workshop: Atmospheric Propagation and Acceptability Studies p 1-17 Oct. 1994

Avail: CASI HC A03/MF A03

The detailed properties of sonic booms have to be better understood before commercial, next generation, supersonic and hypersonic *aircraft can be properly developed. Experimental tests and measure*ments are needed to help sort the physical details of the flows at realistic test conditions. Some of these tests can be made in wind tunnels, but the need for full flight conditions simulation, the problem of tunnel wall interference, and the short distance the shocks can be examined from the aircraft, limit the usefulness of wind tunnel tests. Previous measurement techniques for examining the flow field of aircraft in flight have included pressure measurements on the aircraft, ground based pressure measurements, and flow field measurements made with chase aircraft. Obtaining data with chase planes is a slow and difficult process, and is limited in how close it can be obtained to the test aircraft. A need clearly existed for a better technique to examine the shock structure from the plane to large distances from the plane. A new technique has been recently developed to obtain schlieren photographs of aircraft in flight (SAF). Preliminary results have been obtained, and the technique holds promise as a tool to study the shape and approximate strength of the shock wave structure around the test aircraft, and examine shock wave details all the way from the aircraft to near the ground. The current paper describes this approach, and gives some preliminary test results. Author

N95-14912*# Lockheed Engineering and Sciences Co., Hampton, VA.

AN APPROXIMATE RIEMANN SOLVER FOR THERMAL AND CHEMICAL NONEQUILIBRIUM FLOWS

RAMADAS K. PRABHU Oct. 1994 18 p

(Contract(s)/Grant(s): NAS1-19000; RTOP 232-01-04-06)

(NASA-CR-195003; NAS 1.26:195003) Avail: CASI HC A03/MF A01

Among the many methods available for the determination of inviscid fluxes across a surface of discontinuity, the flux-difference-splitting technique that employs Roe-averaged variables has been used extensively by the CFD community because of its simplicity and its ability to capture shocks exactly. This method, originally developed for perfect gas flows, has since been extended to equilibrium as well as nonequilibrium flows. Determination of the Roe-averaged variables for the case of a perfect gas flow is a simple task; however, for thermal and chemical nonequilibrium flows, some of the variables are not uniquely defined. Methods available in the literature to determine these variables seem to lack sound bases. The present paper describes a simple, yet accurate, method to determine all the variables for nonequilibrium flows in the Roe-average state. The basis for this method is the requirement that the Roe-averaged variables form a consistent set of thermodynamic variables. The present method satisfies the requirement that the square of the speed of sound be positive. Author

N95-14922*# Eloret Corp., Palo Alto, CA.

DEVELOPMENT AND APPLICATION OF STRUCTURAL DYNAMICS ANALYSIS CAPABILITIES Final Technical Report, 1 Feb. 1988 - 30 Sep. 1994

KLAUS W. HEINEMANN and SHIG HOZAKI 15 Nov. 1994 240 p

(Contract(s)/Grant(s): NCC2-518)

(NASA-CR-197229; NAS 1.26:197229) Avail: CASI HC A11/MF A03

Extensive research activities were performed in the area of *multidisciplinary modeling and simulation of aerospace vehicles that* are relevant to NASA Dryden Flight Research Facility. The efforts involved theoretical development, computer coding, and debugging of the STARS code. New solution procedures were developed in such areas as structures, CFD, and graphics, among others. Furthermore, systems-oriented codes were developed for rendering the code truly multidisciplinary and rather automated in nature. Also, work was performed in pre- and post-processing of engineering analysis data. Author

N95-15306* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

LANDING GEAR ENERGY ABSORPTION SYSTEM Patent

CHRISTOPHER P. HANSEN, inventor (to NASA) 22 Nov. 1994 7 p Filed 1 Dec. 1993 Supersedes N94-29448 (32 - 8, p 3300)

(NASA-CASE-MSC-22277-1; US-PATENT-5,366,181; US-PATENT-APPL-SN-159606; US-PATENT-CLASS-244-104R; US-PATENT-CLASS-244-100R; US-PATENT-CLASS-188-381; INT-PATENT-CLASS-B64C-25/58) Avail: US Patent and Trademark Office

A landing pad system is described for absorbing horizontal and vertical impact forces upon engagement with a landing surface where *circumferentially arranged landing struts respectively have a clevis* which receives a slidable rod member and where the upper portion of a slidable rod member is coupled to the clevis by friction washers which are force fit onto the rod member to provide for controlled constant force energy absorption when the rod member moves relative to the clevis. The lower end of the friction rod is pivotally attached by a ball and socket to a support plate where the support plate is arranged to slide in a transverse direction relative to a housing which contains an energy absorption material for absorbing energy in a transverse direction. Official Gazette of the U.S. Patent and Trademark Office

N95-15547 Wright Lab., Wright-Patterson AFB, OH.

LARGE AMPLITUDE NONLINEAR RESPONSE OF FLAT ALUMINUM, AND CARBON FIBER PLASTIC BEAMS AND PLATES Interim Report, 1 Oct. 1992 - 1 Sep. 1993

HOWARD F. WOLFE and CYNTHIA A. SHROYER Jun. 1994 92 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): AF PROJ. 2401)

(AD-A282440; WL-TM-94-3077) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This progress report presents the results of a continuing study to improve the understanding of nonlinear dynamic behavior of aerospace structures subjected to high levels of excitation. Tests were continued with a clamped-clamped (C-C) aluminum beam. A summary of the results is presented. Tests were conducted with a C-C carbon fiber reinforced plastic (CFRP) beam and a pinned-pinned (P-P) aluminum beam. A summary of these results is also presented. Flat plate tests began with an aluminum plate. The shapes of the total, axial, and bending strain power spectral densities for the C-C aluminum and the CFRP beams were quite similar. Both showed a small frequency increase and slight peak broadening as the levels of excitation increased. The nonlinear displacement shapes for the two cases were also quite similar. Further analysis is needed for the P-P aluminum beam case. Finally, a method of estimating the RMS stress for the multimodal response of a panel is presented. DTIC

N95-15604*# Lockheed Engineering and Sciences Co., Hampton, VA.

LAMINAR AND TURBULENT FLOW COMPUTATIONS OF TYPE 4 SHOCK-SHOCK INTERFERENCE AEROTHERMAL LOADS USING UNSTRUCTURED GRIDS

GURURAJA R. VEMAGANTI Oct. 1994 58 p

(Contract(s)/Grant(s): NAS1-19000; RTOP 232-01-04-06)

(NASA-CR-195008; NAS 1.26:195008) Avail: CASI HC A04/MF A01

This report presents computations for the Type 4 shock-shock interference flow under laminar and turbulent conditions using unstructured grids. Mesh adaptation was accomplished by remeshing, refinement, and mesh movement. Two two-equation turbulence models were used to analyze turbulent flows. The mean flow governing equations and the turbulence governing equations are solved in a coupled manner. The solution algorithm and the details pertaining to its implementation on unstructured grids are described. Computations were performed at two different freestream Reynolds numbers at a freestream Mach number of 11. Effects of the variation in the impinging shock location are studied. The comparison of the results in terms of wall heat flux and wall pressure distributions is presented. Author

N95-15728*# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.

ASSESSMENT OF CTAS ETA PREDICTION CAPABILITIES Annual Report

MICHAEL A. BOLENDER 1 Nov. 1994 42 p

(Contract(s)/Grant(s): NCC2-669)

(NASA-CR-197224; NAS 1.26:197224) Avail: CASI HC A03/MF A01

This report summarizes the work done to date in assessing the trajectory fidelity and estimated time of arrival (ETA) prediction capability of the NASA Ames Center TRACON Automation System (CTAS) software. The CTAS software suite is a series of computer programs designed to aid air traffic controllers in their tasks of safely scheduling the landing sequence of approaching aircraft. in particular, this report concerns the accuracy of the available measurements (e.g., position, altitude, etc.) that are input to the software, as well as the accuracy of the final data that is made available to the air traffic controllers.

Derived from text

N95-15785*# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.

GROUNDSPEED FILTERING FOR CTAS

GARY L. SLATER 11 Nov. 1994 16 p

(Contract(s)/Grant(s): NCC2-669)

(NASA-CR-197223; NAS 1.26:197223) Avail: CASI HC A03/MF A01

Ground speed is one of the radar observables which is obtained along with position and heading from NASA Ames Center radar. Within the Center TRACON Automation System (CTAS), groundspeed is converted into airspeed using the wind speeds which CTAS obtains from the NOAA weather grid. This airspeed is then used in the trajectory synthesis logic which computes the trajectory for each individual aircraft. The time history of the typical radar groundspeed data is generally quite noisy, with high frequency variations on the order of five knots, and occasional 'outliers' which can be significantly different from the probable true speed. To try to smooth out these speeds and make the ETA estimate less erratic, filtering of the ground speed is done within CTAS. In its base form, the CTAS filter is a 'moving average' filter which averages the last ten radar values. In addition, there is separate logic to detect and correct for 'outliers', and acceleration logic which limits the groundspeed change in adjacent time samples. As will be shown, these additional modifications do cause significant changes in the actual groundspeed filter output. The conclusion is that the current ground speed filter logic is unable to track accurately the speed variations observed on many aircraft. The Kalman filter logic however, appears to be an improvement to the current algorithm used to smooth ground speed variations, while being simpler and more efficient to implement. Additional logic which can test for true 'outliers' can easily be added by looking at the difference in the a priori and post priori Kalman estimates, and not updating if the difference in these quantities is too large.

Derived from text

N95-15898*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

WIND-TUNNEL BLOCKAGE AND ACTUATION SYSTEMS TEST OF A TWO-DIMENSIONAL SCRAMJET INLET UNSTART MODEL AT MACH 6

SCOTT D. HOLLAND Nov. 1994 38 p See also videotape supplement L-0194-41

(Contract(s)/Grant(s): RTOP 763-23-35-08)

(NASA-TM-109152; NAS 1.15:109152) Avail: CASI HC A03/MF A01

The present study examines the wind-tunnel blockage and actuation systems effectiveness in starting and forcibly unstarting a two-dimensional scramjet inlet in the NASA Langley 20-Inch Mach 6 Tunnel. The intent of the overall test program is to study (both experimentally and computationally) the dynamics of the inlet unstart; however, prior to the design and fabrication of an expensive, instrumented wind-tunnel model, it was deemed necessary first to examine potential wind-tunnel blockage issues related to model sizing and to examine the adequacy of the actuation systems in accomplishing the start and unstart. The model is equipped with both a moveable cowl and aft plug. Windows in the inlet sidewalls allow limited optical access to the internal shock structure; schlieren video was used to identify inlet start and unstart. A chronology of each actuation sequence is provided in tabular form along with still frames from the schlieren video. A pitot probe monitored the freestream conditions throughout the start/unstart process to determine if there was a blockage effect due to the model start or unstart. Because the purpose of this report is to make the phase I (blockage and actuation systems) data rapidly available to the community, the data is presented largely without analysis of the internal shock interactions or the unstart process. This series of tests indicated that the model was appropriately sized for this facility and identified operability limits required first to allow the inlet to start and second to force the unstart. Author

N95-15899* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

TWO-DIMENSIONAL SCRAMJET INLET UNSTART MODEL: WIND-TUNNEL BLOCKAGE AND ACTUATION SYSTEMS TEST (Videotape Supplement)

SCOTT D. HOLLAND Nov. 1994 See also NASA-TM-109152 Videotape supplement: 10 min. 52 sec. playing time, in color, in VHS and Beta formats

(Contract(s)/Grant(s): RTOP 763-23-35-08)

(NASA-TM-109984; NONP-NASA-SUPPL-VT-94-32020) Avail: CASI VHS A02/BETA A22

This supplement to NASA TM 109152 shows the Schlieren video (10 min. 52 sec., color, Beta and VHS) of the external flow field and a portion of the internal flow field of a two-dimensional scramjet inlet

model in the NASA Langley 20-Inch Mach 6 Tunnel. The intent of the overall test program is to study (both experimentally and computationally) the dynamics of the inlet unstart; this (phase I) effort examines potential wind-tunnel blockage issues related to model sizing and the adequacy of the actuation systems in accomplishing the start and unstart. The model is equipped with both a moveable cowl and aft plug. Windows in the inlet sidewalls allow limited optical access to the internal shock structure. In the video, flow is from right to left, and the inlet is oriented inverted with respect to flight, i.e., with the cowl on top. The plug motion is obvious because the plug is visible in the aft window. The cowl motion, however, is not as obvious because the cowl is hidden from view by the inlet sidewall. The end of the cowl actuator arm, however, becomes visible above the inlet sidewalls between the windows when the cowl is up (see figure 1b of the primary document). The model is injected into the tunnel and observed though several actuation sequences with two plug configurations over a range of unit freestream Reynolds number at a nominal freestream Mach number of 6. The framing rate and shutter speed of the camera were too slow to fully capture the dynamics of the unstart but did prove sufficient to identify inlet start and unstart. This series of tests indicated that the model was appropriately sized for this facility and identified operability limits required first to allow the inlet to start and second to force the unstart. Author

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GEOSCIENCES

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

A95-62279* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
APPLICATION OF AIRBORNE FIELD MILL DATA FOR USE IN LAUNCH SUPPORT
RAY HARRIS-HOBBS Aeromet, Inc., Tulsa, OK, US, KATHY GIORI SRI International, Menlo Park, CA, US, MICHAEL BELLMORE Aeromet, Inc., Tulsa, OK, US, and ARLEEN LUNSFORD Aeromet, Inc., Tulsa, OK, US Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572) vol. 11, no. 3 June 1994 p. 738-750
(Contract(s)/Grant(s): DASG60-84-C-0117; DASG60-89-C-0147; F04701-90-C-0023; NAS10-11853)
(HTN-95-50054) Copyright

An airborne field mill (ABFM) system was implemented on a Learjet 36A and was used to collect electric-field and microphysical data for summertime convective clouds near Cape Canaveral and the Kennedy Space Center. This system is described and the method used for calibrating it is outlined. Data from this ABFM system were used to investigate the relationship between the strengths of electric fields at the boundaries of summer maritime convective clouds and the distances from these cloud where the fields could first be detected by this system. The relationship between the electric-field strengths at the boundaries of convective clouds and selected radar-measurable parameters of these clouds were also investigated. This study shows promise that the radar volume of these clouds can be used to estimate the order of magnitude electric-field intensity. It is possible that selected remote radar measurements could be incorporated into the launch commit criteria as a means of providing greater confidence and flexibility for determining safe stand-off distances for launch vehicles from convective clouds. Author (Herner)

N95-13725*# *Cincinnati Univ., OH. Dept. of Aerospace Engineering* and Engineering Mechanics.
ATMOSPHERIC AND WIND MODELING FOR ATC Final Report
GARY L. SLATER Nov. 1990 48 p
(Contract(s)/Grant(s): NAG2-175)
(NASA-CR-196786; NAS 1.26:196786) Avail: CASI HC A03/MF A01

The section on atmospheric modeling covers the following topics: the standard atmosphere, atmospheric variations, atmosphere requirements for ATC, and implementation of a software model for Center/Tracon Advisory System (CTAS). The section on wind modeling covers the following topics: wind data — NOAA profiler system; wind profile estimation; incorporation of various data types into filtering scheme; spatial and temporal variation; and software implementation into CTAS. The appendices contain Matlab codes for atmospheric routines and for wind estimation. CASI

N95-13885*# Aerojet-General Corp., Azusa, CA.
EARTH OBSERVING SYSTEM (EOS)/ADVANCED MICROWAVE SOUNDING UNIT-A (AMSU-A) SOFTWARE ASSURANCE PLAN Final Report, 1-28 Feb. 1994
ROBERT SCHWANTJE and CLAUDE SMITH Aug. 1994 51 p
(Contract(s)/Grant(s): NAS5-32314)
(NASA-CR-196059; NAS 1.26:196059; CRDL-309; REPT-10428A)
Avail: CASI HC A04/MF A01

This document defines the responsibilities of Software Quality Assurance (SOA) for the development of the flight software installed in EOS/AMSU-A instruments, and the ground support software used in the test and integration of the EOS/AMSU-A instruments. Author

N95-15749# Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.
TDWR SCAN STRATEGY IMPLEMENTATION
DANIEL P. HYNEK 2 Sep. 1994 19 p
(Contract(s)/Grant(s): DTFA01-93-Z-02012; F19628-90-C-0002)
(AD-A284877; ATC-222) Avail: CASI HC A03/MF A01

The Terminal Doppler Weather Radars (TDWR's) installed at major airports around the country are intended to enhance the safety of air travel by the detection and timely warning of hazardous wind shear conditions in the airport terminal area. To meet these objectives, scan strategies to efficiently cover the protected airspace were developed after extensive testing at several sites with different meteorological environments. Since the topology and geometry differ at each TDWR location, special considerations were necessary to define the specific scan sequences for each site. This report describes the criteria used to establish these scan sequences, including the determination of the lowest practicable elevation angle for each site - the 'surface scan,' which is used to detect microburst surface outflows, and other special scans such as the 'MTS scan,' which is used to illuminate the remote Moving Target Simulator (MTS). DTIC

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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.

A95-62262
STABILIZATION OF OBJECTS WITH UNKNOWN NONSTATIONARY PARAMETERS, USING ADAPTIVE NONLINEAR CONTINUOUS CONTROL SYSTEMS
B. V. ULANOV UPI, Uralsk (Russia) Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 21-24 In RUSSIAN refs
(BTN-94-EIX94461407944) Copyright

In solving problems associated with flight control, adaptive sys-

tems are widely employed. To meet practical requirements such as limitations for the amount and continuity of control, adaptive nonlinear continuous control has been synthesized. Such control stabilizes an object with unknown nonstationary parameters, varying arbitrarily but within a limited range. The nonlinear type of control gives the opportunity to withstand limitations for the amount of control. EI

N95-13727*# Texas A&M Univ., College Station, TX. Dept. of Electrical Engineering.

KNOWLEDGE-BASED PROCESSING FOR AIRCRAFT FLIGHT CONTROL

JOHN H. PAINTER, EMILY GLASS, GREGORY ECONOMIDES, and PAUL RUSSELL Hampton, VA NASA Oct. 1994 97 p
(Contract(s)/Grant(s): NAG1-1066; RTOP 505-64-52-01)
(NASA-CR-194976; NAS 1.26:194976) Avail: CASI HC A05/MF A02

This Contractor Report documents research in Intelligent Control using knowledge-based processing in a manner dual to methods found in the classic stochastic decision, estimation, and control discipline. Such knowledge-based control has also been called Declarative, and Hybid. Software architectures were sought, employing the parallelism inherent in modern object-oriented modeling and programming. The viewpoint adopted was that Intelligent Control employs a class of domain-specific software architectures having features common over a broad variety of implementations, such as management of aircraft flight, power distribution, etc. As much attention was paid to software engineering issues as to artificial intelligence and control issues. This research considered that particular processing methods from the stochastic and knowledge-based worlds are duals, that is, similar in a broad context. They provide architectural design concepts which serve as bridges between the disparate disciplines of decision, estimation, control, and artificial intelligence. This research was applied to the control of a subsonic transport aircraft in the airport terminal area.
Author

N95-13895# Galaxy Scientific Corp., Pleasantville, NJ.

ARTIFICIAL INTELLIGENCE WITH APPLICATIONS FOR AIRCRAFT Final Report

L. HARRISON, P. SAUNDERS, and J. JANOWITZ Aug. 1994 374 p
(Contract(s)/Grant(s): DTFAO3-89-C-00043)
(DOT/FAA/CT-94/41) Avail: CASI HC A16/MF A03

This report provides an overview of artificial intelligence (AI) technology, one of the more complex applications of digital systems. This report examines AI-based technology, focusing on three fields: neural networks, fuzzy logic, and expert systems. This report provides the reader with the background and a basic understanding of the fundamentals of these fields. Another section examines aspects of the AI development environment, including languages, tools, and AI-based hardware components. Some of the proposed aviation-related applications for both civil and military aircraft, including pilot assistants and diagnostic aids, are surveyed. Additionally, certification issues, including regulations, guidelines, and verification and validation techniques are examined. Human factors issues relating to the use of this technology are identified and reviewed. In addition, the report identifies safety issues and concerns over the use of this technology in airborne systems.
Author

N95-14159*# Rome Lab., Griffiss AFB, NY.

GENERIC ARCHITECTURES FOR FUTURE FLIGHT SYSTEMS

RICHARD J. WOOD *In* Research Inst. for Computing and Information Systems, RICIS Symposium 1992: Mission and Safety Critical Systems Research and Applications 16 p 30 Oct. 1992
Avail: CASI HC A03/MF A03

Generic architecture for future flight systems must be based on open system architectures (OSA). This provides the developer and integrator the flexibility to optimize the hardware and software systems to match diverse and unique applications requirements. When developed properly OSA provides interoperability, commonality, graceful upgradability, survivability and hardware/software transportability to greatly minimize life cycle costs and supportability. Architecture flexibility can be achieved to take advantage of commercial developments by basing these developments on vendor-neutral commercially accepted standards and protocols. Rome Laboratory presently has a program that addresses requirements for OSA.
Author

N95-14161*# Lockheed Engineering and Sciences Co., Houston, TX.

SPACE GENERIC OPEN AVIONICS ARCHITECTURE (SGOAA): OVERVIEW

RICHARD B. WRAY and JOHN R. STOVALL *In* Research Inst. for Computing and Information Systems, RICIS Symposium 1992: Mission and Safety Critical Systems Research and Applications 16 p 30 Oct. 1992
Avail: CASI HC A03/MF A03

A space generic open avionics architecture created for NASA is described. It will serve as the basis for entities in spacecraft core avionics, capable of being tailored by NASA for future space program avionics ranging from small vehicles such as Moon ascent/descent vehicles to large ones such as Mars transfer vehicles or orbiting stations. The standard consists of: (1) a system architecture; (2) a generic processing hardware architecture; (3) a six class architecture interface model; (4) a system services functional subsystem architectural model; and (5) an operations control functional subsystem architectural model.
Author (revised)

N95-14357# Loral Systems, Inc., Orlando, FL. Advanced Distribution Simulation Technology Program Office.

ADST ARWA VISUAL SYSTEM MODULE SOFTWARE DESIGN DOCUMENT

ROBERT ANSCHUETZ 28 Feb. 1994 67 p
(Contract(s)/Grant(s): N61339-91-D-0001)
(AD-A283874; ADST/WDL/TR-94-00325) Avail: CASI HC A04/MF A01

The ADST ARWA Visual System Module Software Design Document describes the system design of the VSM CSCI. This Software Design Document outlines the structure and composition of the CSCI sub-functions (CSC's and CSU's) and provides a detailed description of each.
DTIC

N95-14652# Rockwell International Corp., Huntsville, AL. Rocketdyne Div.

AUTOMATED TEST ENVIRONMENT FOR A REAL-TIME CONTROL SYSTEM

RONALD O. HALL *In* Huntsville Association of Technical Societies, TABES 1994: 10th Annual Technical and Business Exhibition and Symposium 5 p 1994
(TABES PAPER 94-631) Avail: CASI HC A01/MF A04

An automated environment with hardware-in-the-loop has been developed by Rocketdyne Huntsville for test of a real-time control system. The target system of application is the man-rated real-time system which controls the Space Shuttle Main Engines (SSME). The primary use of the environment is software verification and validation, but it is also useful for evaluation and analysis of SSME avionics hardware and mathematical engine models. It provides a test bed for the integration of software and hardware. The principles and skills upon which it operates may be applied to other target systems, such as those requiring hardware-in-the-loop simulation and control system development. Potential applications are in problem domains demanding highly reliable software systems requiring testing to formal requirements and verifying successful transition to/from off-nominal system states.
Author

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PHYSICS

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

A95-62635
ON INTRODUCTION OF ARTIFICIAL INTELLIGENCE ELEMENTS TO HEAT POWER ENGINEERING
A. F. DREGALIN KGTU, Kazan (Russia) and R. R. NAZYROVA Izvestiya VUZ: Aviatsionnaya Tekhnika (ISSN 0579-2975) no. 4 October-December 1993 p. 90-94 In RUSSIAN refs (BTN-94-EIX94461407961) Copyright

The basic problems of 'the thermodynamic intelligence' of personal computers have been outlined. The thermodynamic intellect of personal computers as a concept has been introduced to heat processes occurring in engines of flying vehicles. In particular, the thermodynamic intellect of computers is determined by the possibility of deriving formal relationships between thermodynamic functions. In chemical thermodynamics, a concept of a characteristic function has been introduced. EI

N95-14610*# Pratt and Whitney Aircraft, East Hartford, CT.
ULTRA-HIGH BYPASS RATIO JET NOISE Final Report
JOHN K. C. LOW Cleveland, OH NASA Oct. 1994 64 p (Contract(s)/Grant(s): NAS3-26618; RTOP 538-03-11) (NASA-CR-195394; E-9172; NAS 1.26:195394) Avail: CASI HC A04/MF A01

The jet noise from a 1/15 scale model of a Pratt and Whitney Advanced Ducted Propulsor (ADP) was measured in the United Technology Research Center anechoic research tunnel (ART) under a range of operating conditions. Conditions were chosen to match engine operating conditions. Data were obtained at static conditions and at wind tunnel Mach numbers of 0.2, 0.27, and 0.35 to simulate inflight effects on jet noise. Due to a temperature dependence of the secondary nozzle area, the model nozzle secondary to primary area ratio varied from 7.12 at 100 percent thrust to 7.39 at 30 percent thrust. The bypass ratio varied from 10.2 to 11.8 respectively. Comparison of the data with predictions using the current Society of Automotive Engineers (SAE) Jet Noise Prediction Method showed that the current prediction method overpredicted the ADP jet noise by 6 decibels. The data suggest that a simple method of subtracting 6 decibels from the SAE Coaxial Jet Noise Prediction for the merged and secondary flow source components would result in good agreement between predicted and measured levels. The simulated jet noise flight effects with wind tunnel Mach numbers up to 0.35 produced jet noise inflight noise reductions up to 12 decibels. The reductions in jet noise levels were across the entire jet noise spectra, suggesting that the inflight effects affected all source noise components. Author

N95-14618*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NOISE RADIATION BY INSTABILITY WAVES IN COAXIAL JETS
MILO D. DAHL and PHILIP J. MORRIS 1994 16 p Presented at the 25th Fluid Dynamics Conference, Colorado Springs, CO, 20-23 Jun. 1994; sponsored by AIAA
(Contract(s)/Grant(s): RTOP 505-62-52)
(NASA-TM-106738; E-9141; NAS 1.15:106738; AIAA PAPER 94-2190) Avail: CASI HC A03/MF A01

In this paper predictions are made for the noise radiation from supersonic coaxial jets. The noise in the downstream arc of a supersonic jet is dominated by highly directional radiation from the supersonically convecting large scale structures in the jet mixing layer. Since the mean flow is not described easily in terms of simple analytic functions, a numerical prediction is made for its development. The compressible Reynolds-averaged boundary layer equations in cylindrical polar coordinates are solved. A mixing length turbulence model is used. Empirical correlations are developed the effects of velocity and temperature ratio and Mach number. Both normal and inverted velocity profiles are considered. Comparisons with measurements for both single and coaxial jets show good agreement. The large scale structures are modeled as instability waves. The noise radiation generated by the instability waves is determined by a matching between the inner instability wave solution and the outer acoustic solution. Predictions are made for the differences between the noise radiated by coaxial jets with different operating conditions and a single equivalent jet with the same exit area, thrust, and mass-flow. Author

N95-14638# Army Strategic Defense Command, Huntsville, AL. Technology Integration and Matrix Management Office.
AERO-OPTICS SYSTEM INTEGRATION
TROY A. STREET *In* Huntsville Association of Technical Societies, TABES 1994: 10th Annual Technical and Business Exhibition and Symposium 4 p 1994 Sponsored by Secretary of the Army (TABES PAPER 94-604) Avail: CASI HC A01/MF A04

A Delphi study has been conducted in the field of aero-optics research and development. The study includes the system components of aerodynamics, optical materials, optical analytics, optical seekers, and aero-optical integration of the system components into an aero-optical system. The Delphi forecast data is divided into short, medium, and long range periods for planning purposes. The study results are applicable to the stated planning periods for endoatmospheric interceptors with full range infrared guidance systems. Author

N95-14886*# Mississippi Univ., University, MS. Dept. of Physics and Astronomy.
ATMOSPHERIC EFFECTS ON THE RISETIME AND WAVESHAPE OF SONIC BOOMS
RICHARD RASPET, HENRY E. BASS, and PATRICE BOULANGER *In* NASA. Langley Research Center, High-Speed Research: 1994 Sonic Boom Workshop: Atmospheric Propagation and Acceptability Studies p 123-136 Oct. 1994
Avail: CASI HC A03/MF A03

Accurate prediction of human response to sonic booms from proposed HSCT aircraft depends on a knowledge of the waveshape and risetime of the boom at the ground. In previous work, we have developed a numerical technique to predict the combined effects of molecular absorption and finite wave distortion on the sonic boom as it propagates from the aircraft to the top of the turbulent boundary layer. We have more recently developed a scattering center based model to calculate the effects of turbulence on the sonic boom waveform as it propagates through this boundary layer. Calculations have been performed using single scales of turbulence and compared to measurements at Edwards AFB in the late 1960's. A model of the atmosphere involving two scales each for convective and mechanical turbulence has been developed and fit to meteorological data collected during JAPE 2. Scattering calculations employing this model underpredict the number of unperturbed waveforms. In order to develop a more realistic model of the atmosphere, the JAPE 2 meteorological data has been fit to a von Karman spectrum. Results of scattering using this multi-scale model will be presented. The combination of finite wave effects with turbulent scattering predictions includes the principal effects of the atmosphere on the sonic boom from the HSCT. Author

N95-14887*# Pennsylvania State Univ., University Park, PA.
THE EFFECT OF AIRCRAFT SPEED ON THE PENETRATION OF SONIC BOOM NOISE INTO A FLAT OCEAN
VICTOR W. SPARROW *In* NASA. Langley Research Center, High-Speed Research: 1994 Sonic Boom Workshop: Atmospheric Propagation and Acceptability Studies p 137-156 Oct. 1994
Avail: CASI HC A03/MF A03

As U.S. aircraft manufacturers now have focused their HSCT efforts on overwater supersonic flight, a great deal more must be known about sonic booms propagating overwater and interacting with the ocean. For example, it is thought that atmospheric turbulence effects

are often much less severe over water than over land. Another important aspect of the overwater flight problems is the penetration of the sonic boom noise into the ocean, where there could be an environmental impact on sea life. This talk will present a brief review on the penetration of sonic boom noise into a large body of water with a flat surface. It has been determined recently that faster supersonic speeds imply greater penetration of sonic boom noise into the ocean. The new theory is derived from the original Sawyers paper and from the knowledge that for level flight a boom's duration is proportional to the quantity M/(M(exp 2)-1)(exp 3/8) where M is the Mach number. It is found that for depths of 10 m or less, the peak SPL varies less than 6 dB over a wide range of M. For greater depths, 100 m for example, increased Mach numbers may increase the SPL by 15 dB or more. Author

N95-14889*# Wyle Labs., Inc., Arlington, VA.
USAF SINGLE-EVENT SONIC BOOM PREDICTION MODEL: PCBOOM3
KENNETH J. PLOTKIN, MICAH DOWNING, and JULIET A. PAGE *In* NASA. Langley Research Center, High-Speed Research: 1994 Sonic Boom Workshop: Atmospheric Propagation and Acceptability Studies p 171-184 Oct. 1994
Avail: CASI HC A03/MF A03

The Air Force has developed PCBoom3, a general-purpose, single-event sonic boom prediction model. The model operates on an IBM PC or compatible, under DOS or Windows. It is accessed via an integrated environment which controls building of input cases, running boom calculations, displaying contours and signatures, and managing all associated data. The primary boom calculation is via a variation of FOBOOM, the focus-boom extension of Thomas's program. Aircraft input is either via a user-provided F-function, or simple N-wave F-functions tabulated for about 20 current aircraft. A fast boom calculation, based on Plotkin's SBORT algorithms, is included for simple N-wave F-functions in a windless atmosphere and flight altitudes up to 60,000 feet. After a run is complete, the user can access an index identifying significant events (focal zones, beginning of footprint, etc.), then plot boom amplitude contours and signatures or spectra at any point in the footprint. The primary uses of this program are expected to be operational planning and boom incident investigation. However, because of the commonality between FOBOOM and the MDBOOM program currently being used for low boom configuration design, this program is of interest to the HSCT community, especially as supersonic route planning activity increases. The Air Force recently conducted a flight test program to evaluate the focal zone capabilities of PCBoom3. Initial results of that program validate the prediction of focal zone geometry, amplitudes, and waveforms. Author

N95-15059*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE AEROACOUSTICS OF SUPERSONIC COAXIAL JETS
MILO D. DAHL Nov. 1994 182 p
(Contract(s)/Grant(s): RTOP 505-52-52)
(NASA-TM-106782; E-9235; NAS 1.15:106782) Avail: CASI HC A09/MF A02

Instability waves have been established as the dominant source of mixing noise radiating into the downstream arc of a supersonic jet when the waves have phase velocities that are supersonic relative to ambient conditions. Recent theories for supersonic jet noise have used the concepts of growing and decaying linear instability waves for predicting radiated noise. This analysis is extended to the prediction of noise radiation from supersonic coaxial jets. Since the analysis requires a known mean flow and the coaxial jet mean flow is not described easily in terms of analytic functions, a numerical prediction is made for its development. The Reynolds averaged, compressible, boundary layer equations are solved using a mixing length turbulence model. Empirical correlations are developed for the effects of velocity and temperature ratios and Mach number. Both normal and inverted velocity profile coaxial jets are considered. Comparisons with measurements for both single and coaxial jets show good agreement. The results from mean flow and stability calculations are used to predict the noise radiation from coaxial jets with different operating conditions. Comparisons are made between different coaxial jets and a single equivalent jet with the same total thrust, mass flow, and exit area. Results indicate that normal velocity profile jets can have noise reductions compared to the single equivalent jet. No noise reductions are found for inverted velocity profile jets operated at the minimum noise condition compared to the single equivalent jet. However, it is inferred that changes in area ratio may provide noise reduction benefits for inverted velocity profile jets. Author

N95-15743*# Allied-Signal Aerospace Co., Phoenix, AZ.
ADVANCED TURBINE TECHNOLOGY APPLICATIONS PROJECT (ATTAP) Annual Report, 1993
Jul. 1994 57 p
(Contract(s)/Grant(s): DEN3-335; RTOP 778-32-21)
(NASA-CR-195393; E-9171; REPT-31-12089; NAS 1.26:195393) Avail: CASI HC A04/MF A01

Reports technical effort by AlliedSignal Engines in sixth year of DOE/NASA funded project. Topics include: gas turbine engine design modifications of production APU to incorporate ceramic components; fabrication and processing of silicon nitride blades and nozzles; component and engine testing; and refinement and development of critical ceramics technologies, including: hot corrosion testing and environmental life predictive model; advanced NDE methods for internal flaws in ceramic components; and improved carbon pulverization modeling during impact. ATTAP project is oriented toward developing high-risk technology of ceramic structural component design and fabrication to carry forward to commercial production by 'bridging the gap' between structural ceramics in the laboratory and near-term commercial heat engine application. Current ATTAP project goal is to support accelerated commercialization of advanced, high-temperature engines for hybrid vehicles and other applications. Project objectives are to provide essential and substantial early field experience demonstrating ceramic component reliability and durability in modified, available, gas turbine engine applications; and to scale-up and improve manufacturing processes of ceramic turbine engine components and demonstrate application of these processes in the production environment. Author

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SPACE SCIENCES

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

N95-13717*# MCAT Inst., Moffett Field, CA.
PLANETARY ENTRY EXPERIMENTS Final Report
ROGER A. CRAIG San Jose, CA Jul. 1994 128 p
(Contract(s)/Grant(s): NCC2-762)
(NASA-CR-194215; NAS 1.26:194215; MCAT-94-005) Avail: CASI HC A07/MF A02

The final report summarizes the results from three research areas: (1) window design for the radiometric measurement of the forebody radiative heating experienced by atmospheric entry spaceraft; (2) survey of the current understanding of chemical species on selected solar system bodies and assess the importance of measurements with regard to vehicle environment and with regard to understanding of planetary atmospheres with emphasis on Venus, Mars, and Titan; and (3) measure and analyze the radiation (VUV to near-IR) from the shock heated gas cap of a blunt body in an Ames arc Jet wind-tunnel facility. For individual titles, see N95-13718 through N95-13721.

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GENERAL

N95-13640# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
AGARD HIGHLIGHTS 94/2
1994 46 p
(AGARD-HIGHLIGHTS-94/2) Copyright Avail: CASI HC A03/MF A01

Various aspects of research and development in aerospace sciences are discussed. Specific topics considered include: aircraft engine technology transfer; lessons learned from a historical review of aircraft operations; and pilot vertigo. CASI

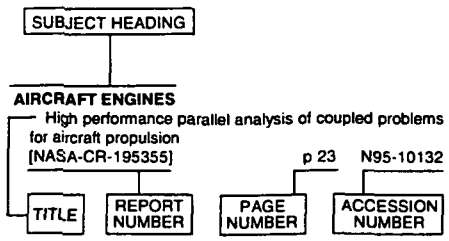
N95-13663*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A REVIEW OF 50 YEARS OF AERODYNAMIC RESEARCH WITH NACA/NASA
M. LEROY SPEARMAN Oct. 1994 12 p
(Contract(s)/Grant(s): RTOP 505-69-20-01)
(NASA-TM-109163; NAS 1.15:109163) Avail: CASI HC A03/MF A01

Continuous improvements in flight systems have occurred over the past 50 years due, in part, to continuous improvements in aerodynamic research techniques and capabilities. This paper traces that research from the first-hand perspective of the author who, beginning in 1944, has taken part in the NACA/NASA aerodynamic research effort through studies in low-speed wind tunnels, high-speed subsonic tunnels, transonic tunnels, supersonic tunnels, and hypersonic tunnels. New problems were found as systems advanced from low-speed propeller-driven designs to more sophisticated high-speed jet- and rocket-propelled designs. The paper reviews some of these problems and reflects on some of the solutions that have been developed in the course of various aerodynamic research programs in the past. Some of the factors, both technical and nontechnical, that have influenced the aerodynamic design, research, and development of various flight systems will be mentioned. Author (revised)

N95-15065*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RESEARCH AND TECHNOLOGY HIGHLIGHTS, 1993
Aug. 1994 264 p Contains NCSA Mosaic window view and access instructions as supplement
(NASA-TM-4575; L-17397; NAS 1.15:4575) Avail: CASI HC A12/MF A03

This report contains highlights of the major accomplishments and applications that have been made by Langley researchers and by our university and industry colleagues during the past year. The highlights illustrate both the broad range of the research and technology activities supported by NASA Langley Research Center and the contributions of this work toward maintaining United States leadership in aeronautics and space research. This report also describes some of the Center's most important research and testing facilities. Author (revised)

Typical Subject Index Listing



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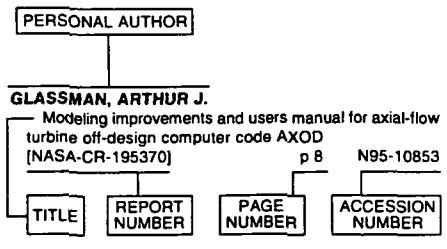

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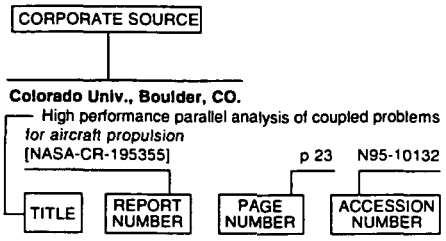

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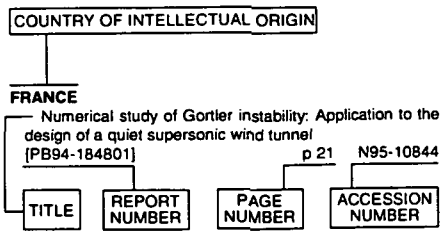

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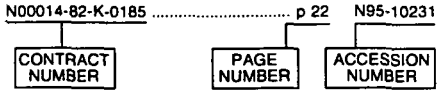

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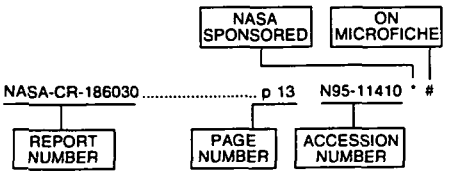

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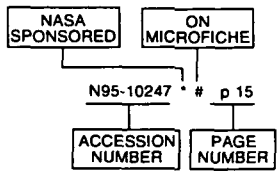

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