NASA SP-7037 (326)
January 1996

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and
Space Administration
**Scientific and Technical
Information Office**

The NASA STI Office ... in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Office plays a key part in helping NASA maintain this important role.

The NASA STI Office provides access to the NASA STI Database, the largest collection of aeronautical and space science STI in the world. The Office is also NASA's institutional mechanism for disseminating the results of its research and development activities.

Specialized services that help round out the STI Office's diverse offerings include creating custom thesauri, building customized databases, organizing and publishing research results ... even providing videos.

For more information about the NASA STI Office, you can:

Phone the NASA Access Help Desk at (301) 621-0390

Fax your question to the NASA Access Help Desk at (301) 621-0134

E-mail your question via the **Internet** to help@sti.nasa.gov

Write to: NASA Access Help Desk
NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090-2934

SCAN Goes Electronic!

If you have electronic mail or if you can access the Internet, you can view biweekly issues of *SCAN* from your desktop absolutely free!

***E**lectronic SCAN* takes advantage of computer technology to inform you of the latest worldwide, aerospace-related, scientific and technical information that has been published.

No more waiting while the paper copy is printed and mailed to you. You can view *Electronic SCAN* the same day it is released—up to 191 topics to browse at your leisure. When you locate a publication of interest, you can print the announcement. You can also go back to the *Electronic SCAN* home page and follow the ordering instructions to quickly receive the full document.

Electronic SCAN
Timely
Flexible
Complete
FREE!

Start your free access to *Electronic SCAN* today. Over 1,000 announcements of new reports, books, conference proceedings, journal articles . . . and more—available on your computer every two weeks.

For Internet access to *E-SCAN,* use any of the following addresses:

http://www.sti.nasa.gov

ftp.sti.nasa.gov

gopher.sti.nasa.gov

National Aeronautics and Space Administration

Scientific and Technical Information Office

To receive a free subscription, send e-mail for complete information about the service first. Enter **scan@sti.nasa.gov** on the address line. Leave the subject and message areas blank and send. You will receive a reply in minutes.

Then simply determine the *SCAN* topics you wish to receive and send a second e-mail to **listserv@sti.nasa.gov**. Leave the subject line blank and enter a subscribe command in the message area formatted as follows:

Subscribe <**desired list**> <**Your name**>

For additional information, e-mail a message to **help@sti.nasa.gov**.

Phone: (301) 621-0390

Fax: (301) 621-0134

Write: NASA Access Help Desk
NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090-2934

Looking just for *Aerospace Medicine and Biology* reports?
Although hard copy distribution has been discontinued, you can still receive these vital announcements through your *E-SCAN* subscription. Just **subscribe SCAN-AEROMED** in the message area of your e-mail to **listserv@sti.nasa.gov**.

New Feature! 'subscribe SCAN-AEROMED'

11/95

Introduction

This issue of *Aeronautical Engineering, A Continuing Bibliography with Indexes* (NASA SP-7037) lists 120 reports, articles, and other documents recently announced in the NASA STI Database.

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.

Two indexes—subject and author are included.

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

Table of Contents

Records are arranged in categories 1 through 19, the first nine coming from the Aeronautics division of *STAR*, followed by the remaining division titles. Selecting a category will link you to the collection of records cited in this issue pertaining to that category.

1 Aeronautics 1

2 Aerodynamics 3

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

3 Air Transportation and Safety 9

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

4 Aircraft Communications and Navigation 12

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

5 Aircraft Design, Testing and Performance 13

Includes aircraft simulation technology.

6 Aircraft Instrumentation 17

Includes cockpit and cabin display devices; and flight instruments.

7 Aircraft Propulsion and Power 17

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

8 Aircraft Stability and Control 18

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

9 Research and Support Facilities (Air) 21

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

10 Astronautics 22

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

11 Chemistry and Materials 22

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

12 Engineering 24

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

13 Geosciences 31

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

14 Life Sciences 33

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

15 Mathematical and Computer Sciences 33

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.

16 Physics 36

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

17 Social Sciences 37

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

18 Space Sciences 37

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

19 General 37

Indexes

Two indexes are available. You may use the **Find** command under the **Tools** menu while viewing the PDF file for direct match searching on any text string. You may also view the indexes provided, for searching on *NASA Thesaurus* subject terms and author names.

Subject Term Index 39

Author Index 45

Selecting an index above will link you to that comprehensive listing.

Appendix

Select **Appendix** for important information about NASA Scientific and Technical Information (STI) Office products and services, including registration with the NASA Center for AeroSpace Information (CASI) for access to the NASA CASI TRS (Technical Report Server), and availability and pricing information for cited documents.

Typical Report Citation and Abstract

ON MICROFICHE ↓

ACCESSION NUMBER → **N96-10751#** Sandia National Labs., Albuquerque, NM. ← CORPORATE SOURCE

TITLE → **Minimizing phylogenetic number to find good evolutionary trees**

AUTHORS → Goldberg, Leslie Ann; Goldberg, Paul W.; Phillips, Cynthia A.; Sweedyk, Elizabeth (California Univ., Berkeley, CA.); and Warnow, Tandy (Pennsylvania Univ., Philadelphia, PA.) ← AUTHORS' AFFILIATION

PUBLICATION DATE → 1995 26 p Presented at the 1995 Symposium on Combinatorial Pattern Matching, Helsinki, Finland, 4-7 Jul. 1995 Sponsored by California Legislative Grant

CONTRACTS/GRANTS → Contract(s)/Grant(s): (DE-AC04-94AL-85000; NSF CCR-94-57800)

REPORT NO.(S) → Report No.(s): (DE95-011893; SAND-95-0831C; CONF-9507123-1) Avail: CASI HC A03/MF A01 ← AVAILABILITY AND PRICE CODE

ABSTRACT → Inferring phylogenetic trees is a fundamental problem in computational-biology. We present a new objective criterion, the phylogenetic number, for evaluating evolutionary trees for species defined by biomolecular sequences or other qualitative characters. The phylogenetic number of a tree T is the maximum number of times that any given character state arises in T. By contrast, the classical parsimony criterion measures the total number of times that different character states arise in T. We consider the following related problems: finding the tree with minimum phylogenetic number, and computing the phylogenetic number of a given topology in which only the leaves are labeled by species. When the number of states is bounded (as is the case for biomolecular sequence characters), we can solve the second problem in polynomial time. We can also compute a fixed-topology 2-phylogeny (when one exists) for an arbitrary number of states. This algorithm can be used to further distinguish trees that are equal under parsimony. We also consider a number of other related problems. DOE

SUBJECT TERMS → *Algorithms; Biological Evolution; Chemical Evolution; Genetics; Molecular Biology*

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 326)

JANUARY 1996

01 AERONAUTICS (GENERAL)

N96-10383*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HBCUs Research Conference agenda and abstracts Abstracts Only
Dutta, Sunil; comp. Aug. 1995 64 p Conference held in Cleveland, OH, 18-20 Apr. 1995
Report No.(s): (NASA-CP-10175; E-9717; NAS 1.55: 10175) Avail: CASI HC A04/MF A01

The purpose of this Historically Black Colleges and Universities (HBCUs) Research conference was to provide an opportunity for principal investigators and their students to present research progress reports. The abstracts included in this report indicate the range and quality of research topics such as aeropropulsion, space propulsion, space power, fluid dynamics, designs, structures and materials being funded through grants from Lewis Research Center to HBCUs. The conference generated extensive networking between students, principal investigators, Lewis technical monitors, and other Lewis researchers. For individual titles, see N96-10384 through N96-10413.
Aircraft Engines; Aircraft Structures; Conferences; Fluid Dynamics; Propulsion;

N96-10748* National Aeronautics and Space Administration, Washington, DC.
Aeronautical engineering: A continuing bibliography with indexes (supplement 321)
Sep. 1995 173 p
Report No.(s): (NASA-SP-7037 (321); NAS 1.21:7037 (321)) Avail: CASI HC A08

This bibliography lists 496 reports, articles, and other documents introduced into the NASA scientific and technical information system in Sep. 1995. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment, and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics. Author
Aerodynamics; Aeronautical Engineering; Aeronautics; Bibliographies; Indexes (documentation);

N96-10859*# University of Southern California, Los Angeles, CA. Inst. of Safety and Systems Management.
The effects of Crew Resource Mangement (CRM) training in airline maintenance: Results following three years' experience Final Report, 1994
Taylor, J. C.; and Robertson, M. M.; 30 Jan. 1995 52 p
Contract(s)/Grant(s): (NCC2-812)
Report No.(s): (NASA-CR-199266; NAS 1.26:199266)
Avail: CASI HC A04/MF A01

This report describes three years' evaluation of the effects of one airline's Crew Resources Management (CRM) training operation for maintenance. This evaluation focuses on the post-training attitudes of maintenance managers' and technical support professionals, their reported behaviors, and the safety, efficiency and dependable maintenance performance of their units. The results reveal a strong positive effect of the training. The overall program represents the use of CRM training as a long-term commitment to improving performance through effective communication at all levels in airline maintenance operations. The initial findings described in our previous progress reports are reinforced and elaborated here. The current results benefit from the entire pre-post training survey, which now represents total attendance of all managers and staff professionals. Additionally there are now full results from the two-month, six-month, and 12-month follow-up questionnaires, together with as many as 33 months of post-training performance data, using several indicators. In this present report, we examine participants' attitudes, their reported behaviors following the training, the performance of their work units, and the relationships among these variables. Attitudes include those measured immediately before and after the training as well as participants' attitudes months after their training. Performance includes measures, by work units, of on-time flight departures, on-schedule maintenance releases, occupational and aircraft safety, and efficient labor costs. We report changes in these performance measures following training, as well their relationships with the training participants' attitudes. Highlights of results from this training program include increased safety and improved costs associated with positive attitudes about the use of more assertive communication, and the improved management of stress. Improved

on-time performance is also related to those improved attitudes, as well as favorable attitudes about participative management. Author
Aircraft Maintenance; Airline Operations; Commercial Aircraft; Maintenance Training;

N96-10950# General Accounting Office, Washington, DC. National Security and International Affairs Div.
Report to the Chairman, Subcommittee on Readiness, Committee on Armed Services, House of Representa tives. Strategic airlift: Further efforts can be taken to extend aircraft service life
15 Sep. 1994 17 p
Report No.(s): (GAO/NSIAD-94-222; B-257655) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

The U.S. Transportation Command is responsible for the peacetime and wartime mobility system, and its Air Mobility Command (AMC) provides the strategic airlift aircraft to fly the critical, early arriving troops and cargo for overseas deployments. The C-141, which has been the backbone of the airlift fleet, is nearing the end of its service life and has been under severe flight restrictions in recent years. The new airlift aircraft, the C-17, has had numerous technical problems and is behind schedule. Planned buys of it have been reduced. Thus, it is important to find ways to fly current strategic airlift aircraft less in peacetime in order to ensure their availability for wartime. In response to C-141 flight restrictions, AMC temporarily expanded the use of commercial and tanker aircraft for regularly scheduled cargo and passenger missions. It also plans to upgrade its strategic airlift simulator capability, which will allow it to reduce in-aircraft training. However, AMC can do more. First, it can continue to use commercial and tanker aircraft to fly scheduled missions not requiring the unique capabilities of the C-141. Second, AMC can make maximum use of the upgraded simulators by transferring more of the air refueling and local proficiency training from the C-5 and the C-141. Moreover, it can institute a companion trainer aircraft program for the C-5 and C-141. That involves flying smaller, less-costly aircraft for training that does not require larger aircraft and would be similar to programs the Air Force already has and AMC has for tanker aircraft. Derived from text
Air Transportation; Armed Forces (united States); C-141 Aircraft; C-5 Aircraft; Military Aircraft; Military Operations; Tanker Aircraft; Transport Aircraft;

N96-10985* National Aeronautics and Space Administration, Washington, DC.
Aeronautical engineering: A continuing bibliography with indexes (supplement 319)
Jul. 1995 133 p
Report No.(s): (NASA-SP-7037 (319); NAS 1.21:7037 (319)) Avail: CASI HC A07

This report lists 349 reports, articles and other documents recently announced in the NASA STI Database. 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. Derived from text
Aerodynamics; Aeronautical Engineering; Aeronautics; Bibliographies; Indexes (documentation);

N96-11336# Technische Hogeschool, Delft (Netherlands).
MIMO identification techniques and software development in the frequency domain for helicopter and flexible aircraft Technical Results 1994
Sridhar, J. K.; Breeman, J. H.; Mulder, J. A.; and Fokkerweg, Anthony; Feb. 1995 43 p See also PB95-242855 Prepared in cooperation with National Aerospace Lab., Amsterdam, Netherlands
Report No.(s): (PB95-242848) Avail: CASI HC A03/MF A01

A software-package for frequency-domain analysis and system identification for helicopters was developed, on a personal computer, using Matlab 4.0 (for Windows). The software is capable of extracting key information on coupled rigid rotor dynamic and aeroelastic modes. As frequency domain analysis can be greatly aided by graphics, user friendly plotting routines are needed. The objective of the report is to give an account of the progress made in the year 1994. With the beginning of the project, it is believed that the end results will support academic and industrial activities in the Netherlands in the areas leading to model identification, validation, handling qualities evaluation, control system design etc. These can potentially play a major role in improved quality, reduced risk and cost during the development phase. NTIS
Applications Programs (computers); Control Systems Design; Flight Control; Frequencies; Helicopters; Mimo (control Systems); Software Development Tools; Software Engineering; System Identification;

N96-11337# National Aerospace Lab., Amsterdam (Netherlands).
MIMO identification techniques and software development in the frequency domain for helicopter and flexible aircraft Progress Report 1994
Sridhar, J. K.; Breeman, J. H.; Mulder, J. A.; and Fokkerweg, Anthony; Feb. 1995 8 p See also PB95-242848 Prepared in cooperation with National Aerospace Lab., Amsterdam, Netherlands
Report No.(s): (PB95-242855) Avail: CASI HC A02/MF A01

The significant outcome of the project was a successful development of a prototype of an interactive computer package based on Matlab 4.0 (for windows) for helicopter identification in frequency domain. The major components of the package include, estimation of high quality frequency response functions based on improved MIMO theory, interactive model structure determination, multivariate spectral analysis, handling quality metric estimates, model formulation studies, time domain simulation and user friendly menu driven sessions. NTIS

Applications Programs (computers); Flexible Wings; Frequencies; Helicopters; Mimo (control Systems); Software Development Tools; Software Engineering;

N96-11338# Technische Univ., Delft (Netherlands).

Development of a multiple input/multiple output (MIMO) parameter identification methods and software in the frequency domain and the evaluation of optimal input signals for the helicopter and flexible aircraft: An overview and project plan

Sridhar, J. K.; Breeman, J. H.; Mulder, J. A.; and Weg, Anthony Fokker; (National Aerospace Lab., Amsterdam, Netherlands.) Dec. 1994 33 p Prepared in cooperation with National Aerospace Lab., Amsterdam, Netherlands

Report No.(s): (PB95-242871) Avail: CASI HC A03/MF A01

Several countries in NATO organization have recently formed a working Group to give an overview of system identification of rotorcraft. The results of the working groups shows that rotorcraft identification still remains a challenging area as compared to fixed wing aircraft. With the beginning of this project, it is aimed to develop advanced methods and software that will support academic and industrial activities in the Netherlands in the areas leading to model identification, validation, handling qualities evaluation, control system design etc. These can potentially play a major contribution in improved quality, reduced risk and cost during the rotorcraft development phase. NTIS

Applications Programs (computers); Flexible Wings; Frequencies; Helicopters; Mimo (control Systems); Parameter Identification; System Identification;

N96-11632* National Aeronautics and Space Administration, Washington, DC.

Aeronautical engineering: A continuing bibliography with indexes (supplement 322)

Oct. 1995 228 p

Report No.(s): (NASA-SP-7037 (322); NAS 1.21:7037 (322)) Avail: CASI HC A11

This bibliography lists 719 reports, articles, and other documents introduced into the NASA scientific and technical information system in Oct. 1995. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment, and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics. Author

Aerodynamics; Aeronautical Engineering; Bibliographies; Fluid Dynamics; Indexes (documentation);

N96-11683*# Queensland Univ., Brisbane (Australia). Dept. of Mechanical Engineering.

Shock tunnel studies of scramjet phenomena 1994

1995 145 p Sponsored in cooperation with the Australian Research Council

Contract(s)/Grant(s): (NAGW-674)

Report No.(s): (NASA-CR-199445; NAS 1.26:199445) Avail: CASI HC A07/MF A02

A new expansion tube facility has been built, and is in the process of being commissioned. It has a bore of 90 mm, and has been designed for peak rupture pressures of 100 Mpa. It is configured with multiple sections and diaphragm location stations to give optimized performance over a range of sub and superorbital conditions. It has a compound piston arrangement for a two stage compression, designed to maximize the length of shock expansion tube which can be driven within a fixed total facility length. Experiments have been successfully performed with a dummy first stage piston, and a rubber energy absorbing brake. The results agree well with a one-dimensional stress wave model of the piston impacting on the rubber, and codes for piston motion. Strain of the rubber is restricted to approximately 20 percent at which level no damage is to be expected in the buffer material, and none has been observed, indicating that the mechanism will be fully reuseable. For individual titles, see N96-11684 through N96-11691.

Boundary Layers; Enthalpy; Gas Expansion; Hypersonic Flow; Nozzle Flow; Shock Tubes; Shock Tunnels; Skin Friction; Stress Waves; Supersonic Combustion; Supersonic Combustion Ramjet Engines; Thrust Measurement;

02 AERODYNAMICS

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

N96-10136*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

Effect of wake structure on blade-vortex interaction phenomena: Acoustic prediction and validation

Gallman, Judith M.; Tung, Chee; Schultz, Klaus J.; Splettstoesser, Wolf; and Buchholz, Heino; 1995 15 p

Report No.(s): (NASA-TM-110825; NAS 1.15:110825; AD-A294477) Avail: CASI HC A03/MF A01

During the Higher Harmonic Control Aeroacoustic Rotor Test, extensive measurements of the rotor aerodynamics, the far-field acoustics, the wake geometry, and the blade motion for powered, descent, flight conditions were made.

These measurements have been used to validate and improve the prediction of blade-vortex interaction (BVI) noise. The improvements made to the BVI modeling after the evaluation of the test data are discussed. The effects of these improvements on the acoustic-pressure predictions are shown. These improvements include restructuring the wake, modifying the core size, incorporating the measured blade motion into the calculations, and attempting to improve the dynamic blade response. A comparison of four different implementations of the Ffowcs Williams and Hawkings equation is presented. A common set of aerodynamic input has been used for this comparison. DTIC

Aeroacoustics; Blade-vortex Interaction; Descent; Helicopter Wakes; Rotary Wings; Rotor Aerodynamics; Sound Pressure; Vortices;

N96-10325*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

Experimental investigation of wing installation effects on a two-dimensional mixer/ejector nozzle for supersonic transport aircraft

Anderson, David J.; Lambert, Heather H.; and Mizukami, Masashi; Jul. 1992 31 p

Contract(s)/Grant(s): (RTOP 537-02-23)

Report No.(s): (NASA-TM-105713; E-7107; NAS 1.15: 105713) Avail: CASI HC A03/MF A01

Experimental results from a wind tunnel test conducted to investigate propulsion/airframe integration (PAI) effects are presented. The objectives of the test were to examine rough order-of-magnitude changes in the acoustic characteristics of a mixer/ejector nozzle due to the presence of a wing and to obtain limited wing and nozzle flow-field measurements. A simple representative supersonic transport wing planform, with deflecting flaps, was installed above a two-dimensional mixer/ejector nozzle that was supplied with high-pressure heated air. Various configurations and wing positions with respect to the nozzle were studied. Because of hardware problems, no acoustics and only a limited set of flow-field data were obtained. For most hardware configurations tested, no significant propulsion/airframe integration effects were identified. Significant effects were seen for extreme flap deflections. The combination of the exploratory nature of the test and the limited flow-field instrumentation made it impossible to identify definitive propulsion/airframe integration effects. Author (revised)

Acoustic Properties; Ejectors; Engine Airframe Integration; Exhaust Nozzles; Flow Distribution; Inlet Flow; Noise Reduction; Nozzle Flow; Supersonic Transports; Wind Tunnel Tests; Wings;

N96-10573*# Arizona State Univ., Tempe, AZ. Dept. of Mechanical and Aerospace Engineering.

Development of multiobjective optimization techniques for sonic boom minimization Progress Report

Chattopadhyay, Aditi; Narayan, Johnny R.; Pagaldipti, Narayanan; and Wensheng, XU; 1995 31 p

Contract(s)/Grant(s): (NCC2-5064)

Report No.(s): (NASA-CR-199083; NAS 1.26:199083) Avail: CASI HC A03/MF A01

An optimization procedure is developed for the simultaneous improvement of the aerodynamic and sonic boom characteristics of high speed aircraft. From a sonic boom perspective, it is desirable to minimize the first peak in the overpressure signal at a specified distance away from the aircraft. From aerodynamic point of view, the aerodynamic drag coefficient ratio must be minimized while maintaining the lift coefficient at desired level. The optimization procedure is applied to wing-body configurations related to high speed aircraft. The objectives of this current research are: (1) development of a multiobjective optimization procedure for aerospace vehicles with the integration of sonic boom and aerodynamic performance criteria; and (2) development of semi-analytical approach for calculating sonic boom design sensitivities. CASI

Aerodynamic Coefficients; Aerodynamics; Aerospace Vehicles; Lift Drag Ratio; Optimization; Overpressure; Sonic Booms;

N96-10804*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

A far-wing line shape theory which satisfies the detailed balance principle

Ma, Q.; Tipping, R. H.; (Alabama Univ., Tuscaloosa, AL.) Hartmann, J.-M.; (Paris-Sud Univ., Orsay, France.) and Boulet, C.; (Paris-Sud Univ., Orsay, France.) 1995 23 p

Report No.(s): (NASA-TM-111075; NAS 1.15:111075) Avail: CASI HC A03/MF A01

A far-wing theory in which the validity of the detailed balance principle is maintained in each step of the derivation is presented. The role of the total density matrix including the initial correlations is analyzed rigorously. By factoring out the rapidly varying terms in the complex-time development operator in the interaction representation, better approximate expressions can be obtained. As a result, the spectral density can be expressed in terms of the line-coupling functions in which two coupled lines are arranged symmetrically and whose frequency detunings are omega - 1/2(omega(sub ji) + omega (sub j'i'). Using the approximate values omega - omega(sub ji) results in expressions that do not satisfy the detailed balance principle. However, this principle remains satisfied for the symmetrized spectral density in which not only the coupled lines are arranged symmetrically, but also the initial and final states belonging to the same lines are arranged symmetrically as well. Author

Absorption Spectra; Balance; Correlation; Line Shape; Molecular Dynamics; Theorems;

N96-10863*# Vigyan Research Associates, Inc., Hampton, VA.
A guide to the use of the pressure disk rotor model as implemented in INS3D-UP
Chaffin, Mark S.; 1 Sep. 1995 28 p Prepared in cooperation with Army Aviation Systems Command, Hampton, VA
Contract(s)/Grant(s): (NAS1-19672; RTOP 505-59-36-01)
Report No.(s): (NASA-CR-4692; NAS 1.26:4692) Avail: CASI HC A03/MF A01

This is a guide for the use of the pressure disk rotor model that has been placed in the incompressible Navier-Stokes code INS3D-UP. The pressure disk rotor model approximates a helicopter rotor or propeller in a time averaged manner and is intended to simulate the effect of a rotor in forward flight on the fuselage or the effect of a propeller on other aerodynamic components. The model uses a modified actuator disk that allows the pressure jump across the disk to vary with radius and azimuth. The cyclic and collective blade pitch angles needed to achieve a specified thrust coefficient and zero moment about the hub are predicted. The method has been validated with experimentally measured mean induced inflow velocities as well as surface pressures on a generic fuselage. Overset grids, sometimes referred to as Chimera grids, are used to simplify the grid generation process. The pressure disk model is applied to a cylindrical grid which is embedded in the grid or grids used for the rest of the configuration. This document will outline the development of the method, and present input and results for a sample case. Author

Actuator Disks; Applications Programs (computers); Flight Simulation; Horizontal Flight; Incompressible Flow; Mathematical Models; Navier-stokes Equation; Pressure Gages; Rotary Wings;

N96-10910*# North Carolina State Univ., Raleigh, NC. Dept. of Mechanical and Aerospace Engineering.
Semi-span model testing in the National Transonic Facility Annual Status Report, Aug. 1995
Chokani, Ndaona; and Milholen, II, William E.; Aug. 1995 27 p
Contract(s)/Grant(s): (NCC1-169)
Report No.(s): (NASA-CR-199272; NAS 1.26:199272) Avail: CASI HC A01/MF A01

The objectives of the present research are: (1) to develop a computational approach to support semi-span model test techniques in the NTF; and (2) to integrate this approach with the conduct of an experimental test program. To meet these objectives, the following approach is taken. A state-of-the-art three-dimensional Navier-Stokes solver is employed to compute the flow over both a full-span configuration and a semi-span configuration mounted on the sidewall of the tunnel. The computations are validated by making direct comparisons to experimental data for both configurations. Then, the semi-span computational results are compared to the full-span results to document how the flow over the semi-span configuration differs from that over the full-span configuration. The results of this comparative study will be used to provide a conceptual framework within which a semi-spa model test technique may be implemented in the NTF. Author

Computational Fluid Dynamics; Computational Grids; Navier-stokes Equation; Semispan Models; Wind Tunnel Models; Wind Tunnel Tests;

N96-10995 Naval Air Warfare Center, Warminster, PA. Aircraft Div.
Anemometer design using the aerodynamic drag of circular cylinders with vortex controlling surface protrusions
Lake, Robert E.; 9 May 1995 22 p Limited Reproducibility: More than 20% of this document may be affected by poor print
Report No.(s): (AD-A294307) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

A series of wind tunnel and flight tests were conducted to determine the ability of four anemometer configurations to accurately measure helicopter rotor downwash outflow magnitude and direction. The anemometers were designed to use the aerodynamic drag produced on a circular cylinder as the sensing stimulus. The non-linearities in drag with respect to Reynolds numbers that are associated with smooth cylinder flow were overcome by incorporating vortex controlling surface protrusions. The four surface protrusion configurations discussed here include vertical flutes, helical strakes, and small and large grid mesh. Measurement performance was quantified by determining the sensor's range, calibration accuracy, linearity, frequency response, accuracy in measuring angle of wind incidence, and ability to correct angle of attack induced errors. Testing demonstrated that the four configurations show comparable downwash measuring performance to the ion beam deflection anemometer. Although the sensor's design was intended for measuring helicopter rotor downwash, the results from this paper can be applied to a variety of high velocity measurement applications as well. DTIC

Aerodynamic Drag; Anemometers; Circular Cylinders; Downwash; Flight Tests; Frequency Ranges; Nonlinearity; Reynolds Number; Rotary Wings; Vortices; Wind Tunnel Tests;

N96-11132# Arnold Engineering Development Center, Arnold AFS, TN.
AEDC (Arnold Engineering Development Center) Hypersonics Test and Evaluation Workshop Final Report
Stallings, D. W.; Jul. 1995 51 p Workshop held at Arnold AFS, TN, 6-8 Apr. 1994
Report No.(s): (AD-A296563; AEDC-TR-95-9) Avail: CASI HC A04/MF A01

On April 6-8, 1994, a Hypersonic Test and Evaluation (T&E) Workshop was held at Arnold Engineering Development Center (AEDC). This workshop was sponsored by Dr. Leonidas Sakell of the Air Force Office of Scientific Research (AFOSR). The organizers of the workshop were Maj. M. Briski for the AEDC Air Force and R.K. Matthews for Micro Craft Technology, support contractor for aerodynamic testing at AEDC. During the original planning for this workshop, two goals were set. These were: (1) Define methodology as it applies to development of hypersonic flight systems; and (2) Develop methodologies for two specific technology areas in hypersonics: aerodynamics and aerothermal. As the meeting progressed, it seemed there were broader concerns which should be addressed. Consequently, the goals shifted somewhat to encompass two major subjects: Define an integrated hypersonic T&E methodology. Describe an optimum plan for using the existing national assets in ground test, flight test, and computational capability. This report describes some of the discussion which ensued and presents conclusions from the meeting. DTIC

Aerodynamic Characteristics; Computer Systems Performance; Contractors; Hypersonic Flight; Hypersonics; Product Development; Wind Tunnel Tests;

N96-11138# Lockheed Corp., Fort Worth, TX.

Unsteady transonic wind tunnel tests on a semispan straked delta wing, model oscillating in pitch. Part 2: Selected data points for harmonic oscillation Final Report, Mar. 1989 - Dec. 1993

Cunningham, Jr., Atlee M.; Denboer, Ruud G.; Dogger, C. S.; Geurts, E. G.; and Retel, A. P.; Jun. 1995 126 p

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

Report No.(s): (AD-A296785; WL-TR-94-3095-PT-2) Avail: CASI HC A07/MF A02

A wind tunnel investigation was conducted in 1992 to investigate the unsteady aerodynamic aspects of transonic high incidence flows over a simple straked wing model. This test was designed to show how low speed vortex type flows evolve into complicated shock vortex interacting flows at transonic speeds. Requirements for this test were based on a low speed test conducted in 1986 on a full span model in the NLR Low Speed Tunnel. The transonic model was a semispan version of the low speed model with some modifications. It was equipped with a three-component semispan balance to measure total wing loads, seven rows of high response pressure transducers to measure unsteady pressures and 15 vertical accelerometers to measure model motion and vibrations. The model was oscillated sinusoidally in pitch at various amplitudes and frequencies for mean model incidences varying from 4 deg to 48 deg. In addition, maneuver type transient motions of the model were tested with amplitudes of 16 deg and 30 deg total rotation at various starting angles. The test was conducted in the NLR HST in the Mach range of 0.225 to 0.90 with some preliminary vapor screen flow visualization data taken at M=O.6 and 0.9. This part of the report presents selected data points for harmonic oscillations. DTIC

Delta Wings; Harmonic Oscillation; High Pressure; Low Speed; Models; Oscillations; Semispan Models; Transonic Flow; Transonic Speed; Transonic Wind Tunnels; Unsteady Aerodynamics; Vortices; Wind Tunnel Tests; Wing Loading;

N96-11162*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

Vortex wakes of rotorcraft

McCroskey, W. J.; 1995 25 p

Report No.(s): (NASA-TM-110822; NAS 1.15:110822; AD-A294465) Avail: CASI HC A03/MF A01

This paper presents an overview of the complex unsteady vortical flows that comprise the wakes of rotary-wing aircraft; of the effects these tangled vortical structures have on the performance, noise, and vibration; and of some of the recent attempts to measure, predict, and control the phenomena. The main points are illustrated with a number of examples from the recent literature and technical conferences. DTIC

Aerodynamic Forces; Air Flow; Computational Fluid Dynamics; Conferences; Flow Distribution; Flow Visualization; Rotary Wing Aircraft; Rotary Wings; Rotor Blades; Unsteady Flow; Vibration; Vortices; Wakes;

N96-11164*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

Prediction and measurement of blade-vortex interaction loading

Tung, Chee; Gallman, Judith M.; Kube, Roland; Brooks, Thomas F.; and Rahier, Gilles; 1995 12 p

Report No.(s): (NASA-TM-110824; NAS 1.15:110824; AD-A294468) Avail: CASI HC A03/MF A01

An extensive quantity of airload measurements was obtained for a pressure-instrumented model of the BO-105 main rotor for a large number of higher-harmonic control (HHC) settings at Duits-Nederlandse Wind Tunnel (DNW). The wake geometry, vortex strength, and vortex core size were also measured through a laser light sheet technique and LDV. These results are used to verify the BVI airload prediction methodologies developed by AFDD, DLR, NASA Langley, and ONERA. The comparisons show that an accurate prediction of the blade motion and the wake geometry is the most important aspect of the BVI airload predictions. DTIC

Aerodynamic Loads; Blade-vortex Interaction; Bo-105 Helicopter; Rotors; Vortices; Wakes; Wind Tunnels;

N96-11212*# Arizona State Univ., Tempe, AZ. Dept. of Mechanical and Aerospace Engineering.
Multidisciplinary design optimization using multiobjective formulation techniques Final Report
Chattopadhyay, Aditi; and Pagaldipti, Narayanan S.; Aug. 1995 32 p
Contract(s)/Grant(s): (NCA2-778)
Report No.(s): (NASA-CR-199290; NAS 1.26:199290) Avail: CASI HC A03/MF A01

This report addresses the development of a multidisciplinary optimization procedure using an efficient semi-analytical sensitivity analysis technique and multilevel decomposition for the design of aerospace vehicles. A semi-analytical sensitivity analysis procedure is developed for calculating computational grid sensitivities and aerodynamic design sensitivities. Accuracy and efficiency of the sensitivity analysis procedure is established through comparison of the results with those obtained using a finite difference technique. The developed sensitivity analysis technique are then used within a multidisciplinary optimization procedure for designing aerospace vehicles. The optimization problem, with the integration of aerodynamics and structures, is decomposed into two levels. Optimization is performed for improved aerodynamic performance at the first level and improved structural performance at the second level. Aerodynamic analysis is performed by solving the three-dimensional parabolized Navier Stokes equations. A nonlinear programming technique and an approximate analysis procedure are used for optimization. The procedure developed is applied to design the wing of a high speed aircraft. Results obtained show significant improvements in the aircraft aerodynamic and structural performance when compared to a reference or baseline configuration. The use of the semi-analytical sensitivity technique provides significant computational savings. Author
Aerodynamics; Aerospace Vehicles; Aircraft Structures; Computational Fluid Dynamics; Computational Grids; Finite Difference Theory; Multidisciplinary Design Optimization; Navier-stokes Equation; Spacecraft Design;

N96-11224*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Pressure distributions from subsonic tests of a NACA 0012 semispan wing model
Applin, Zachary T.; Sep. 1995 174 p
Contract(s)/Grant(s): (RTOP 538-05-14-01)
Report No.(s): (NASA-TM-110148; NAS 1.15:110148) Avail: CASI HC A08/MF A02

An unswept, semispan wing model incorporating a NACA 0012 airfoil section was tested in the Langley 14- by 22-Foot Subsonic Tunnel. This report contains pressure data which document effects of wing configuration and free-stream conditions on wing pressure distributions. The untwisted wing incorporated a full-span, leading-edge Krueger flap and a full-span, single-slotted trailing-edge flap. The trailing-edge flap was tested at a deflection angle of 40 degrees and the Krueger flap at a deflection of 55 degrees. Three wing configurations were tested: cruise, trailing-edge flap only, and Knueger flap and trailing-edge flap deployed. Tests were conducted at free-stream dynamic pressures of 15, 30 and 60 psf, with corresponding chord Reynolds numbers of 1.22 to 2.11 million and Mach numbers of 0.12 to 0.20. Angles of attack presented range from 0 to 20 degrees, depending on wing configuration. The data are presented without analysis. Author
Aerodynamic Configurations; Airfoil Profiles; Dynamic Pressure; Free Flow; Pressure Distribution; Semispan Models; Subsonic Speed; Unswept Wings; Wind Tunnel Tests;

N96-11469# National Aerospace Lab., Tokyo (Japan).
On the Hypersonic Flight Experiment (HYFLEX) project
Shirouzu, Masao; Inouye, Yasutoshi; Takizawa, Minoru; Kai, Takashi; Yamamoto, Yukimitsu; Fujii, Keisuke; Takaki, Ryouji; Shouji, Hirokazu; Ishimoto, Shinji; and Ito, Takeshi; et al 20 Sep. 1995 11 p Prepared in cooperation with National Space Development Agency, Tokyo, Japan Avail: CASI HC A03/MF A01

A hypersonic flight experiment project of a lifting-body type vehicle named HYFLEX (Hypersonic Flight Experiment) is in progress by the National Aerospace Laboratory and the National Space Development Agency as a part of collaborative activities for the development of HOPE. The vehicle will be separated at a velocity of about 3.9 km/s from the second stage of the J-1 launcher and will acquire flight data during its glide descent. This paper describes the purpose and the outline of the experiment, aerodynamic characteristics, sub-components, and guidance and control of the vehicle, as well as onboard data acquisition and schedule. Technological targets of the HYFLEX project are also discussed in comparison with the requirements for operational spaceplane like HOPE. Author
Aerodynamic Characteristics; Aerospace Planes; Flight Control; Hypersonic Flight; Lifting Bodies;

N96-11543# Wright Lab., Wright-Patterson AFB, OH.
A compilation of the mathematics leading to the doublet-lattice method Final Report, Aug. - Nov. 1994
Blair, Max; 1 Nov. 1994 161 p Supercedes WL-TR-92-3028
Report No.(s): (WL-TM-95-3022) Avail: CASI HC A08/MF A02

This report supersedes WL-92-3028. This report provides a theoretical development of the doublet-lattice method, the method of choice for most subsonic unsteady aerodynamic modelling for over twenty years. This is a tutorial based on many key mathematical developments pro-

vided in the References section. An example source code is provided in the Appendix. CASI
Aeroelasticity; Boundary Element Method; Lattices (mathematics); Potential Flow; Selection; Unsteady Aerodynamics;

N96-11686*# Queensland Univ., Brisbane (Australia). Dept. of Mechanical Engineering.
Lift, drag and thrust measurement in a hypersonic impulse facility c02
Tuttle, S. L.; Mee, D. J.; and Simmons, J. M.; In its Shock Tunnel Studies of Scramjet Phenomena 1994 1995 9 p Presented at the 18th AIAA Aerospace Ground Testing Conference, Colorado Springs, CO, 20-23 Jun. 1994 (For primary document see N96-11683 01-01)
Report No.(s): (AIAA PAPER 94-2596) Copyright Avail: CASI HC A02/MF A02

This paper reports the extension of the stress wave force balance to the measurement of forces on models which are non-axisymmetric or which have non-axisymmetric load distributions. Recent results are presented which demonstrate the performance of the stress wave force balance for drag measurement, for three-component force measurement and preliminary results for thrust measurement on a two-dimensional scramjet nozzle. In all cases, the balances respond within a few hundred microseconds. Author
Aerodynamic Drag; Drag Measurement; Force Distribution; Hypersonic Flow; Hypersonic Nozzles; Lift; Shock Tunnels; Stress Waves; Test Facilities; Thrust Loads; Thrust Measurement; Wind Tunnel Tests;

N96-11687*# Queensland Univ., Brisbane (Australia). Dept. of Mechanical Engineering.
Measurements of scramjet thrust in shock tunnels c02
Stalker, R. J.; Simmons, J. M.; Paull, A.; and Mee, D. J.; In its Shock Tunnel Studies of Scramjet Phenomena 1994 1995 11 p Presented at the 18th AIAA Aerospace Ground Testing Conference, Colorado Springs, CO, 20-23 Jun. 1994 (For primary document see N96-11683 01-01)
Report No.(s): (AIAA PAPER 94-2516) Copyright Avail: CASI HC A03/MF A02

By using results obtained in tests on supersonic combustion of hydrogen in air, the conditions governing model size and operating pressure levels for shock tunnel experiments on models of flight vehicles with scramjet propulsion are established. It is seen that large models are required. The development of the stress wave force balance is then described, and its use as a method of measuring thrust/drag on such models is discussed. Test results on a simple, fully integrated scramjet model, with intakes, combustion chambers, thrust surfaces and exterior surfaces, using a 13 percent silane 87 percent hydrogen fuel mixture, showed that a steady state with thrust generation could be achieved within the shock tunnel test time, and the thrust could be measured. Results are presented for a range of stagnation enthalpies, and show that the scramjet model produces net positive thrust at velocities up to 2.4 km/sec. Author
Force Distribution; Scale Models; Shock Tunnels; Steady State; Stress Waves; Thrust Loads; Thrust Measurement; Wind Tunnel Tests;

N96-11757 Institut Franco-Allemand de Recherches, Saint-Louis (France).
Use of particle image velocimetry for the measurement of a non-laminar velocity field on an oscillating NACA0012-airfoil [Einsatz der particle image velocimetry zur messung von instationaeren geschwindigkeitsfeldern an einem schwingenden NACA0012-profil]
Wernert, P.; Schaefer, H. J.; Raffel, M.; and Kompenhans, J.; 1994 64 p In GEORGIAN; Text in GERMAN; summaries in FRENCH and ENGLISH Prepared in cooperation with Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Goettingen (Germany, F.R.). Inst. fuer Stroemungsmechanik
Report No.(s): (PB95-224655; ISL-R-108/94) Avail: Issuing Activity (National Technical Information Services (NTIS))

Experiments on dynamic stalling of oscillating rotor blade airfoils was carried out in a joint measurement project. The non-laminar velocity field over a NACA0012-airfoil oscillating in pitch was studied in a low-velocity wind tunnel using particle-image velocimetry. Because of the short measurement time of only a few microseconds, the determination of the complete and instantaneous velocity field was possible. The results of the measurements display the strongly non-laminar behavior of the flow field over the oscillating airfoil, particularly in the region of decreasing angle of attack, and yield new insights into fundamental flow phenomena. The experimentally measured velocity fields and the quantities such as vorticity derived from the measurements are of great interest for the validation of numerical computations. The measurements display a finer structure of the mixing of different vortex systems than were predicted by numerical simulations. Open questions about the reproducibility and the dynamics of the observed phenomena remain. Finally, the introduction of additional measurement techniques combined with digital image processing or the use of pressure-sensitive dyes or foils could make possible a more complete picture of the dynamic stall process.
NTIS
Aerodynamic Stalling; Airfoils; Oscillating Flow; Particle Image Velocimetry; Velocity Distribution; Velocity Measurement; Vorticity; Wind Tunnel Tests;

N96-11872*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Tables of properties of airfoil polynomials
Desmarais, Robert N.; and Bland, Samuel R.; Sep. 1995 21 p

Contract(s)/Grant(s): (RTOP 505-63-50-12)
Report No.(s): (NASA-RP-1343; L-17420; NAS 1.61: 1343)
Avail: CASI HC A03/MF A01

This monograph provides an extensive list of formulas for airfoil polynomials. These polynomials provide convenient expansion functions for the description of the downwash and pressure distributions of linear theory for airfoils in both steady and unsteady subsonic flow. Author
Airfoils; Downwash; Kernel Functions; Polynomials; Pressure Distribution; Subsonic Flow;

N96-12028 Illinois Inst. of Tech., Chicago, IL.
Feedback control of unsteady flow separation over airfoils Ph.D. Thesis
Rao, Prashant Sadananda; 1994 115 p
Avail: Univ. Microfilms Order No. DA9427251

This study considers the problem of maintaining attached flow over airfoils undergoing maneuvers that are not known a priori. This has applications in aerodynamics where the ability to control unsteady flow separation results in safer and more maneuverable aircraft. The system to be controlled is distributed in nature and described by the nonlinear partial differential equations of boundary layer theory and the continuity equation. It is impractical to measure, in the field, the pressure gradient and the velocity boundary condition imposed by the potential flow on the boundary layer. A model is therefore developed to determine both the pressure gradient and the velocity boundary condition using the time-history of the motion of the airfoil. Comparison is made with experimental results obtained for a NACA 0012 airfoil undergoing a pitch-up motion and a sinusoidal oscillation about a fixed spanwise axis. The technique of suction is used as the control input for its demonstrated ability to control unsteady separation and its known ability to maintain laminar flow which results in reduced drag. An approach is developed that attempts to define the desired state as broadly as possible. The desired state is defined by specifying the ratio of the thickness of the attached layer to the displacement thickness that is to be maintained. This simplifies the problem considerable since the two dimensional boundary layer equation is replaced by the one dimensional integral momentum equation. A control law is then developed using an approach based on Lyapunov's second method which guarantees asymptotic stability of the controller provided that the desired state is controllable. Simulation results are presented that combine the potential flow model with finite difference models of the boundary layer and the control law. The simulations were run considering a flat plate airfoil pitching up at a constant pitch rate. The control law was found to be effective at maintaining attached flow for all the situations considered. Dissert. Abstr.
Airfoils; Boundary Layer Control; Boundary Layer Separation; Feedback Control; Potential Flow; Suction; Two Dimensional Boundary Layer; Unsteady Flow;

N96-12050*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
Flight test evaluation of the E-systems Differential GPS category 3 automatic landing system
Kaufmann, David N.; and McNally, B. David; 1 Sep. 1995 499 p
Report No.(s): (NASA-TM-110368; NAS 1.15:110368; A-950096) Avail: CASI HC A21/MF A04

Test flights were conducted to evaluate the capability of Differential Global Positioning System (DGPS) to provide the accuracy and integrity required for International Civil Aviation Organization (ICAO) Category (CAT) III precision approach and landings. These test flights were part of a Federal Aviation Administration (FAA) program to evaluate the technical feasibility of using DGPS based technology for CAT III precision approach and landing applications. An IAI Westwind 1124 aircraft (N24RH) was equipped with DGPS receiving equipment and additional computing capability provided by E-Systems. The test flights were conducted at NASA Ames Research Center's Crows Landing Flight Facility, Crows Landing, California. The flight test evaluation was based on completing 100 approaches and landings. The navigation sensor error accuracy requirements were based on ICAO requirements for the Microwave Landing System (MLS). All of the approaches and landings were evaluated against ground truth reference data provided by a laser tracker. Analysis of these approaches and landings shows that the E-Systems DGPS system met the navigation sensor error requirements for a successful approach and landing 98 out of 100 approaches and landings, based on the requirements specified in the FAA CAT III Level 2 Flight Test Plan. In addition, the E-Systems DGPS system met the integrity requirements for a successful approach and landing or stationary trial for all 100 approaches and landings and all ten stationary trials, based on the requirements specified in the FAA CAT III Level 2 Flight Test Plan. Author
Aircraft Landing; Approach Indicators; Automatic Landing Control; Civil Aviation; Flight Tests; Global Positioning System; Ground Truth; Microwave Landing Systems; Technology Assessment;

03 AIR TRANSPORTATION AND SAFETY

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

N96-10669 National Inst. of Standards and Technology, Gaithersburg, MD.
Carbon monoxide production in compartment fires: Reduced-scale enclosure test facility
Bryner, N. P.; Johnsson, E. L.; and Pitts, W. M.; Nov. 1994 218 p See also PB93-146702 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

Report No.(s): (PB95-231700; NISTIR-5568) Avail: Issuing Activity (National Technical Information Service (NTIS))

Carbon monoxide production during room fires has been investigated using natural-gas fires within a reduced-scale enclosure (RSE), an 0.98 m x 0.98 m x 1.46 m(w x h x d) room with a single door opening centered in the front wall. This series of 125 fires with heat release rates (HRR) from 7 to 650 kW and global equivalence ratio phi(sub g) from 0.2 to 4.2, respectively, has demonstrated that the upper layer is nonuniform in temperature and gas species, and that upper-layer oxygen is depleted for underventilated fires with high-temperature upper layers. For fires having HRR exceeding 400 kW (phi(sub g) greater than 2), carbon monoxide concentrations of up to 3.5 percent have been observed in the front portion of the upper layer. Carbon monoxide concentrations in the rear were consistently lower being on the order of 2.0 percent for phi(sub g) greater than 2. NTIS

Carbon Monoxide; Combustion Products; Enclosure; Fires; Fuels; Gas Composition; Scale Models;

N96-10993# Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.

The new ADS-33 process: Cautions for implementation

Kolwey, Herman G.; 25 Jan. 1995 7 p

Report No.(s): (AD-A294302) Avail: CASI HC A02/MF A01

This paper presents the author's view that the new ADS-33 test methods must be very carefully applied in practice in order to avoid potential damage or loss of the test aircraft. This opinion comes about after review of several accidents, both fixed and rotary wing, and finding a common thread of frequency related control inputs. A discussion ensued within the AHS Test and Evaluation Committee, bringing forth some seven accidents/incidents involving these these methods. This Technical Note is the final result. DTIC

Accident Investigation; Damage; Fixed Wings; Losses; Rotary Wings; Test Vehicles;

N96-11141# Federal Aviation Administration, Washington, DC. Office of Civil Aviation Security.

Criminal acts against civil aviation

1994 101 p

Report No.(s): (AD-A296813) Avail: CASI HC A06/MF A02

Criminal Acts Against Civil Aviation Since 1986, the Federal Aviation Administration's Office of Civil Aviation Security has been publishing an annual report entitled Criminal Acts Against Civil Aviation. This report is a compilation of criminal incidents against civil aviation aircraft and interests worldwide. As in last year's publication, the 1994 issue contains feature articles and geographic overviews. Incidents are summarized in the overviews, and the feature articles focus on specific aviation-related issues or case histories. There is also a section in which incidents are compared for the 5-year period, 1990 to 1994. Charts, graphs, and maps appear throughout the publication. New to this year's edition is a Product Survey, which appears on the last page of the booklet. This questionnaire can be separated and returned. The information contained in this publication is derived from a variety of foreign and domestic sources. In many cases, however, specific details of a particular incident, especially those occurring outside the United States, may not be available. While the FAA makes every effort to provide complete and accurate information, it is not always possible to verify accounts of some incidents. The FAA maintains records of aircraft hijackings, bombing attacks, and other significant criminal acts against civil and general aviation interests worldwide, which are used to compile this report. Offenses such as these represent serious threats to aviation safety and, in those incidents involving U.S. air carriers or facilities outside the United States, are often intended as symbolic attacks against the United States. DTIC

Air Piracy; Case Histories; Charts; Civil Aviation; Graphs (charts); Management; Security; Surveys;

N96-11157 Air Force Systems Command, Wright-Patterson AFB, OH. Crew System Ergonomics Information Analysis Center.

Flightdeck party line issues: An aviation safety reporting system analysis Technical Note, Aug. 1993 - Mar. 1994

Rehmann, Albert; Neumeier, Mark; Mitman, Robert; and Reynolds, Michael; Jun. 1995 145 p Limited Reproducibility: More than 20% of this document may be affected by poor print

Report No.(s): (AD-A296812; DOT/FAA/CT-TN95/12) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This document describes an analysis of the Aviation Safety Reporting System (ASRS) with regards to human factors aspects concerning the implementation of data link into the flightdeck. The ASRS database contains thousands of reports concerning actual or potential deficiencies which may compromise the safety of aviation operations in the National Airspace System (NAS). The purpose of this study was to determine the relative frequency of errors and consequences of decisions based on incorrect information received from the party line. Detailed analysis of the reports revealed two types of errors: those attributed to incorrect transmission of party line information (14 percent error rate) and those resulting from flight crew actions/decisions based on the transmitted information (26 percent error rate). Almost half (46 percent) of the reports concerning incorrect flight crew actions were a result of executing unauthorized clearances due to similar call signs. Further analysis of the incident reports also reveals party line informational (PLI) elements that are determined useful by the flight crews.

Based on the reports provided, conclusions are made with regards to the loss of the party line in a data link implementation. DTIC

Aircraft Safety; Data Bases; Data Links; Flight Safety; Frequencies; Human Factors Engineering; National Airspace System; Safety; Systems Analysis;

N96-11357# Army Aeromedical Research Lab., Fort Rucker, AL.

US Army rotary-wing emergency egress study Final Report

Swingle, Timothy R.; May 1995 45 p

Report No.(s): (AD-A296937; USAARL-95-23) Avail: CASI HC A03/MF A01

This study was conducted in support of a NATO AGARD (Advisory Croup for Aerospace Research and Development) effort to survey emergency egress mechanisms for all helicopters. This particular study deals with U.S. Army helicopters. The study consists of photographs and diagrams of each exit system, and a brief synopsis of the emergency egress procedure including: location and description of the operating mechanism, location of and ease of viewing the operating instructions, force required to to operate, direction of opening, size of aperture and restrictions to evacuation, overall ease of operation and access for crews, and extent of instructions in the operators manual. DTIC

Aerospace Systems; Egress; Emergencies; Helicopters; North Atlantic Treaty Organization (NATO); Rotary Wing Aircraft; Surveys;

N96-11404# Wright Lab., Wright-Patterson AFB, OH.

Suppression of high speed turbulent flames in a detonation/deflagration tube

Gmurczyk, G.; and Grosshandler, W. L.; Jan. 1995 62 p

Report No.(s): (PB95-231817; NISTIR-5642) Avail: CASI HC A04/MF A01

Live-fire, full-scale testing has been conducted at Wright-Patterson Air Force Base to identify an agent to replace CF3Br (Halon 1301) for suppressing fires in military aircraft dry bays. The three chemicals being considered (C2HF5, HFC-125; C3F8, FC-218; and CF3I, Halon 13001) had been evaluated in a previous laboratory study, in which unique properties of each chemical were identified in small-scale experiments. The FC-218 provided the most consistent performance in this new series of experiments which examined lean, stoichiometric and rich initial conditions. Large pressure build ups were not observed during suppression of the propane/air mixtures under the current set of conditions. None of the agents could be ruled out for dry bay applications based upon the results of this study. NTIS

Aircraft Safety; Detonation; Fire Extinguishers; Fire Fighting; Flames; Flight Safety;

N96-11662# Purdue Univ., West Lafayette, IN.

HINCOF-1: A code for hail ingestion in engine inlets Interim Report, 10 May 1992 - Feb. 1994

Gopalaswamy, N.; and Murthy, S. N. B.; Aug. 1995 74 p

Contract(s)/Grant(s): (FAA-92-G-002)

Report No.(s): (DOT/FAA/CT-94/80; M/FAA/002-94-1) Avail: CASI HC A04/MF A01

One of the major concerns during hail ingestion into an engine is the resulting amount and space- and time-wise distribution of hail at the engine face for a given geometry of inlet and set of atmospheric and flight conditions. The appearance of hail in the capture streamtube is invariably random in space and time, with respect to size and momentum. During the motion of a hailstone through an inlet, a hailstone undergoes several processes, namely impact with other hailstones and material surfaces of the inlet and spinner, rolling and rebound following impact; heat and mass transfer; phase change; and shattering, the latter three due to friction and impact. Taking all of these factors into account, a numerical code, designated HINCOF-I, has been developed for determining the motion hailstones from the atmosphere, through an inlet, and up to the engine face. The numerical procedure is based on the Monte-Carlo method. The report presents a description of the code, along with several illustrative cases. The code can be utilized to relate the spinner geometry - conical or, more effective, elliptical - to the possible diversion of hail at the engine face into the bypass stream. The code is also useful for assessing the influence of various hail characteristics on the ingestion and distribution of hailstones over the engine face. Author (revised)

Applications Programs (computers); Engine Inlets; Hail; Ingestion (engines); Monte Carlo Method;

N96-11793 Federal Aviation Administration, Washington, DC.

Federal Aviation Administration annual report 1994

1994 103 p Limited Reproducibility: More than 20% of this document may be affected by poor print

Report No.(s): (AD-A294265) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Federal Aviation Administration (FAA) was created in 1958 to promote the safety of civil aviation and to foster air commerce. More than 48,000 career professionals are employed in the principal activities which support this mission: air traffic services; systems research and acquisition; regulation and certification; airport infrastructure development; civil aviation security; and agency administration. In the past three decades, progressive and substantial improvements in Air Traffic Control (ATC) technology, training, airframes, engines, avionics, cabin interiors, and airport security have greatly reduced the risk of air travel. Today, passengers can travel by air more safely, and for less cost, than ever before. And they are doing so in record numbers. In FY 1994, air travel on U.S. air carriers, regional and

commuters increased from 513 million passengers to 555 million-up 8.2% from the previous year and more than double the rate of growth which had been forecast. Along with enplaning roughly 60% of the world's commercial air passengers, the United States also has the world's largest and most active population of general aviation pilots. Aircraft in this category range from the homebuilt, one-seat single engine piston airplanes to the most sophisticated long-range corporate jets and helicopters. DTIC

Air Traffic Control; Air Transportation; Aircraft Safety; Airport Security; Airports; Avionics; Civil Aviation; General Aviation Aircraft; Systems Analysis; Technological Forecasting; United States;

N96-11798# Army Aeromedical Research Lab., Fort Rucker, AL.

US Army rotary-wing emergency egress study Final Report

Swingle, Timothy R.; May 1995 45 p

Report No.(s): (AD-A296737; USAARL-95-23) Avail: CASI HC A03/MF A01

This study was conducted in support of a NATO AGARD (Advisory Group for Aerospace Research and Development) effort to survey emergency egress mechanisms for all helicopters. This particular study deals with U.S. Army helicopters. The study consists of photographs and diagrams of each exit system, and a brief synopsis of the emergency egress procedure including: location and description of the operating mechanism, location of and ease of viewing the operating instructions, force required to operate, direction of opening, size of aperture and restrictions to evacuation, overall ease of operation and access for crews, and extent of instructions in the operators manual. DTIC

Aircraft Safety; Egress; Emergencies; Flight Crews; Flight Safety; Helicopters;

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

N96-11048# Air Force Flight Test Center, Edwards AFB, CA.

A limited evaluation of the traffic Alert/Collision avoidance system for T-1A cell formation station keeping (Have cell) Technical Letter Report, 20 Jan. - 6 Jun. 1995

White, III, Andrew B.; Odisho, II, Edwin V.; Bagley, Daniel T.; Clark, Trevor M.; and Morgan, David J.; 9 Jun. 1995 68 p

Contract(s)/Grant(s): (AF PROJ. M94-C)

Report No.(s): (AD-A296355; AFFTC-TLR-95-36) Avail: CASI HC A04/MF A01

This report presents the results of a limited evaluation of the suitability of the T-1A's Traffic Alert/Collision Avoidance System (TCAS) for cell formation station-keeping procedures during instrument meteorological conditions. The TCAS system was evaluated during cell formation takeoff, climb, cruise, and descent. The accuracy of the TCAS in bearing, range and altitude was evaluated. The aircraft were flown through a high density traffic area to evaluate the effects of the high traffic density on TCAS performance characteristics during cell formation station-keeping. A safe cone of operation was defined. A workload study was accomplished to evaluate pilot workload while using TCAS to fly cell formation in the T-1A. DTIC

Air Traffic; Air Traffic Control; Collision Avoidance; Control Systems Design; Navigation Aids; Stationkeeping; Technology Assessment;

N96-11151 Maryland Univ., College Park, MD.

Vision-based navigation and recognition Annual Report No. 2, Apr. 1993 - Mar. 1994

Rosenfeld, Azriel; Jun. 1995 28 p Limited Reproducibility: More than 20% of this document may be affected by poor print

Contract(s)/Grant(s): (DACA76-92-C-0009)

Report No.(s): (AD-A296397; TEC-0061) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report summarizes image understanding research dealing with many aspects of both navigation and recognition. This research has dealt with the following ten areas: (1) Parallel algorithms; (2)Invariant properties; (3) Image registration; (4) 3-D recovery; (5) Motion analysis; (6) Vision-based navigation; (7) Function-based recognition; (8) Face recognition; and (9) Document understanding. The work done in these areas is summarized in Sections 2-10 of this report. Further details about this work can be found in twelve technical reports issued on the Contract during the period April 1993 - March 1994. A bibliography of these reports is given in Section 11 of this report; the numbers in brackets in Sections 2-10 refer to this list. DTIC

Algorithms; Bibliographies; Brackets; Computer Vision; Image Processing; Navigation; Parallel Processing (computers); Pattern Registration;

N96-11321# Naval Postgraduate School, Monterey, CA.

Design and implementation of an inertial navigation system for real time flight of an unmanned air vehicle M.S. Thesis

Kataras, Dimitris E.; Mar. 1995 185 p

Report No.(s): (AD-A296632) Avail: CASI HC A09/MF A02

Unmanned Air Vehicles present increasing benefits to potential users, with their portability, low cost, and simplicity of operation in any battle theater. Work performed at the Naval Postgraduate School on the ARCHYTAS vehicle converges to totally unattached, autonomous flight in all regimes. Control of this inherently unstable platform is achieved by a Stability Augmentation System, designed to provide flight worthy response to pilot commands from a remote ground station. A critical part of this controller is the navigation system, which furnishes imperative data for the controlling process. This thesis examines the successful design and integration of an Inertial Navigation Sensor Suite with the already existing flight controller for the ARCHYTAS. An Inertial Measurement Unit (IMU) is selected from available systems, and the integration process is presented. The research focuses on system requirements, controller modification, IMU-controller interface procedures, and hardware configuration and installation. A radio frequency communication link that transmits data from the airborne IMU to the ground based flight controller is also developed and tested. Evaluation of the design and implementation is provided through laboratory, hardware-in-the-loop tests. DTIC

Flight Control; Inertial Navigation; Real Time Operation; Remotely Piloted Vehicles; Stability Augmentation; Systems Integration;

N96-11964*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

The development of the Final Approach Spacing Tool (FAST): A cooperative controller-engineer design approach

Lee, Katharine K.; and Davis, Thomas J.; Aug. 1995 11 p

Contract(s)/Grant(s): (RTOP 505-64-13)

Report No.(s): (NASA-TM-110359; A-950081; NAS 1.15: 110359) Avail: CASI HC A03/MF A01

Historically, the development of advanced automation for air traffic control in the United States has excluded the input of the air traffic controller until the need of the development process. In contrast, the development of the Final Approach Spacing Tool (FAST), for the terminal area controller, has incorporated the end-user in early, iterative testing. This paper describes a cooperative between the controller and the developer to create a tool which incorporates the complexity of the air traffic controller's job. This approach to software development has enhanced the usability of FAST and has helped smooth the introduction of FAST into the operational environment. Author

Air Traffic Control; Aircraft Approach Spacing; Approach Control; Automatic Control; Human Factors Engineering; Landing Aids; Software Engineering;

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

N96-10049# Advanced Research Projects Agency, Arlington, VA.

Wingship investigation, volume 1 Final Report

30 Sep. 1994 127 p

Report No.(s): (AD-A294979) Avail: CASI HC A07/MF A02

The Advanced Research Projects Agency (ARPA) has completed an investigation of Wingship concepts and technologies to examine their relevance and utility in future defense applications. A select team of technical experts from U.S. Government and industry was formed by ARPA to assess Wingship-related technologies and mission applications. The diverse group was comprised of Western experts in Wingship-unique and related technologies, including flight controls, aerodynamics, hydrodynamics, propulsion, and advanced structures. Transportation specialists and other mission analysts also participated. The Wingship Investigation concluded that vehicles approaching the efficiency and capacity required for strategic heavy lift are about 10 times larger (in gross weight) than any existing Wingship or other flying water-based craft, and about five-times larger than most experienced Russian or American experts recommend building using current technology. The study concluded that, while the cost and technical risks of developing these very large Wingships are currently unacceptable, there may be some promising military applications for Wingships in the 400- to 1000-ton range. Experience with these relatively smaller vehicles could also permit a growth path for the technology. DTIC

Aerodynamics; Arpa Computer Network; Flight Control; Hydrodynamics; Industries; Propulsion;

N96-10050# Advanced Research Projects Agency, Arlington, VA.

Wingship investigation, volume 3: Technology roadmap Final Report

30 Sep. 1994 208 p

Report No.(s): (AD-A294980) Avail: CASI HC A10/MF A03

The Advanced Research Projects Agency (ARPA) has completed an investigation of Wingship concepts and technologies to examine their relevance and utility in future defense applications. A select team of technical experts from U.S. Government and industry was formed by ARPA to assess Wingship-related technologies and mission applications. The diverse group was comprised of Western experts in Wingship-unique and related technologies, including flight controls, aerodynamics, hydrodynamics, propulsion, and advanced structures. Transportation specialists and

other mission analysts also participated. The Wingship Investigation concluded that vehicles approaching the efficiency and capacity required for strategic heavy lift are about 10 times larger (in gross weight) than any existing Wingship or other flying water-based craft, and about five-times larger than most experienced Russian or American experts recommend building using current technology. The study concluded that, while the cost and technical risks of developing these very large Wingships are currently unacceptable, there may be some promising military applications for Wingships in the 400- to 1000-ton range. Experience with these relatively smaller vehicles could also permit a growth path for the technology. DTIC

Aerodynamics; Arpa Computer Network; Flight Control; Hydrodynamics; Industries;

N96-10051# Advanced Research Projects Agency, Arlington, VA.

Wingship investigation, volume 2: Appendices Final Report

30 Sep. 1994 671 p

Report No.(s): (AD-A294981) Avail: CASI HC A99/MF A06

The Advanced Research Projects Agency (ARPA) has completed an investigation of Wingship concepts and technologies to examine their relevance and utility in future defense applications. A select team of technical experts from U.S. Government and industry was formed by ARPA to assess Wingship related technologies and mission applications. The diverse group was comprised of Western experts in Wingship-unique and related technologies, including flight controls, aerodynamics, hydrodynamics, propulsion, and advanced structures. Transportation specialists and other mission analysts also participated. The Wingship Investigation concluded that vehicles approaching the efficiency and capacity required for strategic heavy lift are about 10 times larger (in gross weight) than any existing Wingship or other flying water-based craft, and about five-times larger than most experienced Russian or American experts recommend building using current technology. The study concluded that, while the cost and technical risks of developing these very large Wingships are currently unacceptable, there may be some promising military applications for Wingships in the 400- to 1000-ton range. Experience with these relatively smaller vehicles could also permit a growth path for the technology. DTIC

Aerodynamics; Arpa Computer Network; Flight Control; Hydrodynamics; Industries; Propulsion;

N96-10209# Lawrence Livermore National Lab., Livermore, CA.

Modal analysis of PATHFINDER unmanned air vehicle

Woehrle, T. G.; Costerus, B. W.; and Lee, C. L.; 19 Oct. 1994 9 p Presented at the International Modal Analysis Conference, Nashville, TN, 13-16 Feb. 1995

Contract(s)/Grant(s): (W-7405-ENG-48)

Report No.(s): (DE95-014127; UCRL-JC-117457; CONF-950240-5) Avail: CASI HC A02/MF A01

An experimental modal analysis was performed on PATHFINDER, a 450-lb, 100-ft wing span, flying-wing-design aircraft powered by solar/electric motors. The aircraft was softly suspended and then excited using random input from a long-stroke shaker. Modal data was taken from 92 measurement locations on the aircraft using newly designed, lightweight, tri-axial accelerometers. A conventional PC-based data acquisition system provided data handling. Modal parameters were calculated, and animated mode shapes were produced using SMS STARStruct(tm) Modal Analysis System software. The modal parameters will be used for validation of finite element models, optimum placement of onboard accelerometers during flight testing, and vibration isolation design of sensor platforms. DOE

Aircraft Structures; Finite Element Method; Flight Tests; Mathematical Models; Pilotless Aircraft; Vibration;

N96-10512*# Arizona State Univ., Tempe, AZ. Dept. of Mechanical and Aerospace Engineering.

An integrated optimum design approach for high speed prop rotors Final Report, Jan. 1993 - Jun. 1995

Chattopadhyay, Aditi; and McCarthy, Thomas R.; 1 Aug. 1995 92 p

Contract(s)/Grant(s): (NCC2-795)

Report No.(s): (NASA-CR-199389; NAS 1.26:199389) Avail: CASI HC A05/MF A01

The objective is to develop an optimization procedure for high-speed and civil tilt-rotors by coupling all of the necessary disciplines within a closed-loop optimization procedure. Both simplified and comprehensive analysis codes are used for the aerodynamic analyses. The structural properties are calculated using in-house developed algorithms for both isotropic and composite box beam sections. There are four major objectives of this study. (1) Aerodynamic optimization: The effects of blade aerodynamic characteristics on cruise and hover performance of prop-rotor aircraft are investigated using the classical blade element momentum approach with corrections for the high lift capability of rotors/propellers. (2) Coupled aerodynamic/structures optimization: A multilevel hybrid optimization technique is developed for the design of prop-rotor aircraft. The design problem is decomposed into a level for improved aerodynamics with continuous design variables and a level with discrete variables to investigate composite tailoring. The aerodynamic analysis is based on that developed in objective 1 and the structural analysis is performed using an in-house code which models a composite box beam. The results are compared to both a reference rotor and the optimum rotor found in the purely aerodynamic formulation. (3) Multipoint optimization: The multilevel optimization procedure of

objective 2 is extended to a multipoint design problem. Hover, cruise, and take-off are the three flight conditions simultaneously maximized. (4) Coupled rotor/wing optimization: Using the comprehensive rotary wing code CAMRAD, an optimization procedure is developed for the coupled rotor/wing performance in high speed tilt-rotor aircraft. The developed procedure contains design variables which define the rotor and wing planforms.

Derived from text

Aircraft Design; Airfoils; Computer Aided Design; Flight Conditions; Multidisciplinary Design Optimization; Propeller Blades; Structural Design; Tilt Rotor Aircraft; Tilting Rotorsa.;

N96-10737*# Boeing Defense and Space Group, Seattle, WA.

Investigation into the impact of agility on conceptual fighter design

Engelbeck, R. M.; Jun. 1995 191 p

Contract(s)/Grant(s): (NAS1-18762; RTOP 505-68-70-09)

Report No.(s): (NASA-CR-195079; NAS 1.26:195079) Avail: CASI HC A09/MF A02

The Agility Design Study was performed by the Boeing Defense and Space Group for the NASA Langley Research Center. The objective of the study was to assess the impact of agility requirements on new fighter configurations. Global trade issues investigated were the level of agility, the mission role of the aircraft (air-to-ground, multi-role, or air-to-air), and whether the customer is Air force, Navy, or joint service. Mission profiles and design objectives were supplied by NASA. An extensive technology assessment was conducted to establish the available technologies to industry for the aircraft. Conceptual level methodology is presented to assess the five NASA-supplied agility metrics. Twelve configurations were developed to address the global trade issues. Three-view drawings, inboard profiles, and performance estimates were made and are included in the report. A critical assessment and lessons learned from the study are also presented. Author

Aircraft Configurations; Aircraft Design; Design Analysis; Fighter Aircraft; Flight Characteristics; Maneuverability; Technology Assessment;

N96-11074# Federal Aviation Administration, Atlantic City, NJ.

Vertical drop test of a narrow-body fuselage section with overhead stowage bins and auxiliary fuel tank system on board Final Report, Oct. 1993 - Sep. 1994

Logue, Thomas V.; McGuire, Robert J.; Reinhardt, Robert J.; Vu, John W.; and Vu, Tong V.; Apr. 1995 147 p

Report No.(s): (AD-A296159; DOT/FAA/CT-94/116) Avail: CASI HC A07/MF A02

In Oct. 1993 the FAA Technical Center conducted a vertical drop test of a narrow- body fuselage section. This test was structured to determine the impact response characteristics of some typical items of mass found aboard transport airplanes to assess the adequacy of the design standards and regulatory requirements for those components. A primary objective of this test was to determine the dynamic response characteristics of the onboard overhead stowage bins and auxiliary fuel tank system, as well as the fuselage section itself, when subjected to a potentially survivable impact. The dynamic impact environment and the resultant response of the onboard overhead stowage bins and auxiliary fuel tank system were characterized. The structural support reactions for those onboard items of mass were measured and compared to predicted values which were based on static analyses and tests. The test was intentionally structured to impose a dynamic load condition in excess of the current design and certification requirements for the onboard items of mass so that the dynamic fracture loads and modes of fracture for those components could also be determined and evaluated. DTIC

Aircraft Design; Drop Tests; Dynamic Loads; Dynamic Response; Fracture Strength; Fuel Tanks; Fuselages; Impact Loads; Impact Tests; Structural Design; Transport Aircraft;

N96-11333# Technische Univ., Delft (Netherlands).

Some comments on production methods for composite aircraft shell structures with minimum production effort and investment

Vanrijn, L. P. v. M.; Jul. 1994 29 p

Report No.(s): (PB95-242798; M-693) Copyright Avail: CASI HC A03/MF A01

The report describes various production methods for composite light aircraft shells, with minimum production effort and low investment cost for the moulds. The methods described are intended for the production of prototypes or single assemblies, with an intermediate fiber content. Autoclave production methods are not considered. NTIS

Aircraft Models; Aircraft Structures; Composite Materials; Composite Structures; Production Engineering; Shells (structural Forms);

N96-11523# Industrial Coll. of the Armed Forces, Washington, DC.

The wingship's potential for strategic lift Research Report, Aug. 1994 - Apr. 1995

Losi, Peter C.; Apr. 1995 43 p

Report No.(s): (AD-A294169; NDU/ICAF-95-S12) Avail: CASI HC A03/MF A01

A Wing-In-Ground-effect (or WIG) aircraft is a vehicle designed to fly just above the surface of the earth in an aerodynamic regime called 'ground effect'. Flying in ground effect allows greater fuel efficiency than realized by conventional aircraft. One large WIG design that combines the cargo capacity of a small ship with the speed of a large air-

craft is currently being considered as a strategic lift vehicle. This 'half-airplane/half-ship' is aptly called a 'wingship'. The main proponent of the wingship design is a company called Aerocon in Arlington, Virginia. In 1993, Aerocon successfully lobbied Congress to provide funding for a study to be completed by the Advanced Research Projects Agency (ARPA) on the potential of wingships as strategic mobility vehicles. This report looks at the preliminary findings of ARPA and the claims of Aerocon regarding the wingship's strategic mobility potential. These two different viewpoints provide most of the 'pros' and 'cons' of wingship development for the strategic mobility mission. Additionally, the report examines some other military, economic, diplomatic, and political factors that should be considered in a decision to pursue this new technology. DTIC

Aerodynamics; Arpa Computer Network; Cargo; Ground Effect (aerodynamics); Ships;

N96-11652*# Research Inst. for Advanced Computer Science, Moffett Field, CA.

A comparison of design variables for control theory based airfoil optimization

Reuther, James; and Jameson, Antony; (Princeton Univ., NJ.) Jul. 1995 9 p

Contract(s)/Grant(s): (NAS2-13721)

Report No.(s): (NASA-CR-199151; NAS 1.26:199151; RIACS-TR-95-13) Avail: CASI HC A02/MF A01

This paper describes the implementation of optimization techniques based on control theory for airfoil design. In our previous work in the area it was shown that control theory could be employed to devise effective optimization procedures for two-dimensional profiles by using either the potential flow or the Euler equations with either a conformal mapping or a general coordinate system. We have also explored three-dimensional extensions of these formulations recently. The goal of our present work is to demonstrate the versatility of the control theory approach by designing airfoils using both Hicks-Henne functions and B-spline control points as design variables. The research also demonstrates that the parameterization of the design space is an open question in aerodynamic design. Author

Aircraft Design; Airfoil Profiles; Airfoils; Computer Aided Design; Control Theory; Optimization;

N96-11694*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.

Flight simulation software at NASA Dryden Flight Research Center

Norlin, Ken A.; 1 Oct. 1995 21 p Presented at the American Institute of Aeronautics and Astronautics Flight Simulation Technologies Conference, Baltimore, MD, 7-10 Aug. 1995

Report No.(s): (NASA-TM-104315; NAS 1.15:104315; H-2052) Avail: CASI HC A03/MF A01

The NASA Dryden Flight Research Center has developed a versatile simulation software package that is applicable to a broad range of fixed-wing aircraft. This package has evolved in support of a variety of flight research programs. The structure is designed to be flexible enough for use in batch-mode, real-time pilot-in-the-loop, and flight hardware-in-the-loop simulation. Current simulations operate on UNIX-based platforms and are coded with a FORTRAN shell and C support routines. This paper discusses the features of the simulation software design and some basic model development techniques. The key capabilities that have been included in the simulation are described. The NASA Dryden simulation software is in use at other NASA centers, within industry, and at several universities. The straightforward but flexible design of this well-validated package makes it especially useful in an engineering environment. Author

Aircraft Configurations; Applications Programs (computers); Computerized Simulation; Fixed Wings; Flight Simulation; Real Time Operation; Software Engineering; Unix (operating System);

N96-11714 Technische Univ., Delft (Netherlands).

Residual strength of stiffened GLARE structures Memorandum Report

Zaal, K. J. j. M.; Vlot, A.; and Vanwimersmagreidanus, B.; Jun. 1994 28 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

Report No.(s): (PB95-242897) Avail: Issuing Activity (National Technical Information Service (NTIS))

An experimental study has been made on the effectiveness of riveted and bonded GLARE-2 stringers across a crack, compared to Al 2024-T3 stringers. The riveted GLARE-2 and Al 2024-T3 stringers were found to have an almost equal stringer. The bonded GLARE-2 and AL 2024-T3 stringer were found to have respectively a 77 percent and 19 percent higher failure load. NTIS

Aircraft Maintenance; Aluminum Alloys; Cracks; Laminates; Residual Strength; Rigid Structures; Riveted Joints; Stringers;

N96-11715# Technische Univ., Delft (Netherlands).

Optimization of the rubber cushion for the rubber pad forming process Memorandum Report

Tel-Or, A.; Sep. 1993 34 p

Report No.(s): (PB95-242905) Avail: CASI HC A03/MF A01

Using different rubber pad geometries the optimization of the pressure level involved in the process of rubber pad forming of metal sheet is investigated. Different combinations of basic rubber elements are used in the production of two aluminum products, a C-shaped profile and a C-shaped profile with joggles. Dealing with two different materials, Al-2024-T3 and Al-6061-T6, the success in the production

process is compared with the original configuration in order to get to general conclusions. NTIS
Aircraft Structures; Aluminum Alloys; Forming Techniques; Metal Working; Rubber;

N96-11976# Technische Univ., Delft (Netherlands).
User's guide for the computer program Wingdesign 4.00
Schilder, H. F.; Jul. 1994 54 p
Report No.(s): (PB95-244067; REPT-M-679) Avail: CASI HC A04/MF A01

A computer program for the structural design of a wing cross section is described. The program is intended for use at the preliminary design stage. The wing is modelled as a conventional metal, stressed-skin structure with two stiffened spar webs. The optimization option of the program is a means of achieving a weight saving in the structure. The user can fix any of the dimensions in the process of optimization. Derived from text
Aircraft Design; Airfoil Profiles; Computer Aided Design; Computer Programs; Stressed-skin Structures; Structural Design; User Manuals (computer Programs); Wings;

N96-12008 Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
Optimum cruise performance of subsonic transport aircraft
Torenbeek, Egbert; 1 Mar. 1995 68 p
Report No.(s): (LR-787; ISBN-90-5623-013-1) Copyright Avail: Issuing Activity (Technische Univ., Delft, Netherlands)

A unified analytical treatment of the cruise performance of subsonic transport aircraft is derived, valid for arbitrary gas turbine powerplant installations: turboprop, turbojet and turbofan powered aircraft. Different from the classical treatment the present report takes into account compressibility effects on the aerodynamic characteristics. Analytical criteria are derived for optimum cruise lift coefficient and Mach number, without and with constraints on the altitude and/or the engine rating. A simple alternative to the Breguet range equation is presented which applies to aircraft cruising at constant altitude and a high Mach number. A practical non-iterative procedure for calculating the mission and reserve fuel loads in the conceptual design stage is proposed as a conclusion of this report. Author
Aerodynamic Coefficients; Compressibility Effects; Gas Turbines; Jet Aircraft; Subsonic Speed; Transport Aircraft;

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

No abstracts in this category.

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.

N96-10928# Energy and Environmental Research of New Jersey, Whitehouse, NJ.
New technology for controlling NO(x) from jet engine test cells Final Report, Aug. 1988 - Feb. 1989
Lyon, Richard K.; Jan. 1995 47 p
Contract(s)/Grant(s): (F08635-88-C-0263; AF PROJ. 3005)
Report No.(s): (AD-A294773; AFCESA/ESL-TR-89-16) Avail: CASI HC A03/MF A01

For some time the U.S. Air Force has been concerned with NO(x) emissions from jet engine test cells operated by the Air Force. While there are no regulations limiting the NO(x) emissions of these facilities, such regulations could develop in the near future and would pose significant problems for the Air Force because no available technology is suited for application to jet engine test cells. This report describes laboratory studies of a new NO(x) control process based on the surprising ability of barium oxide to rapidly capture NO, a process that could be ideally suited to controlling NO(x) emission from jet engine test cells. Thus, experiments were done in which a simulated exhaust gas containing NO was passed through a bed of either granular barium oxide or barium oxide supported on high-strength alumina. Quantitative NO removals were achieved at space velocities ranging from 2010 to 28,000 v/v/hr temperatures from 21 to 610 C, oxygen concentration s of 1.1 to 15.3%, and initial NO concentrations from 94 to 1700 ppm. When NO2 was present in the simulated exhaust, it was also removed. The barium oxide was able to capture NO and NO2 in amounts up to at least 23.5% of its initial weight. The practical implication is that NO(x) emissions of a jet engine test cell could be controlled by replacing the acoustic panels now used to decrease the cell's emission of sound with a set of panel bed filters filled with barium oxide. These panel bed filters would also absorb sound, could fit in the space in the test cell now occupied by the acoustic panels, and would remove NO and NO2 from the exhaust before it is discharged to the environment. This NO(x) removal would occur spontaneously. without any actions by the personnel operating the

test cell and without distracting them in any way from their normal tasks. DTIC

Air Pollution; Aluminum Oxides; Barium Oxides; Engine Tests; Environment Protection; Exhaust Gases; Gas Turbines; Jet Engines; Nitrogen Oxides; Pollution Control; Pollution Monitoring; Quantitative Analysis;

N96-11649*# Allison Engine Co., Indianapolis, IN. Gas Turbine Div.

Advanced Turbine Technology Applications Project (ATTAP) Annual Report, 1992

Dec. 1993 97 p Original contains color illustrations

Contract(s)/Grant(s): (DEN3-336; DE-AI01-90CE- 50330; RTOP 778-32-21)

Report No.(s): (NASA-CR-195446; E-9499; DOE/NASA-0336-5; NAS 1.26:195446; EDR-17038) Avail: CASI HC A05/MF A02; 1 functional color page

The Advanced Turbine Technologies Application Project (ATTAP) is in the fifth year of a multiyear development program to bring the automotive gas turbine engine to a state at which industry can make commercialization decisions. Activities during the past year included reference powertrain design updates, test-bed engine design and development, ceramic component design, materials and component characterization, ceramic component process development and fabrication, ceramic component rig testing, and test-bed engine fabrication and testing. Engine design and development included mechanical design, combustion system development, alternate aerodynamic flow testing, and controls development. Design activities included development of the ceramic gasifier turbine static structure, the ceramic gasifier rotor, and the ceramic power turbine rotor. Material characterization efforts included the testing and evaluation of five candidate high temperature ceramic materials. Ceramic component process development and fabrication, with the objective of approaching automotive volumes and costs, continued for the gasifier turbine rotor, gasifier turbine scroll, extruded regenerator disks, and thermal insulation. Engine and rig fabrication, testing, and development supported improvements in ceramic component technology. Total test time in 1992 amounted to 599 hours, of which 147 hours were engine testing and 452 were hot rig testing. Author

Automobile Engines; Ceramics; Engine Design; Engine Tests; Gas Turbine Engines; Gas Turbines; Technology Utilization;

N96-11688*# Queensland Univ., Brisbane (Australia). Dept. of Mechanical Engineering.

Supersonic combustion ramjet propulsion experiments in a shock tunnel c07

Paull, A.; Stalker, R. J.; and Mee, D. J.; In its Shock Tunnel Studies of Scramjet Phenomena 1994 1995 54 p (For primary document see N96-11683 01-01) Avail: CASI HC A04/MF A02

Measurements have been made of the propulsive effect of supersonic combustion ramjets incorporated into a simple axisymmetric model in a free piston shock tunnel. The nominal Mach number was 6, and the stagnation enthalpy varied from 2.8 MJ kg(exp -1) to 8.5 MJ kg(exp -1). A mixture of 13 percent silane and 87 percent hydrogen was used as fuel, and experiments were conducted at equivalence ratios up to approximately 0.8. The measurements involved the axial force on the model, and were made using a stress wave force balance, which is a recently developed technique for measuring forces in shock tunnels. A net thrust was experienced up to a stagnation enthalpy of 3.7 MJ kg(exp -1), but as the stagnation enthalpy increased, an increasing net drag was recorded. pitot and static pressure measurements showed that the combustion was supersonic. The results were found to compare satisfactorily with predictions based on established theoretical models, used with some simplifying approximations. The rapid reduction of net thrust with increasing stagnation enthalpy was seen to arise from increasing precombustion temperature, showing the need to control this variable if thrust performance was to be maintained over a range of stagnation enthalpies. Both the inviscid and viscous drag were seen to be relatively insensitive to stagnation enthalpy, with the combustion chambers making a particularly significant contribution to drag. The maximum fuel specific impulse achieved in the experiments was only 175 sec., but the theory indicates that there is considerable scope for improvement on this through aerodynamic design. Author

Aerodynamic Drag; Axial Loads; Enthalpy; Force Distribution; Pressure Measurement; Scale Models; Shock Tunnels; Static Pressure; Stress Waves; Supersonic Combustion; Supersonic Combustion Ramjet Engines; Thrust Loads; Wind Tunnel Tests;

08 AIRCRAFT STABILITY AND CONTROL

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

N96-10083*# Lockheed Engineering and Sciences Co., Hampton, VA.

Performance validation of the ANSER control laws for the F-18 HARV Final Report

Messina, Michael D.; Aug. 1995 608 p

Contract(s)/Grant(s): (NAS1-19000; RTOP 505-68-30-05)

Report No.(s): (NASA-CR-198196-PT-2; NAS 1.26: 198196-PT-2) Avail: CASI HC A99/MF A06

The ANSER control laws were implemented in Ada by NASA Dryden for flight test on the High Alpha Research Vehicle (HARV). The Ada implementation was tested in the hardware-in-the-loop (HIL) simulation, and results were

compared to those obtained with the NASA Langley batch Fortran implementation of the control laws which are considered the 'truth model.' This report documents the performance validation test results between these implementations. This report contains the ANSER performance validation test plan, HIL versus batch time-history comparisons, simulation scripts used to generate checkcases, and detailed analysis of discrepancies discovered during testing. Author

Aircraft Control; F-18 Aircraft; Flight Control; Lateral Control; Program Verification (computers); Research Aircraft; Strakes;

N96-10652# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

Applications of L(1) and mixed H(2)/L(1) optimization M.S. Thesis

Spillman, Mark Stephan; Dec. 1994 136 p

Report No.(s): (AD-A289311; AFIT/GAE/ENY/94D-12) Avail: CASI HC A07/MF A02

This thesis explores the use of L(1) and mixed H(2)/L(1) optimization methods to design flight control systems. The L(1) optimization is used to handle tracking issues in the design of digital compensators. Control deflection and rate limitations, overshoot and undershoot limitations and steady-state error requirements are discussed. Model-matching techniques which produce acceptable tracking results with lower order controllers are also examined. New numerical methods for continuous H(2)/L(1) and discrete H(2)/L(1) optimization are presented. These methods are used to design an aircraft controller in continuous and discrete time and the results are compared. DTIC

Compensators; Control Systems Design; Controllers; Digital Systems; Flight Control; Linear Programming; Optimization; Systems Engineering;

N96-10845*# Lockheed Engineering and Sciences Co., Hampton, VA.

Performance validation of the ANSER Control Laws for the F-18 HARV Final Report

Messina, Michael D.; Aug. 1995 285 p

Contract(s)/Grant(s): (NAS1-19000; RTOP 505-68-30-05)

Report No.(s): (NASA-CR-198196-PT-1; NAS 1.26: 198196-PT-1) Avail: CASI HC A13/MF A03

The ANSER control laws were implemented in Ada by NASA Dryden for flight test on the High Alpha Research Vehicle (HARV). The Ada implementation was tested in the hardware-in-the-loop (HIL) simulation, and results were compared to those obtained with the NASA Langley batch Fortran implementation of the control laws which are considered the 'truth model'. This report documents the performance validation test results between these implementations. This report contains the ANSER performance validation test plan, HIL versus batch time-history comparisons, simulation scripts used to generate checkcases, and detailed analysis of discrepancies discovered during testing. Author

Aircraft Control; Control Simulation; F-18 Aircraft; Flight Simulation; Lateral Control; Program Verification (computers); Research Vehicles; Strakes;

N96-11173 Carnegie-Mellon Univ., Pittsburgh, PA.

New adaptive methods for reconfigurable flight control systems, appendix 2 Final Report, 1 Jul. 1992 - 31 Dec. 1994

Bodson, Marc; 15 Feb. 1995 174 p Limited Reproducibility: More than 20% of this document may be affected by poor print

Contract(s)/Grant(s): (F49620-92-J-0386)

Report No.(s): (AD-A293520; AFOSR-95-0231TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The report discusses methods for the design of reconfigurable flight control systems. Model reference adaptive control algorithms were developed which allow for the rapid identification of aircraft parameters after failures or damages and for automatic control redesign. These algorithms are simple enough that they can be implemented in real-time with existing computers. Simulation results were obtained using a detailed nonlinear model of a fighter aircraft. The results demonstrate the ability of the adaptive algorithms to automatically readjust trim values after failures, to restore tracking of the pilot commands despite the loss of actuator effectiveness and to coordinate the use of the remaining surfaces in order to maintain the decoupling between the rotational axes. The report also discusses analytical results that were obtained during the course of the research regarding the stability and convergence properties of multivariable adaptive control algorithms, the use of averaging methods for the analysis of transient response and robustness, and the estimation of uncertainty in dynamic models. A modified recursive least-squares algorithm with forgetting factor is also described which gives fast adaptation under normal conditions while keeping the sensitivity to noise limited when signal to noise ratios are poor. DTIC

Actuators; Automatic Control; Control Systems Design; Dynamic Models; Flight Control; Mathematical Models; Model Reference Adaptive Control; Multivariable Control; Nonlinear Systems; Parameter Identification; Transient Response;

N96-11228# Naval Postgraduate School, Monterey, CA.

A survey of research in helicopter higher harmonic control with plans for nearterm naval postgraduate school tests M.S. Thesis

Carlsen, Jeffrey H.; Mar. 1995 71 p

Report No.(s): (AD-A295121) Avail: CASI HC A04/MF A01

A survey of research in the area of helicopter vibration reduction through the use of higher harmonic bade pitch control is presented. Higher Harmonic Control (HHC) is an active vibration suppression system for helicopters. Vibration is reduced through feathering of helicopter rotor blades at (b-1)omega, b omega, and (b+1)omega harmonic relationships to reduce airframe vibrations at the blade passage frequency b omega where b is the number of blades and omega is the main rotor rotational speed. Research has been in the areas of blade stresses, vibrations, control systems HHC algorithms, and methods of actuation. HHC has also been reported to affect helicopter performance and main rotor noise. Also presented are preliminary plans for performance testing testing of a Higher Harmonic Control system by the Naval Postgraduate School on the U.S. Naval Academy whirl tower at Annapolis. DTIC

Aerodynamic Noise; Feathering; Harmonic Control; Helicopter Control; Helicopters; Rotary Wings; Schools; Surveys; Vibration; Vibration Damping;

N96-11794 Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.

F-14 flight control law design, verification, and validation using computer aided engineering tools

Renfrow, J.; and Denham, Liebler J.; 3 Feb. 1995 5 p Limited Reproducibility: More than 20% of this document may be affected by poor print

Report No.(s): (AD-A294267) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The analog flight control computers (FCC's) in the F-14A/D airplane are currently being replaced with digital FCC's. This FCC upgrade will also include significant flight control law modifications which are designed to improve the aircraft's flying qualities throughout the operating envelope. Teamed with engineers from Grumman Aerospace, the NAWCAD was tasked as the lead activity in the total system development, integration, and testing of the new digital flight control system. These tasks included the development of improved control laws for both the up and away maneuvering flight envelope as well as the takeoff and landing configurations. These control laws engineering tools that were available on the main simulation computer system as well as desk top computer based systems. This paper specifically addresses the methods in use for the F-14 Digital Flight Control System (DFCS) program, however many of the methods used in this effort are currently being applied to the F-18E/F, V-22 and EA-6B programs. DTIC

Airborne/spaceborne Computers; Aircraft Equipment; Analog Computers; Computer Aided Design; Control Systems Design; Digital Systems; F-14 Aircraft; Flight Control; Proving; V-22 Aircraft;

N96-11960 Defence Science and Technology Organisation, Melbourne (Australia). Aeronautical and Maritime Research Lab.

Flight flutter test of a Nomad N24A aircraft fitted with one modified aileron

Farrell, P. A.; and Dunn, S. A.; Jun. 1995 34 p

Report No.(s): (DSTO-TN-0012; AR-009-298) Copyright Avail: Issuing Activity (DSTO, Aeronautical and Maritime Research Lab., PO Box 4331, Melbourne, Victoria, 3001, Australia)

A Nomad aileron was modified by the addition of strain gauges and associated wiring, to permit its use in loads-measurement trials. This modification rendered the aileron nonstandard, so a flight flutter trial was conducted to verify the aeroelastic stability of the loads aircraft when fitted with this aileron. This report describes the flight flutter trial and presents the results. Author

Aerodynamic Stability; Aeroelasticity; Ailerons; Flight Tests; Subsonic Flutter; Wing Loading;

N96-12021*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

Investigation of piloting aids for manual control of hypersonic maneuvers

Raney, David L.; Phillips, Michael R.; and Person, Jr., Lee H.; 1 Oct. 1995 67 p

Contract(s)/Grant(s): (RTOP 505-70-64-01)

Report No.(s): (NASA-TP-3525; NAS 1.60:3525; L- 17446) Avail: CASI HC A04/MF A01

An investigation of piloting aids designed to provide precise maneuver control for an air-breathing hypersonic vehicle is described. Stringent constraints and nonintuitive high-speed flight effects associated with maneuvering in the hypersonic regime raise the question of whether manual control of such a vehicle should even be considered. The objectives of this research were to determine the extent of manual control that is desirable for a vehicle maneuvering in this regime and to identify the form of aids that must be supplied to the pilot to make such control feasible. A piloted real-time motion-based simulation of a hypersonic vehicle concept was used for this study, and the investigation focused on a single representative cruise turn maneuver. Piloting aids, which consisted of an auto throttle, throttle director, autopilot, flight director, and two head-up display configurations, were developed and evaluated. Two longitudinal control response types consisting of a rate-command/attitude-hold system and a load factor-rate/load-factor-hold system were also compared. The complete set of piloting aids, which consisted of the autothrottle, throttle director, and flight director, improved the average Cooper-Harper flying qualities ratings from 8 to 2.6, even though identical inner-loop stability and control augmentation was provided in all cases. The flight director was determined to be the most critical of these aids,

and the cruise turn maneuver was unachievable to adequate performance specifications in the absence of this flight director. Author

Aircraft Maneuvers; Automatic Pilots; Flight Characteristics; Flight Control; Hypersonic Flight; Hypersonic Vehicles; Manual Control; Pilot Performance; Turning Flight;

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.

N96-10004# Air Force Materiel Command, Wright-Patterson AFB, OH. Crew Systems Directorate.

Dynamic scaling of one-seventh size F-15 prototypes for agile flight simulation Final Report, Nov. 1991 - Mar. 1995

Repperger, Daniel W.; Mar. 1995 35 p

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

Report No.(s): (AD-A295057; AL/CF-TR-1995-0028) Avail: CASI HC A03/MF A01

Data from F-15 prototypes, properly dynamically scaled, were delivered to AL/CFBS by Captain Dan Baumann of WL/FIM as a result of the Window on Science Program. The prototypes were run in Israel at the Technion, Israel Institute of Technology by Dr. Ben Gal-Or of the Aeronautical Department. Over 20 runs of data were delivered and they included the Herbst's maneuver, the Cobra maneuver and a host of other agility motion profiles. The moments of inertia that were used to produce the scaling factors included such conditions as the plane having specific levels of bomb loads, as well as three fuel/conditions: low fuel, half fuel, and fully loaded fuel. These motion data delivered to AL/CFBS will be used to emulate supermaneuvers on the DES centrifuge motion simulator. DTIC

Data Acquisition; Dynamic Response; F-15 Aircraft; Flight Simulation; Flight Tests; Jet Aircraft; Maneuverability; Motion Simulation; Scale Models;

N96-10482# Lawrence Livermore National Lab., Livermore, CA.

National Ignition Facility design, performance, and cost

Hogan, W. J.; Paisner, J. A.; and Lowdermilk, W. H.; 16 Sep. 1994 12 p Presented at the ECLIM 23: Laser Interaction With Matter, Oxford, England, 19-23 Sep. 1994

Contract(s)/Grant(s): (W-7405-ENG-48)

Report No.(s): (DE95-011766; UCRL-JC-118523; CONF-9409226-8) Avail: CASI HC A03/MF A01

A conceptual design for the National Ignition Facility (NIF) has been completed and its cost has been estimated by a multilaboratory team. To maximize the performance/cost ratio a compact, segmented amplifier is used in a multipass architecture. Many recent optical and laser technology developments have been incorporated into the final design. The Beamlet project has successfully demonstrated the new concept. The mission of ICF Program using the NEF is to achieve ignition and gain in the laboratory. The facility will be used for defense applications such as weapons physics and weapons effects experiments, and for civilian applications such as inertial fusion energy development and fundamental studies of matter at high energy density. DOE

Design To Cost; Inertial Confinement Fusion; Laser Fusion; Plant Design;

N96-11281*# Wyle Labs., Inc., Huntsville, AL.

Design and development of a high-speed bearing test rig Final Report

Cockburn, J. A.; Jun. 1995 150 p Original contains color illustrations

Contract(s)/Grant(s): (NAS8-38095)

Report No.(s): (NASA-CR-199180; NAS 1.26:199180; WYLE-TR-61820-01) Avail: CASI HC A07/MF A02; 1 functional color page

The development of a high-speed test rig, to be used for compiling an experimental data base of bearing signatures for bearings with known faults, is described. This bearing test rig can be adapted to test oil-film bearings as well as rolling element bearings. This is achieved by mounting the test bearing in one of two special test housings, either of which can be mounted onto a common test shaft which can be driven up to 30,000 rpm. The test bearing housing for rolling element bearings can accommodate proximity displacement transducers, accelerometers, thermocouples, and acoustic emission sensors. The test bearing housing for the fluid-film bearings can accommodate the same instrumentation as well as Bourdon tube-type transducers for measuring oil film pressures around the bearing circumference.

Derived from text

Ball Bearings; Fluid Films; Liquid Bearings; Roller Bearings; Test Facilities;

N96-11510*# MCAT Inst., San Jose, CA.

Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle Final Report, May 1989 - Jan. 1995

Wolf, Stephen W. D.; 1 Jan. 1995 97 p Sponsored by NASA. Ames Research Center Original contains color illustrations

Contract(s)/Grant(s): (RTOP 604-95-05)

Report No.(s): (NASA-CR-199511; NAS 1.26:199511) Avail: CASI HC A05/MF A02; 21 functional color pages

Low-disturbance or 'quiet' wind tunnels are now considered an essential part of meaningful boundary layer transition research. Advances in Supersonic Laminar Flow Control (SLFC) technology for swept wings depends on a better understanding of the receptivity of the transition phenomena

to attachment-line contamination and cross-flows. This need has provided the impetus for building the Laminar Flow Supersonic Wind Tunnel (LFSWT) at NASA-Ames, as part of the NASA High Speed Research Program (HSRP). The LFSWT was designed to provide NASA with an unequaled capability for transition research at low supersonic Mach numbers (<2.5).Thefollowingaretheobectives in support of the new Fluid Mechanic Laboratory (FML) quiet supersonic wind tunnel: (I) Develop a unique injector drive system using the existing FML indraft compressor; (2) Develop an FML instrumentation capability for quiet supersonic wind tunnel evaluation and transition studies at NASA-Ames; (3) Determine the State of the Art in quiet supersonic wind tunnel design; (4) Build and commission the LFSWT; (5) Make detailed flow quality measurements in the LFSWT; (6) Perform tests of swept wing models in the LFSWT in support of the NASA HSR program; and (7) Provide documentation of research progress. Derived from text

Boundary Layer Transition; Cryogenics; Flow Distribution; Flow Measurement; Laminar Flow; Nozzle Design; Supersonic Flow; Supersonic Nozzles; Supersonic Wind Tunnelsab; Swept Wings; Wind Tunnel Apparatus;

N96-11684*# Queensland Univ., Brisbane (Australia). Dept. of Mechanical Engineering.

Design and construction of the X-2 two-stage free piston driven expansion tube c09

Doolan, Con; In its Shock Tunnel Studies of Scramjet Phenomena 1994 1995 18 p (For primary document see N96-11683 01-01) Avail: CASI HC A03/MF A02

This report outlines the design and construction of the X-2 two-stage free piston driven expansion tube. The project has completed its construction phase and the facility has been installed in the new impulsive research laboratory where commissioning is about to take place. The X-2 uses a unique, two-stage driver design which allows a more compact and lower overall cost free piston compressor. The new facility has been constructed in order to examine the performance envelope of the two-stage driver and how well it couple to sub-orbital and super-orbital expansion tubes. Data obtained from these experiments will be used for the design of a much larger facility, X-3, utilizing the same free piston driver concept. Author

Compressors; Design Analysis; Free-piston Engines; Gas Dynamics; Gas Expansion; Performance Tests; Pistons; Shock Tubes;

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.

N96-11247*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

Relative performance comparison between baseline labyrinth and dual-brush compressor discharge seals in a T-700 engine test

Hendricks, Robert C.; Griffin, Thomas A.; (Army Research Lab., Cleveland, OH.)Kline, Teresa R.; (Army Research Lab., Cleveland, OH.)Csavina, Kristine R.; (Sverdrup Technology, Inc., Brook Park, OH.)Pancholi, Arvind; (General Electric Co., Lynn, MA.)and Sood, Devendra; (General Electric Co., Lynn, MA.) Oct. 1995 23 p Presented at the 39th International Gas Turbine and Aeroengine Congress and Exposition, The Hague, Netherlands, 13-16 Jun. 1994; sponsored by ASME

Contract(s)/Grant(s): (RTOP 584-03-11; DA PROJ. 1L1-62211-A-47-A)

Report No.(s): (NASA-TM-106360; E-8154; NAS 1.15: 106360; ARL-MR-232) Avail: CASI HC A03/MF A01

In separate series of YT-700 engine tests, direct comparisons were made between the forward-facing labyrinth and dual brush compressor discharge seals. Compressor speeds to 43 000 rpm, surface speeds to 160 m/s (530 ft/s), pressures to 1 MPa (145 psi), and temperatures to 680 K (765 F) characterized these tests. The wear estimate for 46 hr of engine operations was less than 0.025 mm (0.001 in.) of the Haynes 25 alloy bristles running against a chromium-carbide-coated rub runner. The pressure drops were higher for the dual-brush seal than for the forward-facing labyrinth seal and leakage was lower-with the labyrinth seal leakage being 2-1/2 times greater-implying better seal characteristics, better secondary airflow distribution, and better engine performance (3 percent at high pressure to 5 percent at lower pressure) for the brush seal. (However, as brush seals wear down (after 500 to 1000 hr of engine operation), their leakage rates will increase.) Modification of the secondary flow path requires that changes in cooling air and engine dynamics be accounted for. Author

Air Flow; Brush Seals; Compressors; Engine Tests; Labyrinth Seals; Secondary Flow;

11 CHEMISTRY AND MATERIALS

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

N96-11077# Galaxy Scientific Corp., Pleasantville, NJ.

Fuel containment of auxiliary fuel tanks

Wittlin, Gil; and Muller, Mark; Mar. 1995 31 p

Contract(s)/Grant(s): (DTFA03-89-C-00043)

Report No.(s): (AD-A296170; DOT/FAA/CT-TW94/17) Avail: CASI HC A03/MF A01

This report summarizes activity performed in support of the FAA's Fuel Containment research program. A review was made of previously performed pretest analysis and longitudinal test results for a double-wall cylindrical auxiliary fuel tank. A review was made of the Auxiliary Fuel System Installation Advisory Circular. Available data from recent, pertinent transport category airplane accidents and full-scale crash test results were discussed for their relevance to the Fuel Containment research effort. The fuel tank/airframe installation was defined for the next series of longitudinal- and vertical-impact tests. The outline of a proposed semiempirical procedure was developed. The procedure's potential would be for use in evaluating fuselage- auxiliary fuel tank installations under dynamic loading utilizing available and pending test data. DTIC

Crashworthiness; Cylindrical Tanks; Dynamic Loads; Flight Safety; Fuel Tanks; Fuselages; Performance Tests; Procedures; Transport Aircraft;

N96-11331# Naval Postgraduate School, Monterey, CA.

Non-destructive inspection of composite structures using modal analysis M.S. Thesis

Matthews, Timothy S.; Mar. 1995 117 p

Report No.(s): (AD-A296673) Avail: CASI HC A06/MF A02

Anomalies from manufacturing variability or in-service damage are manifested as subtle differences in the inertial and stiffness matrices of otherwise identical components. Modal analysis seeks to model these constitutive relations by examining a structure's dynamic response to applied vibrations. In this investigation, characterization of anomalies in composite structures is attempted through multi-input, multi-output modal analysis. Two graphite-epoxy specimens manufactured by different processes are subjected to random excitation and frequency response functions are obtained. The dynamic behavior of the structures is compared through modal parameter extraction techniques. Dynamic solutions from a finite element model are used to validate the results. Finally, observations are made concerning the feasibility of extending the procedure to quality assurance and damage detection applications. DTIC

Aircraft Structures; Composite Structures; Damage Assessment; Dynamic Response; Graphite-epoxy Composites; Inspection; Nondestructive Tests; Quality Control; Structural Vibration;

N96-11334# Technische Univ., Delft (Netherlands).

GLARE development: An overview

Holleman, E.; Nov. 1994 42 p

Report No.(s): (PB95-242806) Copyright Avail: CASI HC A03/MF A01

GLARE are bonded arrangements of thin aerospace aluminium alloys sheets and alternating plies of high strength, advanced glass fibers embedded in epoxy adhesive. In accordance with subtask 2.1 of the BE2040 work program, the document focuses on GLARE development, from initial component selection and optimization to the advanced material concept as known today. Was the initial component selection and optimization dictated primarily by material availability, later material optimization was the starting point of many improvements in the performance characteristics of glass/epoxy prepreg in terms of strength, stiffness, adhesion, chemical resistance, etc. Simultaneously, component optimization stimulated the development of very thin aluminium sheets, an essential step to further enhance laminate performance. Today five GLARE grades, coded by number from 1 to 5, have been standardized and are commercialized for aerospace application. NTIS

Aircraft Construction Materials; Aircraft Structures; Aluminum Alloys; Epoxy Matrix Composites; Glass Fiber Reinforced Plastics; Glass Fibers; Laminates;

N96-11484*# Boeing Commercial Airplane Co., Seattle, WA. Technology and Product Development.

Materials research for high-speed civil transport and generic hypersonics: Composites durability Final Report, 15 May 1993 - 28 Feb. 1995

Allen-Lilly, Heather; Cregger, Eric; Hoffman, Daniel; and McCool, Jim; 1 Aug. 1995 92 p

Contract(s)/Grant(s): (NAS1-20013; RTOP 537-06-20-05)

Report No.(s): (NASA-CR-198192; NAS 1.26:198192) Avail: CASI HC A05/MF A01

This report covers a portion of an ongoing investigation of the durability of composites for the High Speed Civil Transport (HSCT) program. Candidate HSCT composites need to possess the high-temperature capability required for supersonic flight. This program was designed to initiate the design, analysis, fabrication, and testing of equipment intended for use in validating the long-term durability of materials for the HSCT. This equipment includes thermally actuated compression and tension fixtures, hydraulic-actuated reversible load fixtures, and thermal chambers. This equipment can be used for the durability evaluation of both composite and adhesive materials. Thermally actuated fixtures are recommended for fatigue cycling when long-term thermomechanical fatigue (TMF) data are required on coupon-sized tension or compression specimens. Long term durability testing plans for polymer matrix composite specimens are included. Author

Aging (materials); Aircraft Construction Materials; Durability; Fatigue Testing Machines; Fatigue Tests; Supersonic Transports; Test Chambers; Thermal Cycling Tests; Thermal Fatigue;

N96-11496*# Boeing Commercial Airplane Co., Seattle, WA. Technology and Product Development.
Materials research for High Speed Civil Transport and generic hypersonics: Adhesive durability Final Report
Allen, Mark R.; Aug. 1995 49 p
Contract(s)/Grant(s): (NAS1-20013; RTOP 537-06-20-05)
Report No.(s): (NASA-CR-198193; NAS 1.26:198193)
Avail: CASI HC A03/MF A01

This report covers a portion of an ongoing investigation of the durability of adhesives for the High Speed Civil Transport (HSCT) program. Candidate HSCT adhesives need to possess the high-temperature capability required for supersonic flight. This program was designed to initiate an understanding of the behavior of candidate HSCT materials when subjected to combined mechanical and thermal loads. Two adhesives (K3A and FM57) and two adherends (IM7/K3B polymeric composite and the titanium alloy Ti-6Al-4V) were used to fabricate thick adherend lap shear specimens. Due to processing problems, only the FM57/titanium bonds could be fabricated successfully. These are currently undergoing thermomechanical fatigue (TMF) testing. There is an acute need for an adhesive to secondarily bond polymeric composite adherends or, alternately, polymeric composites that remain stable at the processing temperatures of today's adhesives. Author
Adhesive Bonding; Adhesives; Aging (materials); Bonded Joints; Durability; Fatigue Tests; Lap Joints; Supersonic Transports; Thermal Fatigue;

N96-11638# Lawrence Livermore National Lab., Livermore, CA.
Development of a sensor and control system for the production of titanium matrix composites
Berzins, L. V.; McClelland, M. A.; and Anklam, T. M.; Mar. 1995 10 p Presented at the 10th International Conference on Composite Materials, Whistler, Canada, 14-18 Aug. 1995
Contract(s)/Grant(s): (W-7405-ENG-48)
Report No.(s): (DE95-014162; UCRL-JC-119347; CONF-950833-2) Avail: CASI HC A02/MF A01

Titanium matrix composites promise to dramatically increase the thrust-to-weight ratio of gas turbine engines. Electron Beam Physical Vapor Deposition (EB-PVD) is ideal for coating fibers if issues with composition control can be worked out. LLNL is developing a control system based on Diode Laser Absorption Spectroscopy (DLAS) for the deposition of titanium orthorhombic alloys. In this paper, the important features and components of a DLAS control system are reviewed and a methodology for selecting the appropriate atomic transitions is described. Data characterizing the diagnostic performance as well as information on potential control strategies is presented. Finally, applications of this diagnostic to other alloy systems are discussed. DOE
Coating; Electron Beams; Electron Transitions; Metal Coatings; Metal Matrix Composites; Titanium Alloys; Vapor Deposition;

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.

N96-10046# Federal Aviation Administration, Atlantic City, NJ.
Operational Test and Evaluation (OT and E) integration and OT and E operational test plan for the offshore Next Generation Weather Radar (NEXRAD)
Martinez, Radame; Stretcher, Baxter; Porcello, John; Guthlein, Peter; and Diviney, William; (Dimensions International, Inc., Alexandria, VA.) May 1995 61 p
Report No.(s): (AD-A294803; DOT/FAA/CT-TN95/21)
Avail: CASI HC A04/MF A01

This document provides the overall philosophy and approach for the National Airspace (NAS) Phase 1 Operational Test and Evaluation (OT&E) Integration and OT&E Operational Testing of the Offshore Next Generation Weather Radar (NEXRAD). A total of 14 Offshore NEXRAD's will be procured under this acquisition: 3 in the Caribbean, 4 in Hawaii, and seven 7 in Alaska. OT&E testing will be performed in two phases. Phase 1 testing will be performed on the redundant configuration in Nov. 1994, in Kauai, Hawaii, and is described herein. Phase 2 testing will be performed on the Remote Monitoring Subsystem (RMS) at a later date and is not described in this document. A separate test plan and test procedures will be developed for Phase 2 OT&E Integration and OT&E Operational Testing. The focus of this document is on Phase 1 limited OT&E Integration and OT&E Operational testing of the Offshore NEXRAD. The testing is limited in nature due to the extensive testing already performed on the single-channel NEXRAD system by the Joint System Program Office (JSPO) and funding constraints placed upon the Federal Aviation Administration (FAA). DTIC
Data Acquisition; Doppler Radar; Meteorological Radar; Performance Tests; Weather Forecasting;

N96-10362# Federal Aviation Administration, Atlantic City, NJ.
Limited Production (LP) Precision Runway Monitor (PRM) Operational Test and Evaluation integration and OT and E Operational Test Plan
Livings, Jeffrey; May 1995 36 p
Report No.(s): (DOT/FAA/CT-TN95/2) Avail: CASI HC A03/MF A01

This document defines the Test Plan and corresponding Test Verification Requirements Traceability Matrix (TVRTM) that will be used to conduct the Limited Production (LP) Precision Runway Monitor (PRM) Operational Test and Evaluation (OT and E) Integration and OT and E Operational tests. These tests will be conducted at the Minneapolis-St. Paul International Airport following the Contractor Site Acceptance Test. The LP PRM OT and E test effort will concentrate on Operational Effectiveness and Suitability. The Operational Effectiveness Test consists of a review of the contractor performed Development Test and Evaluation (DT and E) and Site Acceptance Tests. This review will evaluate whether each of the Measures of Effectiveness had been satisfactorily tested and whether the results meet the Minimum Acceptable Operational REquirements MAORs). This review will be conducted solely by test engineers and does not require the PRM system. The Operational Suitability Tests will expose the test participants (Air Traffic (AT) Controllers and Airway Facilities (AF) Technicians) to the PRM system in an operational environment while they perform specified operational procedures. These tests will be conducted in two separate phases: AT Suitability and AF Suitability. Each of these phases is focused on the specific test participants. Author (DTIC)

Acceptability; Approach Indicators; Display Devices; Flight Tests; Performance Tests; Radar Approach Control; Radar Beacons; Radar Tracking; Runways; Search Radar;

N96-10408*# Prairie View Agricultural and Mechanical Coll., TX.

A 3-D Navier-Stokes CFD study of turbojet/ramjet nozzle plume interactions at Mach 3.0 and comparison with data Abstract Only c34

Chang, Ing; and Hunter, Louis G.; (Lockheed-Fort Worth Co., Fort Worth, TX.) In NASA. Lewis Research Center, HBCUs Research Conference Agenda and Abstracts Aug. 1995 p 35 (For primary document see N96-10383 01-01) Avail: CASI HC A01/MF A01

Advanced airbreathing propulsion systems used in Mach 4-6 mission scenarios, usually consist of a single integrated turboramjet or as in this study, a turbojet housed in an upper bay with a separate ramjet housed in a lower bay. As the engines transition from turbojet to ramjet, there is an operational envelope where both engines operate simultaneously. One nozzle concept under consideration has a common nozzle, where the plumes from the turbojet and ramjet interact with one another as they expand to ambient conditions. In this paper, the two plumes interact at the end of a common 2-D cowl, when they both reach an approximate Mach 3.0 condition and then jointly expand to Mach 3.6 at the common nozzle exit plane. At this condition, the turbojet engine operated at a higher NPR than the ramjet, where the turbojet overpowers the ramjet plume, deflecting it approximately 12 degrees downward and in turn the turbojet plume is deflected 6 degrees upward. In the process, shocks were formed at the deflections and a shear layer formed at the confluence of the two jets. This particular case was experimentally tested and the data used to compare with the PARC3D code with k-kl two equation turbulence model. The 2-D and 3-D centerline CFD solutions are in good agreement, but as the CFD solutions approach the outer sidewall, a slight variance occurs. The outer wall boundary layers are thin and do not present much of an interaction, however, where the confluence interaction shocks interact with the thin boundary layer on the outer wall, strong vortices run down each shock causing substantial disturbances in the boundary layer. These disturbances amplify somewhat as they propagate downstream axially from the confluence point. The nozzle coefficient (CFG) is reduced 1/2 percent as a result of this sidewall interaction, from 0.9850 to 0.9807. This three-dimensional reduction is in better agreement with the experimental value of 0.9790. Author

Computational Fluid Dynamics; Computer Programs; Navier-stokes Equation; Nozzle Flow; Plumes; Ramjet Engines; Supersonic Speed; Turbojet Engines;

N96-10532# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID.

Gas mass transfer for stratified flows

Duffey, R. B.; (Brookhaven National Lab., Upton, NY.)and Hughes, E. D.; 1995 14 p Presented at the ASME/JSME Annual Summer Meeting of the Fluids Engineering Conference, Hilton Head, SC, 13-17 Aug. 1995

Contract(s)/Grant(s): (DE-AC07-76ID-01570; DE-AC02-76CH-00016)

Report No.(s): (DE95-013511; BNL-61801; CONF-950853-5) Avail: CASI HC A03/MF A01

We analyzed gas absorption and release in water bodies using existing surface renewal theory. We show a new relation between turbulent momentum and mass transfer from gas to water, including the effects of waves and wave roughness, by evaluating the equilibrium integral turbulent dissipation due to energy transfer to the water from the wind. Using Kolmogoroff turbulence arguments the gas transfer velocity, or mass transfer coefficient, is then naturally and straightforwardly obtained as a non-linear function of the wind speed drag coefficient and the square root of the molecular diffusion coefficient. In dimensionless form, the theory predicts the turbulent Sherwood number to be Sh(sub t) = (2/(radical)(pi))Sc(sup 1/2), where Sh(sub t) is based on an integral dissipation length scale in the air. The theory confirms the observed nonlinear variation of the mass transfer coefficient as a function of the wind speed; gives the correct transition with turbulence-centered models for smooth surfaces at low speeds; and predicts experimental data from both laboratory and environmental measurements within the data scatter. The differences between the available labora-

tory and field data measurements are due to the large differences in the drag coefficient between wind tunnels and oceans. The results also imply that the effect of direct aeration due to bubble entrainment at wave breaking is no more than a 20% increase in the mass transfer for the highest speeds. The theory has importance to mass transfer in both the geo-physical and chemical engineering literature.

DOE

Aerodynamic Coefficients; Aerodynamic Drag; Dissipation; Energy Transfer; Mass Transfer; Nonlinearity; Surface Roughness; Surface Water; Turbulence; Wind Velocity;

N96-10799 National Defence Research Establishment, Linkoeping (Sweden). Avdelningen foer Sensorteknik.

Analysis of nearfield measurements: Theory [Analys av naerfaeltsmaetningar: Teori]

Larsson, C.; Jan. 1995 44 p In SWAHILI

Report No.(s): (PB95-223624; FOA-R-95-00087-3.2-SE)

Avail: Issuing Activity (National Technical Information Service (NTIS))

The paper describes high-resolution coherent radar imaging. Some methods for imaging are described together with their advantages, disadvantages and limitations. An algorithm for nearfield to farfield transformation of radar cross section was developed. The goal for this work is to make a detailed analysis of nearfield measurements on Swedish fighter aircraft possible. However, the use methods are valid in all measurements with high-resolution coherent radar. Matlab routines including a graphical user interface have been developed. The routines can be used to analyze radar cross section measurements. They also form an open platform for further development of the methods used for analysis. The paper is aimed at those that plan for, perform or analyze radar cross section measurements. NTIS

Algorithms; Coherent Radar; Fighter Aircraft; High Resolution; Imaging Radar; Near Fields; Radar Cross Sections;

N96-10871*# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.

An investigation of bleed configurations and their effect on shock wave/boundary layer interactions Final Report, 10 Oct. 1990 - 26 Jun. 1995

Hamed, Awatef; 7 Sep. 1995 59 p Original contains color illustrations

Contract(s)/Grant(s): (NAG3-1213)

Report No.(s): (NASA-CR-199439; NAS 1.26:199439)

Avail: CASI HC A04/MF A01; 3 functional color pages

The design of high efficiency supersonic inlets is a complex task involving the optimization of a number of performance parameters such as pressure recovery, spillage, drag, and exit distortion profile, over the flight Mach number range. Computational techniques must be capable of accurately simulating the physics of shock/boundary layer interactions, secondary corner flows, flow separation, and bleed if they are to be useful in the design. In particular, bleed and flow separation, play an important role in inlet unstart, and the associated pressure oscillations. Numerical simulations were conducted to investigate some of the basic physical phenomena associated with bleed in oblique shock wave boundary layer interactions that affect the inlet performance.

Author

Corner Flow; Engine Design; Engine Inlets; Oblique Shock Waves; Secondary Flow; Separated Flow; Shock Wave Interaction; Supersonic Inlets;

N96-11023*# Arizona State Univ., Tempe, AZ.

Numerical studies of boundary-layer receptivity Progress Report

Reed, Helen L.; 1 Sep. 1995 24 p

Report No.(s): (NASA-TM-111104; NAS 1.15:111104)

Avail: CASI HC A03/MF A01

Direct numerical simulations (DNS) of the acoustic receptivity process on a semi-infinite flat plate with a modified-super-elliptic (MSE) leading edge are performed. The incompressible Navier-Stokes equations are solved in stream-function/vorticity form in a general curvilinear coordinate system. The steady basic-state solution is found by solving the governing equations using an alternating direction implicit (ADI) procedure which takes advantage of the parallelism present in line-splitting techniques. Time-harmonic oscillations of the farfield velocity are applied as unsteady boundary conditions to the unsteady disturbance equations. An efficient time-harmonic scheme is used to produce the disturbance solutions. Buffer-zone techniques have been applied to eliminate wave reflection from the outflow boundary. The spatial evolution of Tollmien-Schlichting (T-S) waves is analyzed and compared with experiment and theory. The effects of nose-radius, frequency, Reynolds number, angle of attack, and amplitude of the acoustic wave are investigated. This work is being performed in conjunction with the experiments at the Arizona State University Unsteady Wind Tunnel under the direction of Professor William Saric. The simulations are of the same configuration and parameters used in the wind-tunnel experiments.

CASI

Alternating Direction Implicit Methods; Boundary Layer Flow; Far Fields; Flat Plates; Flow Velocity; Incompressible Flow; Leading Edges; Navier-stokes Equation; Time Dependence; Tollmien-schlichting Waves;

N96-11054# Naval Undersea Warfare Center, Newport, RI.

Wall layer microturbulence phenomenology and a Markov probability model for active electromagnetic control of turbulent boundary layers in an electrically conducting medium

Meng, J. C.; 1 Jun. 1995 55 p

Report No.(s): (AD-A296547; NUWC-NPT-TR-10434)

Avail: CASI HC A04/MF A01

A thorough review of the published database on wall layer events and scales is conducted. Attention is focused on microturbulence phenomenology and the temporal and spatial scaling relationships of microturbulent events. The goal is to organize the comprehensive experimental database into a coherent framework for engineering applications to drag and noise control. The premise is that to effectively control the drag and noise in a turbulent flow, the methodology must address the genesis of the most fundamental elements of microturbulence. The Reynolds number dependence of useful parameters, such as the distance between bursts, distance between sweeps, combined ejection and burst duration, and sweep duration, is compared to verify consistency among published results on microturbulence investigations. The dynamic relationships of microturbulent burst power are derived from a heuristic perspective. On the assumption that an electromagnetic turbulence methodology can provide a remote pressure field into the flow at the normal distance from the solid surface where most of turbulence production takes place, the threshold Lorentz pressure power is derived. This derivation is based on the principle that the pressure must equal or exceed the local, natural, turbulent burst power level to have any appreciable effect on the turbulence production process. Expressions of the ratio of Lorentz power to natural microturbulent burst power in terms of the magnetohydrodynamic (MHD) interaction parameter and electrode and magnet spacing Reynolds number are derived. Similarly, the electrode and magnet spacing Reynolds number as a function of MHD interaction parameter and length Reynolds number at threshold condition is shown. DTIC

Active Control; Boundary Layer Control; Data Bases; Magnetohydrodynamics; Markov Processes; Mathematical Models; Phenomenology; Probability Theory; Turbulence Effects; Turbulent Boundary Layer; Turbulent Flow; Wall Flow;

N96-11061# Southern Univ., Baton Rouge, LA.

Structural dynamics of mistuned spatially periodic mechanical systems Final Report, 1 Sep. 1991 - 28 Feb. 1995

Azene, M.; Bajaj, A. K.; and Nwokah, O. D.; Apr. 1995 5 p

Contract(s)/Grant(s): (DAAL03-91-G-0247)

Report No.(s): (AD-A296122; ARO-29130.1-EG-SAH) Avail: CASI HC A01/MF A01

The dynamics of mistuned cyclic systems with special reference to strongly coupled bladed disk assemblies has been investigated. The analysis has utilized ideas from group representation theory, bifurcation theory, singular perturbation theory, and modal analysis techniques. The general analysis methodology developed herein is applicable to any disk with a set of n attached blades which are strongly coupled cyclically, and mistuning or variations can arise in any of the system parameters. In particular, the study provides qualitative and, more importantly, quantitative information in the form of uniformly valid asymptotic expansions for the eigenfrequencies and the modal vectors of the structure. These expansions are used to describe the phenomenon of eigenvalue veering, modal rotations, and other manifestations of the sensitive dependence of eigenfunctions on system parameters which lead to modal bifurcations in the forced response of mistuned cyclic systems. Since this approach is general and systematic, the methodology developed is also extended and applied to other discrete and continuous structures as well. DTIC

Dynamic Response; Dynamic Structural Analysis; Mistuning (turbomachinery); Rotating Disks; Rotor Blades (turbomachinery); Rotor Dynamics; Rotors; Structural Vibration;

N96-11154 Naval Postgraduate School, Monterey, CA.

The effects of low-profile vortex generators on flow in a transonic fan-blade cascade M.S. Thesis

Gamerdinger, Peter M.; Mar. 1995 113 p Limited Reproducibility: More than 20% of this document may be affected by poor print

Report No.(s): (AD-A296726) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Two dimensional fully-mixed-out flow conditions were measured downstream of a two-passage transonic fan-blade cascade which had low-profile vortex generators (VG's) attached to the suction surfaces of the blades. The simulation was conducted using a blowdown wind tunnel at a Mach number of 1.4. The objective was to assess the effects of vortex generating devices on the suction surface shock-boundary layer interaction and the resulting losses. Measurements are reported from tests made with older aluminum blading, with and without VG's, and with a nominally similar new set of steel blading, with and without VG's. Differences between the old and new blading were found to be most significant. While shock structures appeared to be similar with VG's attached, dye injection showed that the shock-induced boundary layer separation was greatly suppressed and the downstream flow was much steadier. With VG's, the flow turning was improved by 0.94 degrees, but the flow loss coefficient increased by about 8%. An extension of the study is needed to fully assess the potential of using low-profile VG's in military fan engines. DTIC

Blowdown Wind Tunnels; Boundary Layers; Fan Blades; Injection; Mach Number; Shock Wave Interaction; Suction; Surface Layers; Two Dimensional Flow; Vortex Generators;

N96-11399 Nebraska Univ., Lincoln, NE.

Modeling and analysis of pulse electrochemical machining Ph.D. Thesis

Wei, Bin; 1994 194 p

Avail: Univ. Microfilms Order No. DA9416921

Pulse Electrochemical Machining (PECM) is a potentially cost effective technology meeting the increasing needs

of precision manufacturing of superalloys, like titanium alloys, into complex shapes such as turbine airfoils. This dissertation reports: (1) an assessment of the worldwide state-of-the-art PECM research and industrial practice; (2) PECM process model development; (3) PECM of a superalloy (Ti-6Al-4V); and (4) key issues in future PECM research. The assessment focuses on identifying dimensional control problems with continuous ECM and how PECM can offer a solution. Previous research on PECM system design, process mechanisms, and dimensional control is analysed, leading to a clearer understanding of key issues in PECM development such as process characterization and modeling. New inter-electrode gap dynamic models describing the gap evolution with time are developed for different PECM processes with an emphasis on the frontal gaps and a typical two-dimensional case. A 'PECM cosine principle' and several tool design formulae are also derived. PECM processes are characterized using concepts such as quasi-equilibrium gap and dissolution localization. Process simulation is performed to evaluate the effects of process inputs on dimensional accuracy control. Analysis is made on three types (single-phase, homogeneous, and inhomogeneous) of models concerning the physical processes (such as the electrolyte flow, Joule heating, and bubble generation) in the interelectrode gap. A physical model is introduced for the PECM with short pulses, which addresses the effect of electrolyte conductivity change on anodic dissolution. PECM of the titanium alloy is studied from a new perspective on the pulsating currents influence on surface quality and dimension control. An experimental methodology is developed to acquire instantaneous currents and to accurately measure the coefficient of machinability. The influence of pulse parameters on the surface passivation is explained based on the correlation among the instantaneous current, gap resistance, and surface microscopical features. A planned research is also introduced including a new concept of gap on-line recognition. In summary, this dissertation presents PECM problem identification, dynamic and physical modeling, and application to machining a titanium alloy. Dissert. Abstr.

Characterization; Dynamic Models; Electrochemical Machining; Heat Resistant Alloys; Mathematical Models; Ohmic Dissipation; Resistance Heating; Technological Forecasting; Technology Assessment; Titanium Alloys;

N96-11442# Sandia National Labs., Albuquerque, NM.

Application of three dimensional Finite Element Analysis to electron beam welding of a high pressure compressor drum rotor

Cowles, Jr., John H.; (Ingenium Technologies Group, Inc., Somers, CT.)Blanford, Mark; Giamei, Anthony F.; (United Technologies Research Center, East Hartford, CT.)and Bruskotter, Michael J.; (Pratt and Whitney Aircraft, East Hartford, CT.) 1995 8 p Presented at the Modeling of Casting, Welding and Advanced Solidification Processes 7, London, England, 10-15 Sep. 1995

Contract(s)/Grant(s): (DE-AC04-94AL-85000)

Report No.(s): (DE95-008817; SAND-95-0503C; CONF-9509118-1) Avail: CASI HC A02/MF A01

Finite Element Analysis capability for application to welding has been developed and enhanced during a two year Cooperative Research and Development Agreement(CRADA) between Pratt & Whitney, United Technologies Research Center, and Sandia National Laboratories. Because of the nature of electron beam welding at Pratt & Whitney -- set-up is time consuming, the parts to be welded are complicated, and experimentation is costly -- finite element analysis has found many potential applications. The results of most interest in these analyses are the residual stress and final distortion of the component. The work has made use of the Sandia finite element codes JACQ3D, for thermal analysis, and JAS3D, for mechanical analysis. Both codes use an efficient, non-linear conjugate gradient solution technique, which enables large problems to be solved on engineering workstations. This presentation describes several technical challenges that were overcome in the application of the Sandia codes to this class of problems. Stress and distortion results predicted for an electron beam weld of a PW4000 gas turbine engine drum rotor will also be discussed. DOE

Applications Programs (computers); Compressor Rotors; Conductive Heat Transfer; Conjugate Gradient Method; Electron Beam Welding; Finite Element Method; Gas Turbine Engines; High Pressure; Residual Stress;

N96-11530# Federal Aviation Administration, Atlantic City, NJ.

Fixed ground antenna radome (FGAR) type 1/3 OT&E integrations and OT&E operational Final Test Report

Baker, Leonard H.; and Sedgwick, Harold G.; May 1995 180 p

Report No.(s): (AD-A294511; DOT/FAA/CT-TN95/23) Avail: CASI HC A09/MF A02

This test report documents the Operational Test and Evaluation (OT&E) Integration and OT&E Operational testing performed on the Type I/Ill, Fixed Ground Antenna Radome (FGAR). The Type I/Ill FGAR is used with the Air Route Surveillance Radar (ARSR)) -1/2 and AN/FPS military radars. The testing was performed at the Federal Aviation Administration (FAA) Technical Center's Elwood En Route Beacon Test Facility (ERBTF) and the Northwest Mountain Region's Trinidad En Route Radar Facility (TAD), Colorado. The testing included: (1) characterization of the primary and secondary radar's electromagnetic performance; (2) human factors; (3) physical characteristics; and (4) physical performance. The electromagnetic performance testing showed no degradation of the primary or secondary radars; there were no human factor problems found; and only minor problems were identified during the physical

characteristics and physical performance tests. The testing determined that the FGAR meets the Operational Suitability and Operational Effectiveness requirements of the FAA. DTIC

Aerial Reconnaissance; Beacons; Flight Paths; Human Factors Engineering; Performance Tests; Radar Antennas; Radar Reflectors; Radar Tracking; Radomes; Surveillance Radar; Systems Integration;

N96-11613# Technische Univ., Delft (Netherlands).
Some considerations on the Eftis-Liebowitz equation for the COD compliance of a center cracked specimen
Schijve, J.; Sep. 1994 12 p
Report No.(s): (PB95-242780; LR-M-695) Avail: CASI HC A03/MF A01

The Eftis-Liebowitz equation is used in R-curve tests for measuring the effective crack length. The same approximate equation is also obtained by a K-ratio correction procedure. This K-ratio procedure has also led to another more simple equation, which gives practically the same compliance. Unfortunately, experimentally obtained compliances are higher than the calculated values. There is an apparent need for accurate FEM calculations. For the time being, compliance calibrations should be carried out in R-curve test programs. NTIS

Aircraft Structures; Aluminum Alloys; Crack Opening Displacement; Crack Propagation; Cracking (fracturing); Metal Sheets; Skin (structural Member);

N96-11671# National Inst. of Standards and Technology, Gaithersburg, MD.
Fracture testing of large-scale thin-sheet aluminum alloy
Dewit, Roland; Fields, Richard J.; Low, III, Samuel R.; Harne, Donald E.; and Foecke, Tim; May 1995 32 p Sponsored by Federal Aviation Administration, Washington, DC
Report No.(s): (PB95-242368; NISTIR-5661) Avail: CASI HC A03/MF A01

A series of fracture tests on large-scale, pre-cracked, aluminum alloy panel was carried out to examine and to characterize the process by which cracks propagate and link up in this material. Extended grips and test fixtures were specially designed to enable the panel specimens to be loaded in tension in a 1780-kN-capacity universal testing machine. Using existing information, a test matrix was set up to explore regions of failure controlled by fracture mechanics, with additional tests near the boundary between plastic collapse and fracture. In addition, a variety of multiple site damage (MSD) configurations were included to distinguish between various proposed linkage mechanisms. All tests but one used anti-buckling guides. The data were analyzed by two different procedures: (1) the plastic zone model based on the residual strength diagram; and (2) the R-curve. The first three tests were used to determine the basic material properties, and these results were then used in the analysis of the subsequent tests with MSD cracks. NTIS

Aircraft Construction Materials; Aircraft Structures; Aluminum Alloys; Crack Propagation; Cracking (fracturing); Fracture Strength; Fuselages; Materials Tests; Metal Sheets; Plastic Properties; Tensile Tests;

N96-11881# Battelle Memorial Inst., Columbus, OH. Applied Technical Computer Group.
Acquisition and reduction of blade-mounted pressure transducer data from a Low Aspect Ratio Fan Final Report, Jun. - Sep. 1993
Russler, Patrick M.; Feb. 1995 24 p Limited Reproducibility: Document partially illegible
Contract(s)/Grant(s): (F33615-91-D-2162)
Report No.(s): (AD-A296404; WL-TR-95-2021) Avail: CASI HC A03/MF A01

This report details the acquisition and reduction of blade-mounted, high-response, pressure transducer data. These data were acquired during the Augmented Damping of Low Aspect Ratio Fans (ADLARF) test conducted at the Compressor Research Facility (CRF) located at Wright-Patterson A.F.B. , Ohio. This report, which is exclusively concerned with the acquisition and digitizing of the blade-mounted data, is intended to compliment other related reports by documenting the data acquisition and reduction procedures. The primary goal of this work is to detail the methodology by which unsteady blade forces and momentum can he determined using blade-mounted pressure transducer data. The secondary goal is to use these data to show how inlet distortion and resulting unsteady forces affect the blade resonance of high-speed fans. By achieving the primary goal in this report, it is hoped that the secondary goal can be better achieved using data from future tests. DTIC

Data Acquisition; Data Reduction; Pressure Sensors; Turbine Blades; Turbocompressors;

N96-11932*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Development of advanced structural analysis methodologies for predicting widespread fatigue damage in aircraft structures
Harris, Charles E.; Starnes, Jr., James H.; and Newman, Jr., James C.; Aug. 1995 26 p
Contract(s)/Grant(s): (RTOP 538-02-01)
Report No.(s): (NASA-TM-110187; NAS 1.15:110187) Avail: CASI HC A03/MF A01

NASA is developing a 'tool box' that includes a number of advanced structural analysis computer codes which, taken together, represent the comprehensive fracture mechanics capability required to predict the onset of widespread fatigue damage. These structural analysis tools have complementary and specialized capabilities ranging from a finite-element-based stress-analysis code for two- and three-dimen-

sional built-up structures with cracks to a fatigue and fracture analysis code that uses stress-intensity factors and material-property data found in 'look-up' tables or from equations. NASA is conducting critical experiments necessary to verify the predictive capabilities of the codes, and these tests represent a first step in the technology-validation and industry-acceptance processes. NASA has established cooperative programs with aircraft manufacturers to facilitate the comprehensive transfer of this technology by making these advanced structural analysis codes available to industry.

Author

Aircraft Structures; Applications Programs (computers); Cracks; Fatigue (materials); Fracture Mechanics; Residual Strength; Structural Analysis;

N96-11974 California Inst. of Tech., Pasadena, CA.
Studies of mixing and combustion in hypervelocity flows with hot hydrogen injection Ph.D. Thesis
Belanger, Jacques Jean; 1993 142 p
Avail: Univ. Microfilms Order No. DA9427278

The ability to build an air-breathing single-stage-to-orbit propulsion system requires the examination of key elements such as turbulent mixing rates, especially at the 'zero shear' fuel-air mixing condition, and combustion efficiency. The required data can only be obtained in experiments which simultaneously match the flight total pressure and total enthalpy as well as the fuel conditions. GALCIT, with its new free piston shock tunnel T5, has the capability to do some of these combustion experiments. But prior to these tests, it was felt that there was a need to simulate the gas dynamical processes in the free piston shock tunnel and also in a new combustion driven shock tunnel built for these experiments so that both systems could be used as efficiently as possible. The numerical code helped explain the piston motion in the free piston shock tunnel. The code was also very useful for the design of the combustion driven shock tunnel. Because hydrogen has to be injected into the combustion chamber of the propulsion system after being used as a cooling fluid, a combustion driven shock tunnel was built to reproduce this 'hot' hydrogen at up to 1500 K for the experiments. To reduce the complexity of the problem, a very basic configuration for the hydrogen injection system was tested. This was first done with an injection system mounted flush with the surface of a flat plate in the test section of T5. Different test conditions as well as Mach 2 and 5 nozzle injectors at angles of 15 or 30 degrees were tested to determine criteria for significant combustion. Lower limits in pressure and enthalpy were found where hydrogen combustion becomes very limited using this 'hot' hydrogen fuel. The second set of experiments still used an injection system mounted slush with the surface but involved a small combustor model previously tested in the hypervelocity HYPULSE facility. Low pressure experiments were performed to reproduce some of the HYPULSE tests and excellent agreement was found. Experiments at high pressure were also performed to better match the real flight total pressure and some hydrogen combustion was detected in these tests. Dissert. Abstr.

Chemical Propulsion; Fuel Injection; Hydrogen Fuels; Hypersonic Combustion; Hypersonic Speed; Hypervelocity Flow; Propulsion System Configurations; Slush Hydrogen; Supersonic Combustion; Supersonic Speed; Turbulent Flow; Turbulent Mixing;

N96-11988 California Inst. of Tech., Pasadena, CA.
The boundary layer on a sharp cone in high-enthalphy Ph.D. Thesis
Germain, Patrick; 1994 163 p
Avail: Univ. Microfilms Order No. DA9418637

An exploratory study of the laminar, transitional and turbulent boundary layer on a 5 deg. half-angle cone in hypervelocity flow was conducted in the high-enthalpy shock tunnel T5 by measurement of the heat flux distribution and by qualitative flow visualization. A novel flow visualization technique using sodium seeding to increase the sensitivity of conventional interferometric techniques by resonant enhancement of the refractivity of the medium was developed to study the boundary layer structure. The experiments were designed to cover a large range of specific reservoir enthalpy, ranging from the perfect-gas regime to the range where significant oxygen and some nitrogen dissociation and recombination effects may be expected in the boundary layer. The presence of atomic species is due to the combined effect of nozzle freezing and frictional heating in the boundary layer. In the laminar regime and in the latter range, the following effects were found to be present: At the same nominal conditions, heat flux levels are higher in air than in nitrogen because of a larger heat release from oxygen recombination at the wall. By varying the reservoir specific enthalpy in air and nitrogen, and from measurements in carbon dioxide, it was found that real-gas effects stabilize the boundary layer. If the transition Reynolds number is renormalized by evaluating it at the reference temperature, the data for a given gas becomes correlated in a plot against reservoir enthalpy. Increasing enthalpy stabilizes the flow. The stabilizing effect is stronger with gases whose lowest activation energy is low. This behavior is opposite to the prediction made by the linear stability theory regarding the second linear mode of instability. The linear stability theory predicts, however, that real-gas effects stabilize the mode. Flow visualization results suggest that the dominant instability mode in the present experiments was the Tollmien-Schlichting mode. Finally, the flow visualization pictures show structures that are not qualitatively different from those of an incompressible turbulent boundary layer, but they do not indicate if real-gas effects change significantly the structure

of the turbulent boundary layer. The heat transfer measurements compare well with semi-empirical predictions.
Dissert. Abstr.
Boundary Layer Transition; Flow Visualization; Heat Flux; Hypersonic Boundary Layer; Hypervelocity Flow; Laminar Boundary Layer; Slender Cones; Turbulent Boundary Layer; Wind Tunnel Tests;

N96-12011 Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
Residual strength of cracked 7075 T6 Al-alloy sheets under high loading rates
Vasek, A.; and Schijve, J.; 1 Apr. 1995 73 p
Report No.(s): (LR-790; ISBN-90-5623-016-6) Copyright Avail: Issuing Activity (Technische Univ., Delft, Netherlands)

Dynamic tests were carried out on long sheet specimens with two collinear cracks. First the ligament between the two cracks fails, which implies that the cracks are linked up to a single crack. Linking up did increase the loading rate (dK/dt) of the outer crack tips up to 2 x 10(exp 4) MPa (sq root) m/s. COD measurements during the fast running crack were made. The residual strength was decreased by about 10 percent as compared to the quasi-static result. Fractographic evidence indicates that a high dK/dt has some effect on the shear lips. It promotes some plane-strain influence, associated with an increased yield stress, due to the high plastic strain rate in the crack tip zone. The results were evaluated in terms of fracture mechanics. The results are bearing on the damage tolerance of aircraft structures built up from 7075-T6 sheet material. Author
Aircraft Structures; Aluminum Alloys; Crack Tips; Cracks; Dynamic Tests; Loading Rate; Metal Sheets; Residual Strength;

13 GEOSCIENCES

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

N96-10127# KSE, Inc., Amherst, MA.
High-temperature NO(x) control process, phase 1 Final Report, Sep. 1988 - Mar. 1989
Kittrell, J. R.; Jan. 1995 74 p
Contract(s)/Grant(s): (F08635-89-C-0065)
Report No.(s): (AD-A294412; AFCESA/ESL-TR-89-36) Avail: CASI HC A04/MF A01

KSE has shown that both mordenite and copper mordenite function a effective catalysts for selective catalytic reduction of NO(x) at medium-to-high temperatures. In this phase 1 SBIR effort, KSE performed calculations and performed limited bench experiments using synthetic exhaust gas to demonstrate that combinations of the two catalysts can be used to provide effective reduction of NO(x) over a wide range of temperatures in the presence of ammonia. Extensive design calculations were performed based on information from an obsolete jet engine test cell (JETC) and a number of unverified engineering assumptions. Although the interpretation of these computations was considered favorable by the contractor, several features of the proposed design appear to be unfavorable: the back pressure is calculated to be 10 inches wg, which is twice Radian 5 recommendation to EPA, and 10 times the Air Force's target value.
DTIC
Air Pollution; Catalysts; Control Systems Design; Design Analysis; Exhaust Gases; Gas Turbine Engines; High Temperature; Jet Engines; Military Aircraft; Nitrogen Oxides; Synthetic Fuels;

N96-10592 Lawrence Livermore National Lab., Livermore, CA.
A solar module fabrication process for HALE solar electric UAV's
Carey, P. G.; Aceves, R. C.; Colella, N. J.; Williams, K. A.; Sinton, R. A.; and Glenn, G. S.; (Spectrolab, Inc., Sylmar, CA.) 12 Dec. 1994 7 p Presented at the 1st World Conference on Photovoltaic Energy Conversion, Waikoloa, HI, 5-9 Dec. 1994 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
Contract(s)/Grant(s): (W-7405-ENG-48)
Report No.(s): (DE95-011719; UCRL-JC-118267; CONF-941203-25) Avail: CASI HC A02

We describe a fabrication process used to manufacture high power-to-weight-ratio flexible solar array modules for use on high-altitude-long-endurance (HALE) solar-electric unmanned air vehicles (UAV's). These modules have achieved power-to-weight ratios of 315 and 396 W/kg for 150 micron-thick monofacial and 110 micron-thick bifacial silicon solar cells, respectively. These calculations reflect average module efficiencies of 15.3% (150 micron) and 14.7% (110 micron) obtained from electrical tests performed by Spectrolab, Inc. under AMO global conditions at 25 C, and include weight contributions from all module components (solar cells, lamination material, bypass diodes, interconnect wires, and adhesive tape used to attach the modules to the wing). The fabrication, testing, and performance of 32 sq m of these modules is described. DOE
Aircraft Power Supplies; Energy Conversion Efficiency; Fabrication; Pilotless Aircraft; Solar Arrays; Solar Cells;

N96-11007# Air Force Systems Command, Wright-Patterson AFB, OH. National Air Intelligence Center.
Journal of materials engineering
18 Apr. 1995 117 p Transl. into ENGLISH from Journal of Materials Engineering, China, no. 5, 2-8, 16-22, 31-35, 43-46 1992 p 1

Report No.(s): (AD-A294238; NAIC-ID(RS)T-0502-94) Avail: CASI HC A06/MF A02

This document contains selected articles from the Journal of Materials Engineering (China), which includes articles concerning: aluminum alloys; aircraft construction materials; wall plates; composite materials; technology assessment; technology utilization; histories; forging; technological forecasting; structural engineering; nondestructive testing (ultrasonics, radiographic inspections, magnetic particle inspection); high temperature alloys; galvanic corrosion testing; shapes; and oxidation and protection of carbon/carbon composites. DTIC

Aircraft Construction Materials; Aluminum Alloys; Carbon-carbon Composites; Dynamic Structural Analysis; Heat Resistant Alloys; Iron Compounds; Materials Tests; Metal Fatigue; Niobium Alloys; Nondestructive Tests; Rectangular Panels; Structural Engineering; Technological Forecasting; Technology Assessment;

N96-11313# National Renewable Energy Lab., Golden, CO.

The green hydrogen report: The 1995 progress report of the Secretary of Energy's Hydrogen Technical Advisory Panel

1995 23 p

Contract(s)/Grant(s): (DE-AC36-83CH-10093)

Report No.(s): (DE95-009213; DOE/GO-10095-179) Avail: CASI HC A03/MF A01

This report presents the idea that hydrogen and electricity, ultimately derived from renewable technologies, will serve as the clean, inexhaustible energy carriers in the next century. The widespread introduction of these energy forms would dramatically reduce the nation's air pollution, enhance its energy security, and ameliorate potential global climate problems. The topics of the report include the role of hydrogen, research priorities, and use of hydrogen in surface transportation and aircraft. DOE

Aircraft Fuels; Automobile Fuels; Clean Energy; Energy Technology; Hydrogen Fuels; Hydrogen-based Energy; Technology Assessment; Transportation Energy;

N96-11413# Air Force Inst. of Tech., Wright-Patterson AFB, OH.

Evaluation of techniques for computer modeling and real time control of a horizontal axis wind turbine blade

Wesenberg, Alan; (Colorado Univ., Boulder, CO.) May 1995 25 p

Report No.(s): (AD-A295130; AFIT/CI/CIA-95-033) Avail: CASI HC A03/MF A01

Wind power generating turbines operate under constant as well as rapidly changing conditions. With fixed pitch blades, many wind turbines are allowed to operate regardless of wind conditions as long as they are able to produce more electricity than it takes to get them started. However, the lifecycle of the turbine blades is often much shorter than expected because of the unsteady aerodynamic environment under which they rotate. Therefore, the National Renewable Energy Laboratory (NREL) has implemented a testing program to determine the aerodynamic conditions, and the frequency with which they occur, which cause the largest amount of fatigue on their variable pitch, three bladed downwind horizontal axis wind turbine (HAWT). Different techniques will be examined for analytically modeling the flow conditions with separation over a rotating turbine blade. Then, some different techniques for implementing a feedback control loop will be investigated to optimize the movement of the variable pitch blades on the NREL HAWT. The different methods analyzed will fall in the two-dimensional, incompressible area with most also being for steady state conditions. The final objective is to provide the reader with a background in dealing with the aerodynamic conditions surrounding a rotating wind turbine in an unsteady aerodynamic environment. DTIC

Aerodynamic Stalling; Computerized Simulation; Incompressible Flow; Real Time Operation; Separated Flow; Turbine Blades; Turbulence Models; Two Dimensional Models; Unsteady Aerodynamics; Wind Turbines;

N96-11429# Argonne National Lab., IL.

The Tracking and Analysis Framework (TAF): A tool for the integrated assessment of acid deposition

Bloyd, C. N.; Henrion, M.; and Marnicio, R. J.; 1995 15 p

Presented at the Air & Waste Management Association (AWMA) Conference on Acid Rain & Electric Utilities: Permits, Allowances, Monitoring & Meteorology, Tempe, AZ, 23-25 Jan. 1995

Contract(s)/Grant(s): (W-31-109-ENG-38)

Report No.(s): (DE95-013497; ANL/DIS/CP-85637; CONF-950196-1) Avail: CASI HC A03/MF A01

A major challenge that has faced policy makers concerned with acid deposition is obtaining an integrated view of the underlying science related to acid deposition. In response to this challenge, the US Department of Energy is sponsoring the development of an integrated Tracking and Analysis Framework (TAF) which links together the key acid deposition components of emissions, air transport, atmospheric deposition, and aquatic effects in a single modeling structure. The goal of TAF is to integrate credible models of the scientific and technical issues into an assessment framework that can directly address key policy issues, and in doing so act as a bridge between science and policy. Key objectives of TAF are to support coordination and communication among scientific researchers; to support communications with policy makers, and to provide rapid response for analyzing newly emerging policy issues; and to provide guidance for prioritizing research programs. This paper briefly describes how TAF was formulated to meet those

objectives and the underlying principals which form the basis for its development. DOE
Acid Rain; Air Pollution; Atmospheric Circulation; Environment Protection; Environmental Monitoring; Integrated Library Systems; Management Information Systems; Pollution Control;

N96-11460# Pacific Northwest Lab., Richland, WA.
Pacific Northwest Laboratory annual report for 1994 to the DOE Office of Energy Research. Part 2: Atmospheric and climate research
Apr. 1995 97 p
Contract(s)/Grant(s): (DE-AC06-76RL-01830)
Report No.(s): (DE95-015264; PNL-10500-PT-2) Avail: CASI HC A05/MF A02

Atmospheric research at Pacific Northwest Laboratory (PNL) occurs in conjunction with the Atmospheric Chemistry Program (ACP) and with the Atmospheric Studies in Complex Terrain (ASCOT) Program. Solicitations for proposals and peer review were used to select research projects for funding in FY 1995. Nearly all ongoing projects were brought to a close in FY 1994. Therefore, the articles in this volume include a summary of the long-term accomplishments as well as the FY 1994 progress made on these projects. The following articles present summaries of the progress in FY 1994 under these research tasks: continental and oceanic fate of pollutants; research aircraft operations; ASCOT program management; coupling/decoupling of synoptic and valley circulations; interactions between surface exchange processes and atmospheric circulations; and direct simulations of atmospheric turbulence. Climate change research at PNL is aimed at reducing uncertainties in the fundamental processes that control climate systems that currently prevent accurate predictions of climate change and its effects. PNL is responsible for coordinating and integrating the field and laboratory measurement programs, modeling studies, and data analysis activities of the Atmospheric Radiation Measurements (ARM) program. In FY 1994, PNL scientists conducted 3 research projects under the ARM program. In the first project, the sensitivity of GCM grid-ad meteorological properties to subgrid-scale variations in surface fluxes and subgrid-scale circulation patterns is being tested in a single column model. In the second project, a new and computationally efficient scheme has been developed for parameterizing stratus cloud microphysics in general circulation models. In the last project, a balloon-borne instrument package is being developed for making research-quality measurements of radiative flux divergence profiles in the lowest 1,500 meters of the Earth's atmosphere. DOE
Atmospheric Chemistry; Atmospheric Circulation; Atmospheric Radiation; Atmospheric Turbulence; Climate; Climate Change; Cloud Physics;

14 LIFE SCIENCES

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

No abstracts in this category.

15 MATHEMATICAL AND COMPUTER SCIENCES

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

N96-10011# Columbia Univ., New York, NY.
Robust control methods Final Report, 1 Nov. 1991 - 15 Jan. 1995
Safonov, Michael G.; 15 Jan. 1995 15 p
Contract(s)/Grant(s): (F49620-92-J-0014)
Report No.(s): (AD-A295018; AFOSR-95-0185TR) Avail: CASI HC A03/MF A01

This is the final report for research supported under AFOSR Grant F49620-92-J-0014 during the period November 1, 1991 through January 15, 1995. During this period research effort was broadly focused on developing the theory of extending class of solvable robust control problems and on developing a theory to accommodate the issues that arise in going from experimental data to robust control designs. Robust control concerns the problem of engineering control systems capable of robustly maintaining performance to within prescribed tolerances in the face of large-but-bounded modeling uncertainties and nonlinearities. A significant breakthrough achieved by the research is a new and remarkably simple Bilinear Matrix. The quality (BMI) embedding of the robust control problem which distills the essential mathematical features of the full spectrum of robust control problems. Besides being simple and mathematically elegant, the BMI significantly expands the class controller design constraints that can be accommodated to include reduced order u/Km control, decentralized control, multi-model control, gain-scheduling, mixed H2/H-infinity control and so forth. A second breakthrough has been the introduction of a new unfalsified control concept providing a remarkably lucid mathematical characterization of the processes of learning and adaptation in robust control design; this theory is expected to lead to much improved techniques for reducing experimental data to practical and reliable control designs for a variety of advanced aerospace engineering applications where robust performance is prerequisite, e.g., aircraft stability augmentation systems, highly maneuverable aircraft design, missile guidance systems, and precision pointing and tracking systems. DTIC
Aerospace Engineering; Aircraft Stability; Augmentation;

Control Systems Design; Controllers; Data Reduction; Design Analysis; Embedding; Stability Augmentation; Systems Engineering;

N96-10031*# SRI International Corp., Menlo Park, CA.
The formal verification used for the AAMP5 and AAMP-FV c61
Srivas, Mandayam; In NASA. Langley Research Center, Third NASA Langley Formal Methods Workshop p 141-147 Jun. 1995 (For primary document see N96-10026 01-59)
Avail: CASI HC A02/MF A03

The main goal of the project was two-fold: First, to investigate the feasibility of formally specifying and verifying a complex commercial microprocessor that was not expressly designed for formal verification. Second, to explore effective ways to transfer the technology to an industrial setting. The choice of the AAMP5 satisfied the first goal since the AAMP5 was not designed for formal verification, but to provide a more than threefold performance improvement while remaining object-code-compatible with the earlier AAMP2, which is used in numerous avionics applications, including the Boeing 737, 747, 757, and 767. To satisfy the technology transfer objective, we had to develop a suitable verification methodology and a formal infrastructure to make the technology usable by practicing engineers. This infrastructure includes techniques for decomposing the microcompressor verification problem into a st of verification conditions that the engineers can formulate and strategies to automate the proof of the verification conditions. The development of the infrastructure was one of the key accomplishments of the project. Most of the infrastructure and methodology are general enough to be reused for other microprocessors, certainly in the verification of another member of the AAMP family. This methodology was used to formally specify the entire microarchitecture and more than half of the instruction set and to verify a core set of eleven AAMP5 instructions representative of several instruction classes. However, the methodology and the formal machinery developed are adequate to cover most of the remaining AAMP5 instructions. Although PVS was the vehicle of the experiment, the methodology is applicable to other sufficiently powerful theorem provers. Author
Avionics; Computer Systems Design; Formalism; Microprocessors; Program Verification (computers); Technology Transfer;

N96-11644# Argonne National Lab., IL.
Automatic differentiation: Obtaining fast and reliable derivatives
Bischof, C. H.; Khademi, P. M.; Pusch, G.; and Carle, A.; (Rice Univ., Houston, TX.) 1994 17 p Presented at the SIAM Symposium on Control Problems in Industry, San Diego, CA, 22-23 Jul. 1994
Contract(s)/Grant(s): (W-31-109-ENG-38)
Report No.(s): (DE95-014244; ANL/MCS/CP-86446; CONF-9407190-1) Avail: CASI HC A03/MF A01

In this paper, the authors introduce automatic differentiation as a method for computing derivatives of large computer codes. After a brief discussion of methods of differentiating codes, they review automatic differentiation and introduce the ADIFOR (Automatic DIfferentiation of FORtran) tool. They highlight some applications of ADIFOR to large industrial and scientific codes (groundwater transport, CFD airfoil design, and sensitivity-enhanced MM5 mesoscale weather model), and discuss the effectiveness and performance of their approach. Finally, they discuss sparsity in automatic differentiation and introduce the SparsLinC library. DOE
Computer Aided Design; Computer Programs; Data Processing; Derivation; Differential Equations;

N96-11822*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Decomposing a complex design problem using CLIPS c61
Rogers, James L.; In NASA. Johnson Space Center, First CLIPS Conference Proceedings, Volume 1 1990 p 200-217 (For primary document see N96-11804 01-63)
Avail: CASI HC A03/MF A04

Many engineering systems are large and multidisciplinary. Before the design of such complex systems can begin, much time and money are invested in determining the possible couplings among the participating subsystems and their parts. For designs based on existing concepts, like commercial aircraft design, the subsystems and their couplings are usually well-established. However, for designs based on novel concepts, like large space platforms, the determination of the subsystems, couplings, and participating disciplines is an important task. Moreover, this task must be repeated as new information becomes available or as the design specifications change. Determining the subsystems is not an easy, straightforward process and often important couplings are overlooked. The design manager must know how to divide the design work among the design teams so that changes in one subsystem will have predictable effects on other subsystems. The resulting subsystems must be ordered into a hierarchical structure before the planning documents and milestones of the design project are set. The success of a design project often depends on the wise choice of design variables, constraints, objective functions, and the partitioning of these among the design teams. Very few tools are available to aid the design manager in determining the hierarchical structure of a design problem and assist in making these decisions. Derived from text
Complex Systems; Couplings; Design Analysis; Functional Design Specifications; Multidisciplinary Design Optimization;

N96-11971*# Institute for Computer Applications in Science and Engineering, Hampton, VA.

Implicit method for the computation of unsteady flows on unstructured grids Final Report

Venkatakrishnan, V.; and Mavriplis, D. J.; Aug. 1995 36 p Submitted for publication in Journal of Computational Physics

Contract(s)/Grant(s): (NAS1-19480; RTOP 505-90-52-01)

Report No.(s): (NASA-CR-198206; NAS 1.26:198206; ICASE-95-60) Avail: CASI HC A03/MF A01

An implicit method for the computation of unsteady flows on unstructured grids is presented. Following a finite difference approximation for the time derivative, the resulting nonlinear system of equations is solved at each time step by using an agglomeration multigrid procedure. The method allows for arbitrarily large time steps and is efficient in terms of computational effort and storage. Inviscid and viscous unsteady flows are computed to validate the procedure. The issue of the mass matrix which arises with vertex-centered finite volume schemes is addressed. The present formulation allows the mass matrix to be inverted indirectly. A mesh point movement and reconnection procedure is described that allows the grids to evolve with the motion of bodies. As an example of flow over bodies in relative motion, flow over a multi-element airfoil system undergoing deployment is computed. Author

Computational Fluid Dynamics; Finite Difference Theory; Finite Volume Method; Grid Generation (mathematics); Inviscid Flow; Unsteady Flow; Unstructured Grids (mathematics); Viscous Flow;

N96-12009 Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.

User's manual for the computer program CUFUS. Quick design procedure for a CUt-out in a FUSelage version 1.0

Heerschap, M. E.; 1 May 1995 137 p

Report No.(s): (LR-789; ISBN-90-5623-015-8) Copyright Avail: Issuing Activity (Technische Univ., Delft, Netherlands)

Cut-outs in pressurized aircraft fuselages are very sensitive to fatigue. This explains the need for a design tool to enable the designer to perform a comprehensive design of this 'difficult' structure. A menu-driven, highly interactive system for the design of cut-outs in pressurized fuselages is described. The design system is set up in such a way that maximum use is made of commercially available software. There are six basic options offered by the system: (1) easy and fast initial model generation; (2) fully interactive, user friendly model editing; (3) preparation for both geometrically linear and nonlinear finite element calculations; (4) preparation for a sensitivity analysis and graphical display of the results of such an analysis; (5) carrying out 'what-if' studies; and (6) pre- and post-processing of a design optimization. This design system is set up as a special purpose design tool. This enables a substantial improvement in the design process, because the time needed for the modeling of the complex structure is greatly reduced. The design system is based on the pre- and post-processor PATRAN. The necessary software is written almost entirely in PATRAN Command Language (PCL). Maximum use is made of the graphical capability of this software package. The finite element calculations, including sensitivity analysis and optimization, are performed by MSC/NASTRAN. Author

Aircraft Design; Applications Programs (computers); Computer Aided Design; Finite Element Method; Fuselages Nastran; Openings; Pressurized Cabins; Structural Design; User Manuals (computer Programs);

N96-12016*# Pennsylvania State Univ., University Park, PA. Dept. of Computer Science and Engineering.

Algorithms for detection of objects in image sequences captured from an airborne imaging system Final Report, 1 Mar. 1994 - 31 Aug. 1995

Kasturi, Rangachar; Camps, Octavia; Tang, Yuan-Liang; Devadiga, Sadashiva; and Gandhi, Tarak; 10 Oct. 1995 63 p

Contract(s)/Grant(s): (NCC2-853)

Report No.(s): (NASA-CR-199579; NAS 1.26:199579; CSE-95-026) Avail: CASI HC A04/MF A01

This research was initiated as a part of the effort at the NASA Ames Research Center to design a computer vision based system that can enhance the safety of navigation by aiding the pilots in detecting various obstacles on the runway during critical section of the flight such as a landing maneuver. The primary goal is the development of algorithms for detection of moving objects from a sequence of images obtained from an on-board video camera. Image regions corresponding to the independently moving objects are segmented from the background by applying constraint filtering on the optical flow computed from the initial few frames of the sequence. These detected regions are tracked over subsequent frames using a model based tracking algorithm. Position and velocity of the moving objects in the world coordinate is estimated using an extended Kalman filter. The algorithms are tested using the NASA line image sequence with six static trucks and a simulated moving truck and experimental results are described. Various limitations of the currently implemented version of the above algorithm are identified and possible solutions to build a practical working system are investigated. Author

Aerial Photography; Airfield Surface Movements; Algorithms; Change Detection; Computer Vision; Image Analysis; Optical Flow (image Analysis); Optical Tracking; Scene Analysis;

16 PHYSICS

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

N96-11124# Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
Evaluation of the sensitivity and limits of the passive acoustic ranging algorithm for single and multiple helicopters Final Report
Carnes, Benny L.; and Morgan, John C.; Mar. 1995 58 p
Report No.(s): (AD-A294453; WES/TR/SL-95-8) Avail: CASI HC A04/MF A01

Passive acoustic ranging (PAR), based on acoustic Doppler shifts, has been proposed as a suitable method for extracting velocity and range information from a source which emits a time-dependent acoustic signal. Operational constraints on the PAR method were evaluated and estimates were made of the limitations of realistic operation under various environmental conditions. In addition, performance of the PAR method was evaluated for multiple helicopters. Several methods of analysis of signals were tested to determine the optimum method for field implementation. It was found that additional information gained from preprocesssing with an artificial neural network would enable the analysis to process a signal from multiple moving sources and enhance the response time of the system. DTIC
Algorithms; Doppler Effect; Helicopters; Rangefinding; Sensitivity; Time Dependence;

N96-11163*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
The effects of vortex modeling on blade-vortex interaction noise prediction
Gallman, Judith M.; Tung, Chee; and Low, Scott L.; 1995 18 p
Report No.(s): (NASA-TM-110823; NAS 1.15:110823; AD-A294466) Avail: CASI HC A03/MF A01

The use of a blade vortex interaction noise prediction scheme, based on CAMRAD/JA, FPR and RAPP, quantifies the effects of errors and assumptions in the modeling of the helicopter's shed vortex on the acoustic predictions. CAMRAD/JA computes the wake geometry and inflow angles that are used in FPR to solve for the aerodynamic surface pressures. RAPP uses these surface pressures to predict the acoustic pressure. Both CAMRAD/JA and FPR utilize the Biot-Savart Law to determine the influence of the vortical velocities on the blade loading and both codes use an algebraic vortex model for the solid body rotation of the vortex core. Large changes in the specification of the vortex core size do not change the inplane wake geometry calculated by CAMRAD/JA and only slightly affect the out-of-plane wake geometry. However, the aerodynamic surface pressure calculated by FPR changes in both magnitude and character with small changes to the core size used by the FPR calculations. This in turn affects the acoustic predictions. Shifting the CAMRAD/JA wake geometry away from the rotor plane by 1/4 chord produces drastic changes in the acoustic predictions indicating that the prediction of acoustic pressure is extremely sensitive to the miss distance between the vortex and the blade and that this distance must be calculated as accurately as possible for acceptable noise predictions. The inclusion or exclusion of a vortex in the FPR-RAPP calculation allows for the determination of the relative importance of that vortex as a BVI noise source. DTIC
Aerodynamics; Blade-vortex Interaction; Control Surfaces; Errors; Helicopters; Miss Distance; Noise Prediction; Vortices; Wakes;

N96-11311# Tennessee Univ., Knoxville, TN. Plasma Science Lab.
Investigation of a uniform glow discharge plasma in atmospheric air Final Scientific Report, 1 Apr. 1994 - 31 Mar. 1995
Roth, J. R.; 26 Jun. 1995 218 p
Contract(s)/Grant(s): (F49620-94-1-0249; AF-AFOSR-0319-89)
Report No.(s): (AD-A296928; UTK-PSL-95-4; AFOSR-95-0476TR) Avail: CASI HC A10/MF A03

During this year, we demonstrated the ability not only to cover the surface of a simulated aircraft fuselage with a thin layer of plasma at one atmosphere in both atmospheric air and helium, but we also demonstrated that this plasma layer would not blow away under the impact of a jet of air from the laboratory service air supply. These results strongly suggest that the one atmosphere plasma layer might be useful for boundary layer control and drag reduction on aircraft. This contract has also resulted in 3 issued patents (to which the U.S. Government has a royalty free license); two patent disclosures; two poster paper presentations at conferences, two archival journal publications, and two invited seminar presentations, at the Kirtland AFB and at the NASA Langley Research Center. It is expected that this work will continue in the wind tunnels at Langley. DTIC
Air Jets; Atmospheric Stratification; Blowing; Fuselages; Glow Discharges; Helium; Plasma Layers; Plasmas (physics);

17 SOCIAL SCIENCES

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

N96-11493* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

Shaping tomorrow (Videotape)
1970 Videotape: 18 min. 30 sec. playing time, in color, with sound
Report No.(s): (NASA-TM-111078; NONP-NASA-VT-95-65627) Avail: CASI VHS A02/BETA A022

The development, history, and opportunities for employment available at the Johnson Space Center (JSC) in Houston, Texas are presented in this video, with special emphasis placed on minorities in the aeronautical engineering fields and at JSC. There are several interviews with black, Hispanic and female engineering and aeronautics professionals and the various projects they work on. Author
Houston (TX); Minorities; Nasa Space Programs; Research Projects;

18 SPACE SCIENCES

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

No abstracts in this category.

19 GENERAL

No abstracts in this category.

Subject Term Index

A

Absorption Spectra, 4
Acceptability, 25
Accident Investigation, 10
Acid Rain, 33
Acoustic Properties, 4
Active Control, 27
Actuator Disks, 5
Actuators, 19
Adhesive Bonding, 24
Adhesives, 24
Aerial Photography, 35
Aerial Reconnaissance, 29
Aeroacoustics, 4
Aerodynamic Characteristics, 6, 7
Aerodynamic Coefficients, 4, 17, 26
Aerodynamic Configurations, 7
Aerodynamic Drag, 5, 8, 18, 26
Aerodynamic Forces, 6
Aerodynamic Loads, 6
Aerodynamic Noise, 20
Aerodynamic Stability, 20
Aerodynamic Stalling, 8, 32
Aerodynamics, 1, 2, 3, 4, 7, 13, 14, 16, 36
Aeroelasticity, 8, 20
Aeronautical Engineering, 1, 2, 3
Aeronautics, 1, 2
Aerospace Engineering, 33
Aerospace Planes, 7
Aerospace Systems, 11
Aerospace Vehicles, 4, 7
Aging (materials), 23, 24
Ailerons, 20
Air Flow, 6, 22
Air Jets, 36
Air Piracy, 10
Air Pollution, 18, 31, 33
Air Traffic, 12
Air Traffic Control, 12, 13
Air Transportation, 2, 12
Airborne/spaceborne Computers, 20
Aircraft Approach Spacing, 13
Aircraft Configurations, 15, 16
Aircraft Construction Materials, 23, 29, 32
Aircraft Control, 19
Aircraft Design, 15, 16, 17, 35
Aircraft Engines, 1
Aircraft Equipment, 20
Aircraft Fuels, 32
Aircraft Landing, 9
Aircraft Maintenance, 2, 16
Aircraft Maneuvers, 21
Aircraft Models, 15
Aircraft Power Supplies, 31
Aircraft Safety, 11, 12
Aircraft Stability, 33
Aircraft Structures, 1, 7, 14, 15, 17, 23, 29, 30, 31
Airfield Surface Movements, 35
Airfoil Profiles, 7, 16, 17
Airfoils, 8, 9, 15, 16
Airline Operations, 2
Airport Security, 12
Airports, 12
Algorithms, 12, 26, 35, 36
Alternating Direction Implicit Methods, 26
Aluminum Alloys, 16, 17, 23, 29, 31, 32
Aluminum Oxides, 18
Analog Computers, 20
Anemometers, 5
Applications Programs (computers), 2, 3, 5, 11, 16, 28, 30, 35
Approach Control, 13
Approach Indicators, 9, 25
Armed Forces (united States), 2
Arpa Computer Network, 13, 14, 16
Atmospheric Chemistry, 33
Atmospheric Circulation, 33
Atmospheric Radiation, 33
Atmospheric Stratification, 36
Atmospheric Turbulence, 33
Augmentation, 33
Automatic Control, 13, 19
Automatic Landing Control, 9
Automatic Pilots, 21
Automobile Engines, 18
Automobile Fuels, 32
Avionics, 12, 34
Axial Loads, 18

B

Balance, 4
Ball Bearings, 21
Barium Oxides, 18
Beacons, 29
Bibliographies, 1, 2, 3, 12
Blade-vortex Interaction, 4, 6, 36
Blowdown Wind Tunnels, 27
Blowing, 36
Bo-105 Helicopter, 6
Bonded Joints, 24
Boundary Element Method, 8
Boundary Layer Control, 9, 27
Boundary Layer Flow, 26
Boundary Layer Separation, 9
Boundary Layer Transition, 22, 31
Boundary Layers, 3, 27
Brackets, 12
Brush Seals, 22

C

C-141 Aircraft, 2
C-5 Aircraft, 2
Carbon Monoxide, 10
Carbon-carbon Composites, 32
Cargo, 16
Case Histories, 10
Catalysts, 31
Ceramics, 18
Change Detection, 35
Characterization, 28
Charts, 10
Chemical Propulsion, 30
Circular Cylinders, 5
Civil Aviation, 9, 10, 12
Clean Energy, 32
Climate, 33
Climate Change, 33
Cloud Physics, 33
Coating, 24
Coherent Radar, 26
Collision Avoidance, 12
Combustion Products, 10
Commercial Aircraft, 2
Compensators, 19
Complex Systems, 34
Composite Materials, 15
Composite Structures, 15, 23
Compressibility Effects, 17
Compressor Rotors, 28
Compressors, 22
Computational Fluid Dynamics, 5, 6, 7, 25, 35
Computational Grids, 5, 7
Computer Aided Design, 15, 16, 17, 20, 34, 35
Computer Programs, 17, 25, 34

Computer Systems Design, 34
Computer Systems Performance, 6
Computer Vision, 12, 35
Computerized Simulation, 16, 32
Conductive Heat Transfer, 28
Conferences, 1, 6
Conjugate Gradient Method, 28
Contractors, 6
Control Simulation, 19
Control Surfaces, 36
Control Systems Design, 2, 12, 19, 20, 31, 34
Control Theory, 16
Controllers, 19, 34
Corner Flow, 26
Correlation, 4
Couplings, 34
Crack Opening Displacement, 29
Crack Propagation, 29
Crack Tips, 31
Cracking (fracturing), 29
Cracks, 16, 30, 31
Crashworthiness, 23
Cryogenics, 22
Cylindrical Tanks, 23

D

Damage, 10
Damage Assessment, 23
Data Acquisition, 21, 24, 29
Data Bases, 11, 27
Data Links, 11
Data Processing, 34
Data Reduction, 29, 34
Delta Wings, 6
Derivation, 34
Descent, 4
Design Analysis, 15, 22, 31, 34
Design To Cost, 21
Detonation, 11
Differential Equations, 34
Digital Systems, 19, 20
Display Devices, 25
Dissipation, 26
Doppler Effect, 36
Doppler Radar, 24
Downwash, 5, 9
Drag Measurement, 8
Drop Tests, 15
Durability, 23, 24
Dynamic Loads, 15, 23
Dynamic Models, 19, 28
Dynamic Pressure, 7
Dynamic Response, 15, 21, 23, 27
Dynamic Structural Analysis, 27, 32
Dynamic Tests, 31

E

Egress, 11, 12
Ejectors, 4
Electrochemical Machining, 28
Electron Beam Welding, 28
Electron Beams, 24
Electron Transitions, 24
Embedding, 34
Emergencies, 11, 12
Enclosure, 10
Energy Conversion Efficiency, 31
Energy Technology, 32
Energy Transfer, 26
Engine Airframe Integration, 4
Engine Design, 18, 26
Engine Inlets, 11, 26
Engine Tests, 18, 22
Enthalpy, 3, 18
Environment Protection, 18, 33
Environmental Monitoring, 33
Epoxy Matrix Composites, 23
Errors, 36
Exhaust Gases, 18, 31
Exhaust Nozzles, 4

F

F-14 Aircraft, 20
F-15 Aircraft, 21
F-18 Aircraft, 19
Fabrication, 31
Fan Blades, 27
Far Fields, 26
Fatigue (materials), 30
Fatigue Testing Machines, 23
Fatigue Tests, 23, 24
Feathering, 20
Feedback Control, 9
Fighter Aircraft, 15, 26
Finite Difference Theory, 7, 35
Finite Element Method, 14, 28, 35
Finite Volume Method, 35
Fire Extinguishers, 11
Fire Fighting, 11
Fires, 10
Fixed Wings, 10, 16
Flames, 11
Flat Plates, 26
Flexible Wings, 3
Flight Characteristics, 15, 21
Flight Conditions, 15
Flight Control, 2, 7, 13, 14, 19, 20, 21
Flight Crews, 12
Flight Paths, 29
Flight Safety, 11, 12, 23
Flight Simulation, 5, 16, 19, 21
Flight Tests, 5, 9, 14, 20, 21, 25
Flow Distribution, 4, 6, 22
Flow Measurement, 22
Flow Velocity, 26
Flow Visualization, 6, 31
Fluid Dynamics, 1, 3
Fluid Films, 21
Force Distribution, 8, 18
Formalism, 34
Forming Techniques, 17
Fracture Mechanics, 30
Fracture Strength, 15, 29
Free Flow, 7
Free-piston Engines, 22
Frequencies, 2, 3, 11
Frequency Ranges, 5
Fuel Injection, 30
Fuel Tanks, 15, 23
Fuels, 10
Functional Design Specifications, 34
Fuselages, 15, 23, 29, 36
Fuselages Nastran, 35

G

Gas Composition, 10
Gas Dynamics, 22
Gas Expansion, 3, 22
Gas Turbine Engines, 18, 28, 31
Gas Turbines, 17, 18
General Aviation Aircraft, 12
Glass Fiber Reinforced Plastics, 23
Glass Fibers, 23
Global Positioning System, 9
Glow Discharges, 36
Graphite-epoxy Composites, 23
Graphs (charts), 10
Grid Generation (mathematics), 35
Ground Effect (aerodynamics), 16
Ground Truth, 9

H

Hail, 11
Harmonic Control, 20
Harmonic Oscillation, 6
Heat Flux, 31
Heat Resistant Alloys, 28, 32

Helicopter Control, 20
Helicopter Wakes, 4
Helicopters, 2, 3, 11, 12, 20, 36
Helium, 36
High Pressure, 6, 28
High Resolution, 26
High Temperature, 31
Horizontal Flight, 5
Houston (TX), 37
Human Factors Engineering, 11, 13, 29
Hydrodynamics, 13, 14
Hydrogen Fuels, 30, 32
Hydrogen-based Energy, 32
Hypersonic Boundary Layer, 31
Hypersonic Combustion, 30
Hypersonic Flight, 6, 7, 21
Hypersonic Flow, 3, 8
Hypersonic Nozzles, 8
Hypersonic Speed, 30
Hypersonic Vehicles, 21
Hypersonics, 6
Hypervelocity Flow, 30, 31

I

Image Analysis, 35
Image Processing, 12
Imaging Radar, 26
Impact Loads, 15
Impact Tests, 15
Incompressible Flow, 5, 26, 32
Indexes (documentation), 1, 2, 3
Industries, 13, 14
Inertial Confinement Fusion, 21
Inertial Navigation, 13
Ingestion (engines), 11
Injection, 27
Inlet Flow, 4
Inspection, 23
Integrated Library Systems, 33
Inviscid Flow, 35
Iron Compounds, 32

J

Jet Aircraft, 17, 21
Jet Engines, 18, 31

K

Kernel Functions, 9

L

Labyrinth Seals, 22
Laminar Boundary Layer, 31
Laminar Flow, 22
Laminates, 16, 23
Landing Aids, 13
Lap Joints, 24
Laser Fusion, 21
Lateral Control, 19
Lattices (mathematics), 8
Leading Edges, 26
Lift, 8
Lift Drag Ratio, 4
Lifting Bodies, 7
Line Shape, 4
Linear Programming, 19
Liquid Bearings, 21
Loading Rate, 31
Losses, 10
Low Speed, 6

M

Mach Number, 27
Magnetohydrodynamics, 27
Maintenance Training, 2
Management, 10
Management Information Systems, 33
Maneuverability, 15, 21
Manual Control, 21
Markov Processes, 27
Mass Transfer, 26
Materials Tests, 29, 32
Mathematical Models, 5, 14, 19, 27, 28
Metal Coatings, 24
Metal Fatigue, 32
Metal Matrix Composites, 24
Metal Sheets, 29, 31
Metal Working, 17
Meteorological Radar, 24
Microprocessors, 34
Microwave Landing Systems, 9
Military Aircraft, 2, 31
Military Operations, 2
Mimo (control Systems), 2, 3
Minorities, 37
Miss Distance, 36
Mistuning (turbomachinery), 27
Model Reference Adaptive Control, 19
Models, 6
Molecular Dynamics, 4
Monte Carlo Method, 11
Motion Simulation, 21
Multidisciplinary Design Optimization, 7, 15, 34
Multivariable Control, 19

N

Nasa Space Programs, 37
National Airspace System, 11
Navier-stokes Equation, 5, 7, 25, 26
Navigation, 12
Navigation Aids, 12
Near Fields, 26
Niobium Alloys, 32
Nitrogen Oxides, 18, 31
Noise Prediction, 36
Noise Reduction, 4
Nondestructive Tests, 23, 32
Nonlinear Systems, 19
Nonlinearity, 5, 26
North Atlantic Treaty Organization (NATO), 11
Nozzle Design, 22
Nozzle Flow, 3, 4, 25

O

Oblique Shock Waves, 26
Ohmic Dissipation, 28
Openings, 35
Optical Flow (image Analysis), 35
Optical Tracking, 35
Optimization, 4, 16, 19
Oscillating Flow, 8
Oscillations, 6
Overpressure, 4

P

Parallel Processing (computers), 12
Parameter Identification, 3, 19
Particle Image Velocimetry, 8
Pattern Registration, 12
Performance Tests, 22, 23, 24, 25, 29
Phenomenology, 27
Pilot Performance, 21
Pilotless Aircraft, 14, 31
Pistons, 22
Plant Design, 21
Plasma Layers, 36
Plasmas (physics), 36
Plastic Properties, 29
Plumes, 25
Pollution Control, 18, 33
Pollution Monitoring, 18

Polynomials, 9
Potential Flow, 8, 9
Pressure Distribution, 7, 9
Pressure Gages, 5
Pressure Measurement, 18
Pressure Sensors, 29
Pressurized Cabins, 35
Probability Theory, 27
Procedures, 23
Product Development, 6
Production Engineering, 15
Program Verification (computers), 19, 34
Propeller Blades, 15
Propulsion, 1, 13, 14
Propulsion System Configurations, 30
Proving, 20

Q

Quality Control, 23
Quantitative Analysis, 18

R

Radar Antennas, 29
Radar Approach Control, 25
Radar Beacons, 25
Radar Cross Sections, 26
Radar Reflectors, 29
Radar Tracking, 25, 29
Radomes, 29
Ramjet Engines, 25
Rangefinding, 36
Real Time Operation, 13, 16, 32
Rectangular Panels, 32
Remotely Piloted Vehicles, 13
Research Aircraft, 19
Research Projects, 37
Research Vehicles, 19
Residual Strength, 16, 30, 31
Residual Stress, 28
Resistance Heating, 28
Reynolds Number, 5
Rigid Structures, 16
Riveted Joints, 16
Roller Bearings, 21
Rotary Wing Aircraft, 6, 11
Rotary Wings, 4, 5, 6, 10, 20
Rotating Disks, 27
Rotor Aerodynamics, 4
Rotor Blades, 6
Rotor Blades (turbomachinery), 27
Rotor Dynamics, 27
Rotors, 6, 27
Rubber, 17
Runways, 25

S

Safety, 11
Scale Models, 8, 10, 18, 21
Scene Analysis, 35
Schools, 20
Search Radar, 25
Secondary Flow, 22, 26
Security, 10
Selection, 8
Semispan Models, 5, 6, 7
Sensitivity, 36
Separated Flow, 26, 32
Shells (structural Forms), 15
Ships, 16
Shock Tubes, 3, 22
Shock Tunnels, 3, 8, 18
Shock Wave Interaction, 26, 27
Skin (structural Member), 29
Skin Friction, 3
Slender Cones, 31
Slush Hydrogen, 30
Software Development Tools, 2, 3
Software Engineering, 2, 3, 13, 16
Solar Arrays, 31
Solar Cells, 31
Sonic Booms, 4
Sound Pressure, 4
Spacecraft Design, 7
Stability Augmentation, 13, 34
Static Pressure, 18
Stationkeeping, 12
Steady State, 8
Strakes, 19
Stress Waves, 3, 8, 18
Stressed-skin Structures, 17
Stringers, 16
Structural Analysis, 30
Structural Design, 15, 17, 35
Structural Engineering, 32
Structural Vibration, 23, 27
Subsonic Flow, 9
Subsonic Flutter, 20
Subsonic Speed, 7, 17
Suction, 9, 27
Supersonic Combustion, 3, 18, 30
Supersonic Combustion Ramjet Engines, 3, 18
Supersonic Flow, 22
Supersonic Inlets, 26
Supersonic Nozzles, 22
Supersonic Speed, 25, 30
Supersonic Transports, 4, 23, 24
Supersonic Wind Tunnelsab, 22
Surface Layers, 27
Surface Roughness, 26
Surface Water, 26
Surveillance Radar, 29
Surveys, 10, 11, 20
Swept Wings, 22
Synthetic Fuels, 31
System Identification, 2, 3
Systems Analysis, 11, 12
Systems Engineering, 19, 34
Systems Integration, 13, 29

T

Tanker Aircraft, 2
Technological Forecasting, 12, 28, 32
Technology Assessment, 9, 12, 15, 28, 32
Technology Transfer, 34
Technology Utilization, 18
Tensile Tests, 29
Test Chambers, 23
Test Facilities, 8, 21
Test Vehicles, 10
Theorems, 4
Thermal Cycling Tests, 23
Thermal Fatigue, 23, 24
Thrust Loads, 8, 18
Thrust Measurement, 3, 8
Tilt Rotor Aircraft, 15
Tilting Rotorsa., 15
Time Dependence, 26, 36
Titanium Alloys, 24, 28
Tollmien-schlichting Waves, 26
Transient Response, 19
Transonic Flow, 6
Transonic Speed, 6
Transonic Wind Tunnels, 6
Transport Aircraft, 2, 15, 17, 23
Transportation Energy, 32
Turbine Blades, 29, 32
Turbocompressors, 29
Turbojet Engines, 25
Turbulence, 26
Turbulence Effects, 27
Turbulence Models, 32
Turbulent Boundary Layer, 27, 31
Turbulent Flow, 27, 30
Turbulent Mixing, 30
Turning Flight, 21
Two Dimensional Boundary Layer, 9

Two Dimensional Flow, 27
Two Dimensional Models, 32

U

United States, 12
Unix (operating System), 16
Unsteady Aerodynamics, 6, 8, 32
Unsteady Flow, 6, 9, 35
Unstructured Grids (mathematics), 35
Unswept Wings, 7
User Manuals (computer Programs), 17, 35

V

V-22 Aircraft, 20
Vapor Deposition, 24
Velocity Distribution, 8
Velocity Measurement, 8
Vibration, 6, 14, 20
Vibration Damping, 20
Viscous Flow, 35
Vortex Generators, 27
Vortices, 4, 5, 6, 36
Vorticity, 8

W

Wakes, 6, 36
Wall Flow, 27
Weather Forecasting, 24
Wind Tunnel Apparatus, 22
Wind Tunnel Models, 5
Wind Tunnel Tests, 4, 5, 6, 7, 8, 18, 31
Wind Tunnels, 6
Wind Turbines, 32
Wind Velocity, 26
Wing Loading, 6, 20
Wings, 4, 17

Personal Author Index

A

Aceves, R. C., 31
Allen, Mark R., 24
Allen-Lilly, Heather, 23
Anderson, David J., 4
Anklam, T. M., 24
Applin, Zachary T., 7
Azene, M., 27

B

Bagley, Daniel T., 12
Bajaj, A. K., 27
Baker, Leonard H., 28
Belanger, Jacques Jean, 30
Berzins, L. V., 24
Bischof, C. H., 34
Blair, Max, 7
Bland, Samuel R., 8
Blanford, Mark, 28
Bloyd, C. N., 32
Bodson, Marc, 19
Boulet, C., 4
Breeman, J. H., 2, 3
Brooks, Thomas F., 6
Bruskotter, Michael J., 28
Bryner, N. P., 9
Buchholz, Heino, 3

C

Camps, Octavia, 35
Carey, P. G., 31
Carle, A., 34
Carlsen, Jeffrey H., 19
Carnes, Benny L., 36
Chaffin, Mark S., 5
Chang, Ing, 25
Chattopadhyay, Aditi, 4, 7, 14
Chokani, Ndaona, 5
Clark, Trevor M., 12
Cockburn, J. A., 21
Colella, N. J., 31
Costerus, B. W., 14
Cowles, Jr., John H., 28
Cregger, Eric, 23
Csavina, Kristine R., 22
Cunningham, Jr., Atlee M., 6

D

Davis, Thomas J., 13
Denboer, Ruud G., 6
Denham, Liebler J., 20
Desmarais, Robert N., 8
Devadiga, Sadashiva, 35
Dewit, Roland, 29
Diviney, William, 24
Dogger, C. S., 6
Doolan, Con, 22
Duffey, R. B., 25
Dunn, S. A., 20
Dutta, Sunil, 1

E

Engelbeck, R. M., 15

F

Farrell, P. A., 20
Fields, Richard J., 29
Foecke, Tim, 29
Fokkerweg, Anthony, 2
Fujii, Keisuke, 7

G

Gallman, Judith M., 3, 6, 36
Gamerdinger, Peter M., 27
Gandhi, Tarak, 35
Germain, Patrick, 30
Geurts, E. G., 6
Giamei, Anthony F., 28
Glenn, G. S., 31
Gmurczyk, G., 11
Gopalaswamy, N., 11
Griffin, Thomas A., 22
Grosshandler, W. L., 11
Guthlein, Peter, 24

H

Hamed, Awatef, 26
Harne, Donald E., 29
Harris, Charles E., 29
Hartmann, J.-M., 4
Heerschap, M. E., 35
Hendricks, Robert C., 22
Henrion, M., 32
Hoffman, Daniel, 23
Hogan, W. J., 21
Holleman, E., 23
Hughes, E. D., 25
Hunter, Louis G., 25

I

Inouye, Yasutoshi, 7
Ishimoto, Shinji, 7
Ito, Takeshi, 7

J

Jameson, Antony, 16
Johnsson, E. L., 9

K

Kai, Takashi, 7
Kasturi, Rangachar, 35
Kataras, Dimitris E., 12
Kaufmann, David N., 9
Khademi, P. M., 34
Kittrell, J. R., 31
Kline, Teresa R., 22
Kolwey, Herman G., 10
Kompenhans, J., 8
Kube, Roland, 6

L

Lake, Robert E., 5
Lambert, Heather H., 4
Larsson, C., 26
Lee, C. L., 14
Lee, Katharine K., 13
Livings, Jeffrey, 24
Logue, Thomas V., 15
Losi, Peter C., 15
Low, III, Samuel R., 29
Low, Scott L., 36
Lowdermilk, W. H., 21
Lyon, Richard K., 17

M

Ma, Q., 4

Marnicio, R. J., 32
Martinez, Radame, 24
Matthews, Timothy S., 23
Mavriplis, D. J., 35
McCarthy, Thomas R., 14
McClelland, M. A., 24
McCool, Jim, 23
McCroskey, W. J., 6
McGuire, Robert J., 15
McNally, B. David, 9
Mee, D. J., 8, 18
Meng, J. C., 26
Messina, Michael D., 18, 19
Milholen, II, William E., 5
Mitman, Robert, 10
Mizukami, Masashi, 4
Morgan, David J., 12
Morgan, John C., 36
Mulder, J. A., 2, 3
Muller, Mark, 22
Murthy, S. N. B., 11

N

Narayan, Johnny R., 4
Neumeier, Mark, 10
Newman, Jr., James C., 29
Norlin, Ken A., 16
Nwokah, O. D., 27

O

Odisho, II, Edwin V., 12

P

Pagaldipti, Narayanan, 4
Pagaldipti, Narayanan S., 7
Paisner, J. A., 21
Pancholi, Arvind, 22
Paull, A., 8, 18
Person, Jr., Lee H., 20
Phillips, Michael R., 20
Pitts, W. M., 9
Porcello, John, 24
Pusch, G., 34

R

Raffel, M., 8
Rahier, Gilles, 6
Raney, David L., 20
Rao, Prashant Sadananda, 9
Reed, Helen L., 26
Rehmann, Albert, 10
Reinhardt, Robert J., 15
Renfrow, J., 20
Repperger, Daniel W., 21
Retel, A. P., 6
Reuther, James, 16
Reynolds, Michael, 10
Robertson, M. M., 1
Rogers, James L., 34
Rosenfeld, Azriel, 12
Roth, J. R., 36
Russler, Patrick M., 29

S

Safonov, Michael G., 33
Schaefer, H. J., 8
Schijve, J., 29, 31
Schilder, H. F., 17
Schultz, Klaus J., 3
Sedgwick, Harold G., 28
Shirouzu, Masao, 7
Shouji, Hirokazu, 7
Simmons, J. M., 8
Sinton, R. A., 31
Sood, Devendra, 22
Spillman, Mark Stephan, 19
Splettstoesser, Wolf, 3
Sridhar, J. K., 2, 3
Srivas, Mandayam, 34
Stalker, R. J., 8, 18
Stallings, D. W., 5
Starnes, Jr., James H., 29
Stretcher, Baxter, 24
Swingle, Timothy R., 11, 12

T

Takaki, Ryouji, 7
Takizawa, Minoru, 7
Tang, Yuan-Liang, 35
Taylor, J. C., 1
Tel-Or, A., 16
Tipping, R. H., 4
Torenbeek, Egbert, 17
Tung, Chee, 3, 6, 36
Tuttle, S. L., 8

V

Vanrijn, L. P. v. M., 15
Vanwimersmagreidanus, B., 16
Vasek, A., 31
Venkatakrishnan, V., 35
Vlot, A., 16
Vu, John W., 15
Vu, Tong V., 15

W

Weg, Anthony Fokker, 3
Wei, Bin, 27
Wensheng, XU, 4
Wernert, P., 8
Wesenberg, Alan, 32
White, III, Andrew B., 12
Williams, K. A., 31
Wittlin, Gil, 22
Woehrle, T. G., 14
Wolf, Stephen W. D., 21

Y

Yamamoto, Yukimitsu, 7

Z

Zaal, K. J. j. M., 16

Availability of Cited Publications

Open Literature Entries (A96-60000 Series)

Inquiries and requests should be addressed to:

NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090-2934.

Orders are also taken by telephone, (301) 621-0390, e-mail, help@sti.nasa.gov, and fax, (301) 621-0134. Please refer to the accession number when requesting publications.

STAR Entries (N96-10000 Series)

One or more sources from which a document announced in *STAR* is available to the public is ordinarily given on the last line of the citation. The most commonly indicated sources and their acronyms or abbreviations are listed below, and their addresses are listed on page APP-3. If the publication is available from a source other than those listed, the publisher and his address will be displayed on the availability line or in combination with the corporate source line.

Avail: NASA CASI. Sold by the NASA Center for AeroSpace Information. Prices for hard copy (HC) and microfiche (MF) are indicated by a price code following the letters HC or MF in the *STAR* citation. Current values for the price codes are given in the tables on page APP-5.

Note on Ordering Documents: When ordering publications from NASA CASI, use the N accession number or other report number. It is also advisable to cite the title and other bibliographic identification.

Avail: SOD (or GPO). Sold by the Superintendent of Documents, U.S. Government Printing Office, in hard copy.

Avail: BLL (formerly NLL): British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England. Photocopies available from this organization at the price shown. (If none is given, inquiry should be addressed to the BLL.)

Avail: DOE Depository Libraries. Organizations in U.S. cities and abroad that maintain collections of Department of Energy reports, usually in microfiche form, are listed in Energy Research Abstracts. Services available from the DOE and its depositories are described in a booklet, *DOE Technical Information Center—Its Functions and Services* (TID-4660), which may be obtained without charge from the DOE Technical Information Center.

Avail: ESDU. Pricing information on specific data, computer programs, and details on Engineering Sciences Data Unit (ESDU) topic categories can be obtained from ESDU International Ltd. Requesters in North America should use the Virginia address while all other requesters should use the London address, both of which are on page APP-3.

Avail: Fachinformationszentrum Karlsruhe. Gesellschaft für wissenschaftlich-technische Information mbH 76344 Eggenstein-Leopoldshafen, Germany.

Avail: HMSO. Publications of Her Majesty's Stationery Office are sold in the U.S. by Pendragon House, Inc. (PHI), Redwood City, CA. The U.S. price (including a service and mailing charge) is given, or a conversion table may be obtained from PHI.

Avail: Issuing Activity, or Corporate Author, or no indication of availability. Inquiries as to the availability of these documents should be addressed to the organization shown in the citation as the corporate author of the document.

Avail: NASA Public Document Rooms. Documents so indicated may be examined at or purchased from the National Aeronautics and Space Administration (JBD-4), Public Documents Room (Room 1H23), Washington, DC 20546-0001, or public document rooms located at NASA installations, and the NASA Pasadena Office at the Jet Propulsion Laboratory.

Avail: NTIS. Sold by the National Technical Information Service. Initially distributed microfiche under the NTIS SRIM (Selected Research in Microfiche) are available. For information concerning this service, consult the NTIS Subscription Section, Springfield, VA 22161.

Avail: Univ. Microfilms. Documents so indicated are dissertations selected from Dissertation Abstracts and are sold by University Microfilms as xerographic copy (HC) and microfilm. All requests should cite the author and the Order Number as they appear in the citation.

Avail: US Patent and Trademark Office. Sold by Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, at the standard price of $1.50 each, postage free.

Avail: (US Sales Only). These foreign documents are available to users within the United States from the National Technical Information Service (NTIS). They are available to users outside the United States through the International Nuclear Information Service (INlS) representative in their country, or by applying directly to the issuing organization.

Avail: USGS. Originals of many reports from the U.S. Geological Survey, which may contain color illustrations, or otherwise may not have the quality of illustrations preserved in the microfiche or facsimile reproduction, may be examined by the public at the libraries of the USGS field offices whose addresses are listed on page APP-3. The libraries may be queried concerning the availability of specific documents and the possible utilization of local copying services, such as color reproduction.

Federal Depository Library Program

In order to provide the general public with greater access to U.S. Government publications, Congress established the Federal Depository Library Program under the Government Printing Office (GPO), with 53 regional depositories responsible for permanent retention of material, inter-library loan, and reference services. At least one copy of nearly every NASA and NASA-sponsored publication, either in printed or microfiche format, is received and retained by the 53 regional depositories. A list of the regional GPO libraries, arranged alphabetically by state, appears on the inside back cover of this issue. These libraries are not sales outlets. A local library can contact a regional depository to help locate specific reports, or direct contact may be made by an individual.

Public Collection of NASA Documents

An extensive collection of NASA and NASA-sponsored publications is maintained by the British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England for public access. The British Library Lending Division also has available many of the non-NASA publications cited in *STAR*. European requesters may purchase facsimile copy or microfiche of NASA and NASA-sponsored documents, those identified by both the symbols # and * from FIZ—Fachinformation Karlsruhe—Bibliographic Service, D-76344 Eggenstein-Leopoldshafen, Germany and TIB—Technische Informationsbibliothek, P.O. Box 60 80, D-30080 Hannover, Germany.

Addresses of Organizations

British Library Lending Division
Boston Spa, Wetherby, Yorkshire
England

Commissioner of Patents and Trademarks
U.S. Patent and Trademark Office
Washington, DC 20231

Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

European Space Agency–
Information Retrieval Service ESRIN
Via Galileo Galilei
00044 Frascati (Rome) Italy

Engineering Sciences Data Unit International
P.O. Box 1633
Manassas, VA 22110

Engineering Sciences Data Unit
International, Ltd.
251–259 Regent Street
London, W1R 7AD, England

Fachinformationszentrum Karlsruhe
Gesellschaft für wissenschaftlich–technische
Information mbH
76344 Eggenstein–Leopoldshafen, Germany

Her Majesty's Stationery Office
P.O. Box 569, S.E. 1
London, England

NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090–2934

National Aeronautics and Space Administration
Scientific and Technical Information Office
(Code JT)
Washington, DC 20546–0001

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

Pendragon House, Inc.
899 Broadway Avenue
Redwood City, CA 94063

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

University Microfilms
A Xerox Company
300 North Zeeb Road
Ann Arbor, MI 48106

University Microfilms, Ltd.
Tylers Green
London, England

U.S. Geological Survey Library National Center
MS 950
12201 Sunrise Valley Drive
Reston, VA 22092

U.S. Geological Survey Library
2255 North Gemini Drive
Flagstaff, AZ 86001

U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

U.S. Geological Survey Library
Box 25046
Denver Federal Center, MS914
Denver, CO 80225

NASA CASI Price Code Table

(Effective January 1, 1995)

CASI PRICE CODE	NORTH AMERICAN PRICE	FOREIGN PRICE
A01	$ 6.00	$ 12.00
A02	9.00	18.00
A03	17.50	35.00
A04–A05	19.50	39.00
A06–A09	27.00	54.00
A10–A13	36.50	73.00
A14–A17	44.50	89.00
A18–A21	52.00	104.00
A22–A25	61.00	122.00
A99	Call For Price	Call For Price

Important Notice

For users not registered at the NASA CASI, prepayment is required. Additionally, a shipping and handling fee of $1.00 per document for delivery within the United States and $9.00 per document for delivery outside the United States is charged.

For users registered at the NASA CASI, document orders may be invoiced at the end of the month, charged against a deposit account, or paid by check or credit card. NASA CASI accepts American Express, Diners' Club, MasterCard, and VISA credit cards. There are no shipping and handling charges. To register at the NASA CASI, please request a registration form through the NASA Access Help Desk at the numbers or addresses below.

Return Policy

Effective June 1, 1995, the NASA Center for AeroSpace Information will gladly replace or make full refund on items you have requested if we have made an error in your order, if the item is defective, or if it was received in damaged condition and you contact us within 30 days of your original request. Just contact our NASA Access Help Desk at the numbers or addresses listed below.

NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090-2934
Telephone: (301) 621-0390
E-mail: help@sti.nasa.gov
Fax: (301) 621-0134

Rev. 5/95

Report Documentation Page

1. Report No. NASA SP-7037 (326)	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Aeronautical Engineering A Continuing Bibliography (Supplement 326)		5. Report Date January 1996 6. Performing Organization Code JT
7. Author(s)		8. Performing Organization Report No. 10. Work Unit No.
9. Performing Organization Name and Address NASA Scientific and Technical Information Office		11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546-0001		13. Type of Report and Period Covered Special Publication 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report lists 120 reports, articles and other documents recently announced in the NASA STI Database.

17. Key Words (Suggested by Author(s)) Aeronautical Engineering Aeronautics Bibliographies		18. Distribution Statement Unclassified – Unlimited Subject Category – 01	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 60	22. Price A04/HC

For sale by the NASA Center for AeroSpace Information, 800 Elkridge Landing Road, Linthicum Heights, MD 21090-2934

Federal Regional Depository Libraries

ALABAMA
AUBURN UNIV. AT MONTGOMERY LIBRARY
Documents Dept.
7300 University Dr.
Montgomery, AL 36117–3596
(205) 244–3650 Fax: (205) 244–0678

UNIV. OF ALABAMA
Amelia Gayle Gorgas Library
Govt. Documents
P.O. Box 870266
Tuscaloosa, AL 35487–0266
(205) 348–6046 Fax: (205) 348–0760

ARIZONA
DEPT. OF LIBRARY, ARCHIVES, AND PUBLIC RECORDS
Research Division
Third Floor, State Capitol
1700 West Washington
Phoenix, AZ 85007
(602) 542–3701 Fax: (602) 542–4400

ARKANSAS
ARKANSAS STATE LIBRARY
State Library Service Section
Documents Service Section
One Capitol Mall
Little Rock, AR 72201–1014
(501) 682–2053 Fax: (501) 682–1529

CALIFORNIA
CALIFORNIA STATE LIBRARY
Govt. Publications Section
P.O. Box 942837 – 914 Capitol Mall
Sacramento, CA 94337–0091
(916) 654–0069 Fax: (916) 654–0241

COLORADO
UNIV. OF COLORADO – BOULDER
Libraries – Govt. Publications
Campus Box 184
Boulder, CO 80309–0184
(303) 492–8834 Fax: (303) 492–1881

DENVER PUBLIC LIBRARY
Govt. Publications Dept. BSG
1357 Broadway
Denver, CO 80203–2165
(303) 640–8846 Fax: (303) 640–8817

CONNECTICUT
CONNECTICUT STATE LIBRARY
231 Capitol Avenue
Hartford, CT 06106
(203) 566–4971 Fax: (203) 566–3322

FLORIDA
UNIV. OF FLORIDA LIBRARIES
Documents Dept.
240 Library West
Gainesville, FL 32611–2048
(904) 392–0366 Fax: (904) 392–7251

GEORGIA
UNIV. OF GEORGIA LIBRARIES
Govt. Documents Dept.
Jackson Street
Athens, GA 30602–1645
(706) 542–8949 Fax: (706) 542–4144

HAWAII
UNIV. OF HAWAII
Hamilton Library
Govt. Documents Collection
2550 The Mall
Honolulu, HI 96822
(808) 948–8230 Fax: (808) 956–5968

IDAHO
UNIV. OF IDAHO LIBRARY
Documents Section
Rayburn Street
Moscow, ID 83844–2353
(208) 885–6344 Fax: (208) 885–6817

ILLINOIS
ILLINOIS STATE LIBRARY
Federal Documents Dept.
300 South Second Street
Springfield, IL 62701–1796
(217) 782–7596 Fax: (217) 782–6437

INDIANA
INDIANA STATE LIBRARY
Serials/Documents Section
140 North Senate Avenue
Indianapolis, IN 46204–2296
(317) 232–3679 Fax: (317) 232–3728

IOWA
UNIV. OF IOWA LIBRARIES
Govt. Publications
Washington & Madison Streets
Iowa City, IA 52242–1166
(319) 335–5926 Fax: (319) 335–5900

KANSAS
UNIV. OF KANSAS
Govt. Documents & Maps Library
6001 Malott Hall
Lawrence, KS 66045–2800
(913) 864–4660 Fax: (913) 864–3855

KENTUCKY
UNIV. OF KENTUCKY
King Library South
Govt. Publications/Maps Dept.
Patterson Drive
Lexington, KY 40506–0039
(606) 257–3139 Fax: (606) 257–3139

LOUISIANA
LOUISIANA STATE UNIV.
Middleton Library
Govt. Documents Dept.
Baton Rouge, LA 70803–3312
(504) 388–2570 Fax: (504) 388–6992

LOUISIANA TECHNICAL UNIV.
Prescott Memorial Library
Govt. Documents Dept.
Ruston, LA 71272–0046
(318) 257–4962 Fax: (318) 257–2447

MAINE
UNIV. OF MAINE
Raymond H. Fogler Library
Govt. Documents Dept.
Orono, ME 04469–5729
(207) 581–1673 Fax: (207) 581–1653

MARYLAND
UNIV. OF MARYLAND – COLLEGE PARK
McKeldin Library
Govt. Documents/Maps Unit
College Park, MD 20742
(301) 405–9165 Fax: (301) 314–9416

MASSACHUSETTS
BOSTON PUBLIC LIBRARY
Govt. Documents
666 Boylston Street
Boston, MA 02117–0286
(617) 536–5400, ext. 226
Fax: (617) 536–7758

MICHIGAN
DETROIT PUBLIC LIBRARY
5201 Woodward Avenue
Detroit, MI 48202–4093
(313) 833–1025 Fax: (313) 833–0156

LIBRARY OF MICHIGAN
Govt. Documents Unit
P.O. Box 30007
717 West Allegan Street
Lansing, MI 48909
(517) 373–1300 Fax: (517) 373–3381

MINNESOTA
UNIV. OF MINNESOTA
Govt. Publications
409 Wilson Library
309 19th Avenue South
Minneapolis, MN 55455
(612) 624–5073 Fax: (612) 626–9353

MISSISSIPPI
UNIV. OF MISSISSIPPI
J.D. Williams Library
106 Old Gym Bldg.
University, MS 38677
(601) 232–5857 Fax: (601) 232–7465

MISSOURI
UNIV. OF MISSOURI – COLUMBIA
106B Ellis Library
Govt. Documents Sect.
Columbia, MO 65201–5149
(314) 882–6733 Fax: (314) 882–8044

MONTANA
UNIV. OF MONTANA
Mansfield Library
Documents Division
Missoula, MT 59812–1195
(406) 243–6700 Fax: (406) 243–2060

NEBRASKA
UNIV. OF NEBRASKA – LINCOLN
D.L. Love Memorial Library
Lincoln, NE 68588–0410
(402) 472–2562 Fax: (402) 472–5131

NEVADA
THE UNIV. OF NEVADA LIBRARIES
Business and Govt. Information Center
Reno, NV 89557–0044
(702) 784–6579 Fax: (702) 784–1751

NEW JERSEY
NEWARK PUBLIC LIBRARY
Science Div. – Public Access
P.O. Box 630
Five Washington Street
Newark, NJ 07101–7812
(201) 733–7782 Fax: (201) 733–5648

NEW MEXICO
UNIV. OF NEW MEXICO
General Library
Govt. Information Dept.
Albuquerque, NM 87131–1466
(505) 277–5441 Fax: (505) 277–6019

NEW MEXICO STATE LIBRARY
325 Don Gaspar Avenue
Santa Fe, NM 87503
(505) 827–3824 Fax: (505) 827–3888

NEW YORK
NEW YORK STATE LIBRARY
Cultural Education Center
Documents/Gift & Exchange Section
Empire State Plaza
Albany, NY 12230–0001
(518) 474–5355 Fax: (518) 474–5786

NORTH CAROLINA
UNIV. OF NORTH CAROLINA – CHAPEL HILL
Walter Royal Davis Library
CB 3912, Reference Dept.
Chapel Hill, NC 27514–8890
(919) 962–1151 Fax: (919) 962–4451

NORTH DAKOTA
NORTH DAKOTA STATE UNIV. LIB.
Documents
P.O. Box 5599
Fargo, ND 58105–5599
(701) 237–8886 Fax: (701) 237–7138

UNIV. OF NORTH DAKOTA
Chester Fritz Library
University Station
P.O. Box 9000 – Centennial and University Avenue
Grand Forks, ND 58202–9000
(701) 777–4632 Fax: (701) 777–3319

OHIO
STATE LIBRARY OF OHIO
Documents Dept.
65 South Front Street
Columbus, OH 43215–4163
(614) 644–7051 Fax: (614) 752–9178

OKLAHOMA
OKLAHOMA DEPT. OF LIBRARIES
U.S. Govt. Information Division
200 Northeast 18th Street
Oklahoma City, OK 73105–3298
(405) 521–2502, ext. 253
Fax: (405) 525–7804

OKLAHOMA STATE UNIV.
Edmon Low Library
Stillwater, OK 74078–0375
(405) 744–6546 Fax: (405) 744–5183

OREGON
PORTLAND STATE UNIV.
Branford P. Millar Library
934 Southwest Harrison
Portland, OR 97207–1151
(503) 725–4123 Fax: (503) 725–4524

PENNSYLVANIA
STATE LIBRARY OF PENN.
Govt. Publications Section
116 Walnut & Commonwealth Ave.
Harrisburg, PA 17105–1601
(717) 787–3752 Fax: (717) 783–2070

SOUTH CAROLINA
CLEMSON UNIV.
Robert Muldrow Cooper Library
Public Documents Unit
P.O. Box 343001
Clemson, SC 29634–3001
(803) 656–5174 Fax: (803) 656–3025

UNIV. OF SOUTH CAROLINA
Thomas Cooper Library
Green and Sumter Streets
Columbia, SC 29208
(803) 777–4841 Fax: (803) 777–9503

TENNESSEE
UNIV. OF MEMPHIS LIBRARIES
Govt. Publications Dept.
Memphis, TN 38152–0001
(901) 678–2206 Fax: (901) 678–2511

TEXAS
TEXAS STATE LIBRARY
United States Documents
P.O. Box 12927 – 1201 Brazos
Austin, TX 78701–0001
(512) 463–5455 Fax: (512) 463–5436

TEXAS TECH. UNIV. LIBRARIES
Documents Dept.
Lubbock, TX 79409–0002
(806) 742–2282 Fax: (806) 742–1920

UTAH
UTAH STATE UNIV.
Merrill Library Documents Dept.
Logan, UT 84322–3000
(801) 797–2678 Fax: (801) 797–2677

VIRGINIA
UNIV. OF VIRGINIA
Alderman Library
Govt. Documents
University Ave. & McCormick Rd.
Charlottesville, VA 22903–2498
(804) 824–3133 Fax: (804) 924–4337

WASHINGTON
WASHINGTON STATE LIBRARY
Govt. Publications
P.O. Box 42478
16th and Water Streets
Olympia, WA 98504–2478
(206) 753–4027 Fax: (206) 586–7575

WEST VIRGINIA
WEST VIRGINIA UNIV. LIBRARY
Govt. Documents Section
P.O. Box 6069 – 1549 University Ave.
Morgantown, WV 26506–6069
(304) 293–3051 Fax: (304) 293–6638

WISCONSIN
ST. HIST. SOC. OF WISCONSIN LIBRARY
Govt. Publication Section
816 State Street
Madison, WI 53706
(608) 264–6525 Fax: (608) 264–6520

MILWAUKEE PUBLIC LIBRARY
Documents Division
814 West Wisconsin Avenue
Milwaukee, WI 53233
(414) 286–3073 Fax: (414) 286–8074

The New NASA Video Catalog is Here

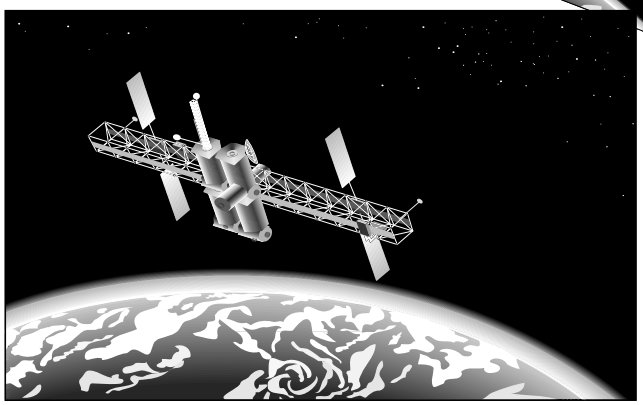
Internet

Access Available

http://www.sti.nasa.gov/STI-homepage.html

Now!

(Select STI Program Publications)



Free!

To order your free copy, call
the NASA Access Help Desk
at (301) 621-0390,
fax to (301) 621-0134, or
e-mail to help@sti.nasa.gov

EXPLORE THE UNIVERSE

This publication was prepared by the NASA Center for AeroSpace Information,
800 Elkridge Landing Road, Linthicum Heights, MD 21090-2934, (301) 621-0390.