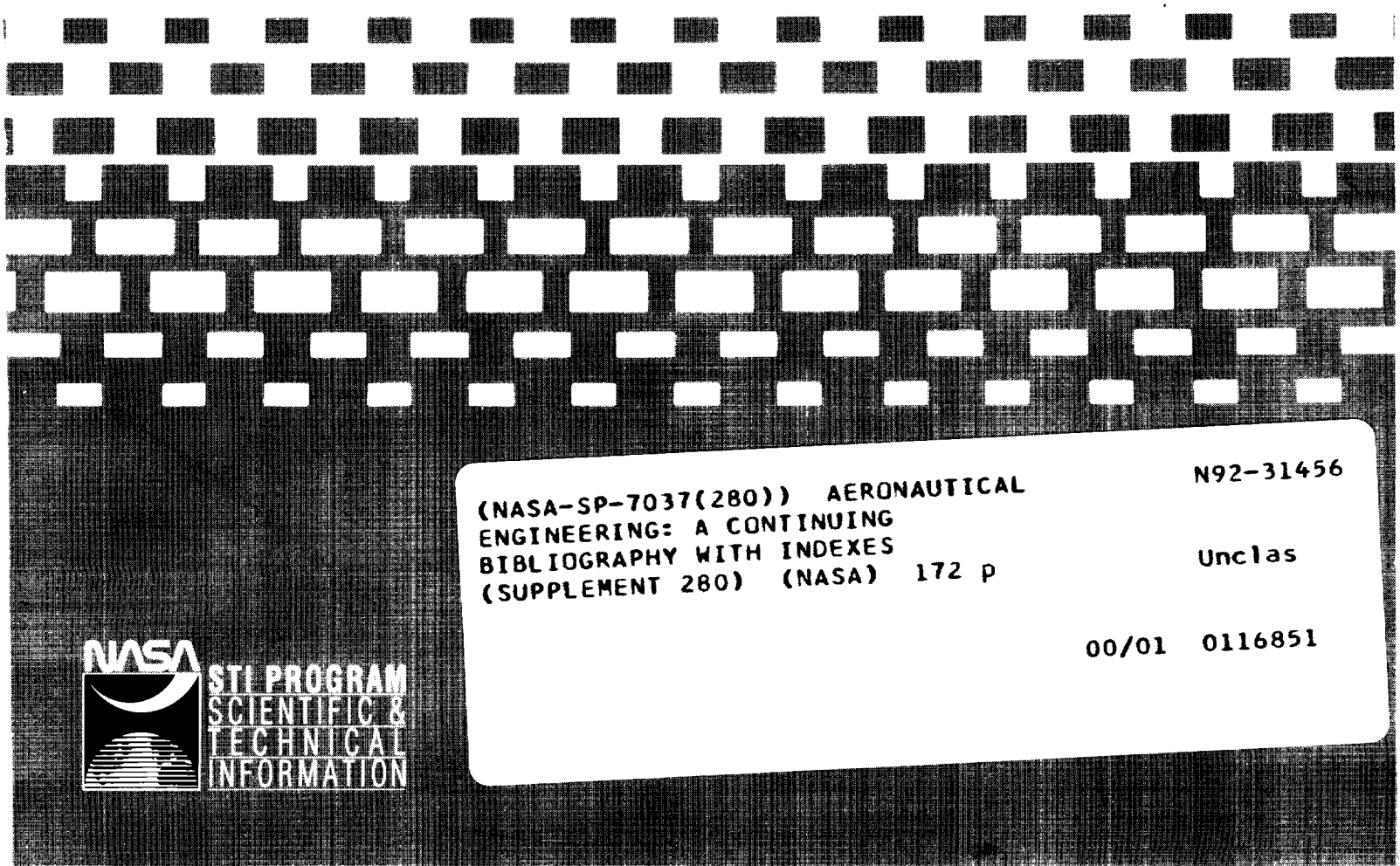
NASA SP-7037 (280)
July 1992

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES



(NASA-SP-7037(280)) AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 280) (NASA) 172 p

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NASA SP-7037 (280)
July 1992

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
Scientific and Technical Information Program
Washington, DC 1992

INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 647 reports, journal articles, and other documents originally announced in June 1992 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

Accession numbers cited in this issue are:

STAR (N-10000 Series)	N92-20046 — N92-22095
IAA (A-10000 Series)	A92-28555 — A92-32534

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

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

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

A cumulative index for 1992 will be published in early 1993.

Information on availability of documents listed, addresses of organizations, and NTIS price schedules are located at the back of this issue.

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Category 11 Chemistry and Materials 487
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Category 12 Engineering 490
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Category 13 Geosciences 504
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Category 14 Life Sciences N.A.
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Category 15 Mathematical and Computer Sciences 506
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.

Category 16 Physics 510
Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

Category 17 Social Sciences 513
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.

Category 18 Space Sciences N.A.
Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

Category 19 General N.A.

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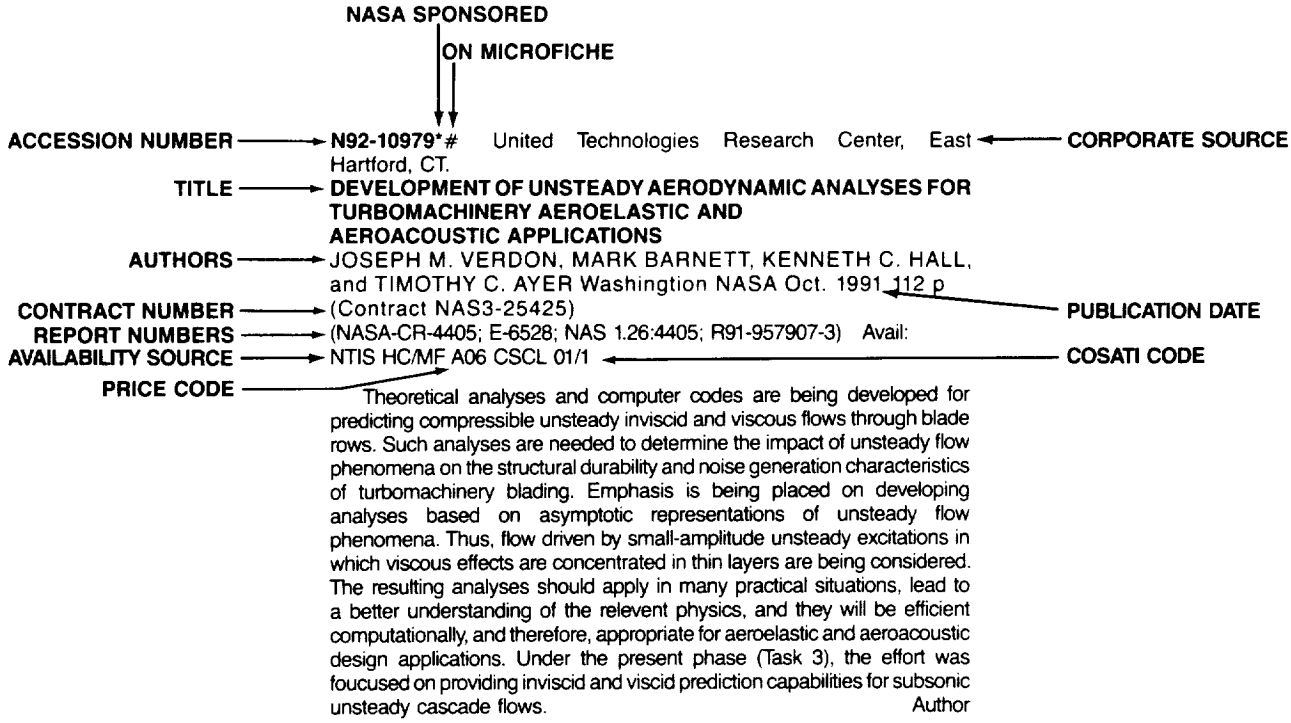
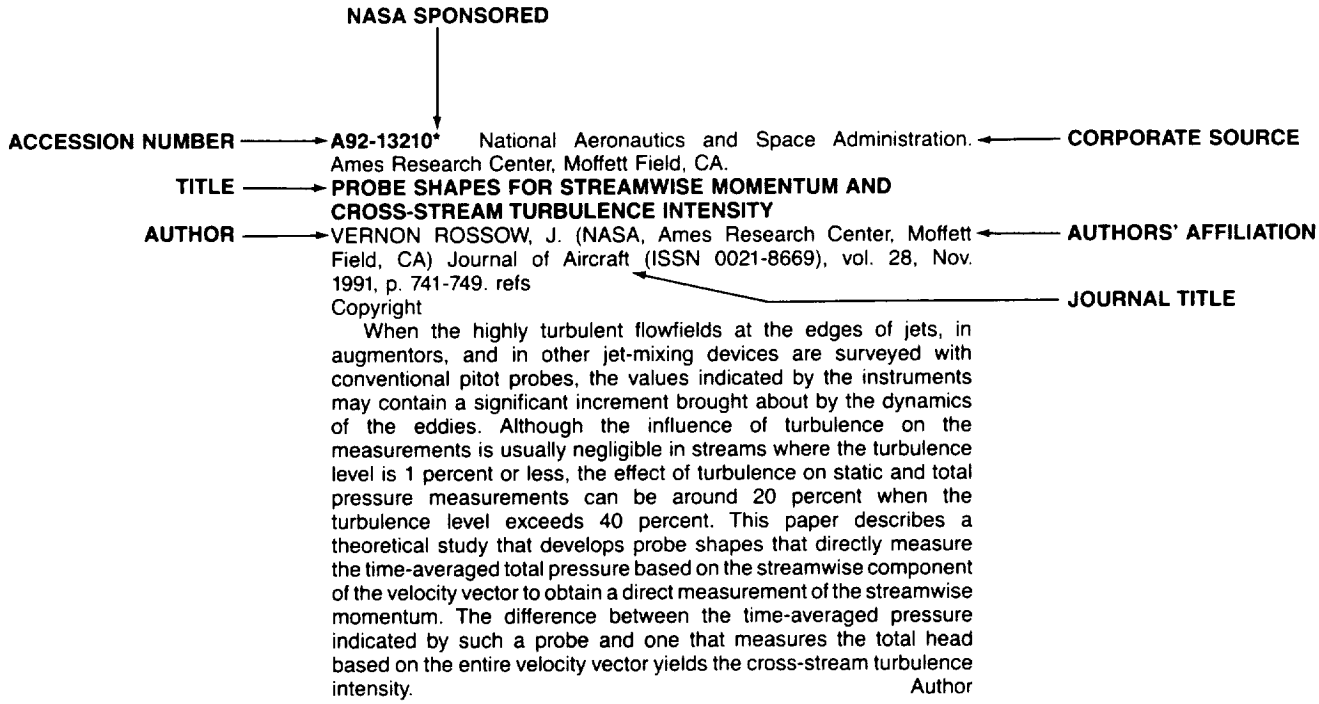
TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 280)

July 1992

01

AERONAUTICS (GENERAL)

A92-28941
36TH ROY CHADWICK LECTURE - MANUFACTURING BREAKOUT 1941-1991: DEVELOPMENT IN AEROSPACE INDUSTRY MANUFACTURING TECHNIQUES
P. H. SUMMERFIELD (British Aerospace, PLC, Woodford, England) Aeronautical Journal (ISSN 0001-9240), vol. 96, Feb. 1992, p. 35-46. refs
Copyright

A development history is presented for the refinement of design-to-manufacture aircraft production management, over the course of a half century that was initiated by the efforts of the Avro Lancaster bomber's development. Many recent concepts of design-for-manufacture were presciently identified by Davies (1939) in time for incorporation into Lancaster production management. An evaluation is made of subsequent progress and of the prospective economies derivable from more aggressive implementation of (1) statistical quality control, (2) time as the unit for cost-accounting, (3) modular organization of manufacturing processes, and (4) a systems approach to management. O.C.

A92-29673* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTEGRATED MULTIDISCIPLINARY ROTORCRAFT OPTIMIZATION RESEARCH AT THE NASA LANGLEY RESEARCH CENTER
HOWARD M. ADELMAN (NASA, Langley Research Center, Hampton, VA), WAYNE R. MANTAY (U.S. Army, Aviation Systems Command, Saint Louis, MO), JOANNE L. WALSH (NASA, Langley Research Center, Hampton, VA), and JOCELYN I. PRITCHARD (NASA, Langley Research Center; U.S. Army, Aerostructures Directorate, Hampton, VA) Vertiflite (ISSN 0042-4455), vol. 38, Mar.-Apr. 1992, p. 45-52. refs
Copyright

NASA-Langley and U.S. Army researchers have developed optimization procedures for improving helicopter rotor blade design processes through more extensive integration of the requisite disciplines. These disciplines encompass rotor aerodynamics, rotor dynamics, rotor structures, airframe dynamics, and acoustics. In the first phase of this integrated optimization approach, acoustics and airframe aerodynamics are decoupled and accounted for as effective constraints on the design for the first three disciplines. In phase two, acoustics is integrated with the first three disciplines; in phase three, airframe dynamics are integrated with the other four disciplines. Representative results are presented from recent work on blade shear force reduction and aerodynamic/dynamic optimization. O.C.

A92-30092
AIRBUS - THE FAMILY EXPANDS
KEN ELLIS Air International (ISSN 0306-5634), vol. 42, March 1992, p. 133-137.
Copyright

A review is presented of the development of the various Airbus commercial transport aircraft derivatives from the first A300B in 1972 to the latest A340 now flying. Consideration is given to the marketing surveys and management decisions that have led to the production of the numerous variations of the basic airframe for freighting, military applications and the Super Transporter that will replace the Super Guppy for parts shipments from the consortium partners to the final assembly plant. Attention is given to some future derivatives including a 600 plus seater that might incorporate a 'double-bubble' fuselage configured either vertically or horizontally. R.E.P.

A92-30141
ANALYSIS OF THE EFFICIENCY OF SOME STRUCTURAL-INSPECTION STRATEGIES IN AIRCRAFT MAINTENANCE [ANALIZ EFFEKTIVNOSTI NEKOTORYKH STRATEGII OSMOTROV KONSTRUKTSII SAMOLETOV V PROTSESSE EKSPLUATATSII]
E. L. ZIMONT and V. IA. SENIK TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 119-122. In Russian. refs
Copyright

A formula is presented, together with its simple graphic representation, for predicting the probability of aircraft structures reaching the critical state, assuming that an existing crack may be overlooked during an inspection. It is shown that, for a large class of inspection strategies, the best distribution of inspections in an aircraft fleet is a uniform distribution throughout the fleet. The most popular inspection strategies are compared using a concrete example. I.S.

A92-30498
THE REINFORCING EFFECT OF COMPOSITE PATCH REPAIRS ON METALLIC AIRCRAFT STRUCTURES
C.-L. ONG and S. B. SHEN (Aero Industry Development Center, Taichung, Republic of China) International Journal of Adhesion and Adhesives (ISSN 0143-7496), vol. 12, Jan. 1992, p. 19-26. refs
Copyright

The various factors that might affect the composite patch repairs on metallic aircraft structures are investigated. These include the selection of patch materials (i.e., the boron/epoxy, b/ep, vs graphite/epoxy, gr/ep) and the fiber-orientation of patches, the use of room-temperature-cured vs high-temperature-cured adhesives, and reduced-temperature bonding vs standard bonding, as well as different repair procedures including co-cure repair, vacuum bag vs clamp pressurization, and stop-drilling at the crack tip. The results indicate that b/ep patches with high-temperature-cured adhesives give better fatigue lives than the gr/ep patches with room-temperature adhesives. Stop-drilling at the crack tip before patching repair was found to reduce the fatigue life by about 60 percent. Misalignment of a directional composite patch with the crack was found to adversely affect the efficiency of the repair. I.S.

A92-31525
FLIGHT VEHICLES OF THE FUTURE
VICKI P. MCCONNELL Advanced Composites (ISSN 0895-0407), vol. 7, no. 1, Jan.-Feb. 1992, p. 28-34.
Copyright

An overview is presented of various conceptual space vehicles

that will require composite materials to meet the speeds, elevated temperatures, and structure/fuel weight ratios necessary for supersonic, hypersonic, and orbital flight. It is noted that probably none of the current concept vehicles will fly without rapid and expanded development of advanced carbon/carbon and polymer-based composites, intermetallic alloys, metal-matrix composites, and ceramic-matrix composites, as well as the complementary fabrication and joining technologies for these materials. Consideration with regard to various composite structural materials is given to the NASP, the Hotol spaceplane, the HSCT, and the Hermes spaceplane. R.E.P.

N92-20204# National Research Council of Canada, Ottawa (Ontario). Inst. for Aerospace Research.
ACTIVITIES OF NRC-CNRC, INSTITUTE FOR AEROSPACE RESEARCH Annual Report, 1990 - 1991 [NRC-CNRC INST. DE RECHERCHE AEROSPATIALE, RAPPORT ANNUEL 1990-1991]
1991 30 p In ENGLISH and FRENCH Original contains color illustrations
(CTN-92-60431) Avail: NTIS HC/MF A03

This report presents a summary of the research projects of the Institute of Aerospace Research (IAR) of the National Research Council of Canada during the fiscal year 1990-1991. The mission of the IAR is to undertake, assist and/or promote research and development in support of the Canadian aerospace community in matters affecting the design, manufacture, performance, use, and safety of aerospace vehicles. IAR facilities include the Applied Aerodynamics Laboratory, the High Speed Aerodynamics Laboratory, the Flight Research Laboratory, and the Structures and Materials Laboratory. During the reporting year, the level of interactions with clients and collaborators has increased steadily. IAR wind tunnels, in particular, attracted a high level of business. Of particular significance was involvement with the Department of National Defence (DND) in the Follow-On Structural Test Program for the CF-18; a collaborative undertaking with CAE Electronics Ltd supporting development of a Dash 8 flight simulator; expanded collaboration with Boeing Canada, deHavilland Division; the acquisition of a Falcon 20 research aircraft; successful negotiations of a follow-on phase of aircraft dynamics research related to high manoeuvrability with DND and the U.S. Air Force; and occupancy of expanded facilities for aircraft structures research.
Author (CISTI)

N92-20205# National Research Council of Canada, Ottawa (Ontario). Flight Research Lab.
ACTIVITIES OF NRC-CNRC, INSTITUTE FOR AEROSPACE RESEARCH, FLIGHT RESEARCH LAB. Annual Progress Report, Fiscal Year 1990 - 1991
Oct. 1991 173 p
(CTN-92-60432) Avail: NTIS HC/MF A08

This report presents a summary of the research projects of the Flight Research Laboratory (FRL) of the National Research Council of Canada during the fiscal year 1990-1991 and a brief indication of future plans for continuing and new projects. Collaborative projects have been undertaken with universities, industry, Canadian government agencies, and international organizations. Names of collaborating organizations are provided for each project. The FRL research fleet facilities include: (1) a fully instrumented DHC-6 Twin Otter atmospheric research aircraft; (2) a Bell 205A airborne simulator which supports inflight investigations of control and cockpit systems, and database generation for aircraft specifications; (3) a Convair 580 research aircraft which is used as a multipurpose flying laboratory; (4) a T-33 flight research aircraft which is used for microgravity research, flight mechanics research, in-flight turbulence and static pressure measurement; and (5) a Falcon 20 research aircraft which joined the fleet this year was acquired as a multipurpose research platform for research on microgravity, avionics, sensors, microwave landing systems, and airborne atmospheric phenomena. Ground facilities include: the Flight Recorder Playback Center, a facility for analysis of recorded information particularly in accident and incident investigations and the Flight Research Laboratory Speech Research Centre which is involved in the development of voice I/O technology and which also supports aircraft accident investigations. CISTI

N92-21501# Wichita State Univ., KS. National Inst. for Aviation Research.
TECHFEST 18 PROCEEDINGS
BRENT D. BOWEN, ed. Jan. 1992 24 p Technologyfest held in Wichita, KS, 15-16 Nov. 1991; sponsored by AIAA and Wichita State Univ.
(NIAR-92-1) Avail: NTIS HC/MF A03 CSCL 01/2

The techfest provided an opportunity to exchange information on the state-of-the-art aviation topics. The areas covered include: (1) NASA research; (2) interdisciplinary research in aviation/aerospace; (3) key needs in general aviation research; (4) advanced computer tools; (5) commercially viable composites; and (6) aircraft design studies.

N92-21502*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AERONAUTICAL RESEARCH IN THE UNITED STATES: CHALLENGES FOR THE 1990'S Abstract Only
BRUCE J. HOLMES *In* Wichita State Univ., Techfest 18 Proceedings 1 p Jan. 1992
Avail: NTIS HC/MF A03 CSCL 01/2

New opportunities for greater performance civil air transportation aircraft derive from the continuing advancements in the aeronautical disciplines: advancements in aerodynamics, structures and materials, propulsion, and flight control technologies. These opportunities impact future subsonic transports, high speed civil transports, and hypersonic vehicles. There are, however, new constraints within which progress will be made, including stringent environmental constraints on engine emissions and noise, old and new safety constraints on operations (especially in severe weather), aging airframes, and changing transportation marketplace demands affecting all of these vehicle classes. Some of the NASA aeronautical research programs will be discussed in four areas: (1) advanced subsonic airplanes; (2) next generation high speed civil transport aircraft (SST's); (3) high performance military aircraft; and (4) next century hypersonic vehicles. This presentation overviews the exciting progress which is possible in aeronautics during the 1990's. Author

N92-21834# Federal Aviation Administration, Washington, DC.
ADVISORY CIRCULAR: CORROSION CONTROL FOR AIRCRAFT
25 Jul. 1991 132 p Original contains color illustrations
(FAA-AC-43-4A) Avail: NTIS HC/MF A07; 24 functional color pages

Identification and treatment of corrosive attack on aircraft structure and engine materials is presented. Corrosion inspection frequency, corrosion identification, and corrosion treatment continues to be the responsibility of the operator and should be accomplished per this Advisory Circular (AC), the manufacturer's recommendations, or the operator's own maintenance program. The procedures presented in this AC are an acceptable means, but not the only acceptable means, of corrosion treatment. The information contained in this AC is applicable to aircraft for which the manufacturer has not published corrosion control information. Where the aircraft manufacturer has published a recommended corrosion inspection schedule and treatment program for a particular aircraft, that program should take precedence over the recommendations of this AC. Author

02

AERODYNAMICS

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

A92-28943
INCOMPRESSIBLE FLOW PAST A FLAT PLATE AEROFOIL WITH LEADING EDGE SEPARATION BUBBLE
B. G. NEWMAN and M.-C. TSE (McGill University, Montreal, Canada) Aeronautical Journal (ISSN 0001-9240), vol. 96, Feb. 1992, p. 57-64. refs
Copyright

A simple flow model has been developed to predict the size of the separation bubble which forms at the sharp leading edge of a flat plate aerofoil at incidence alpha which are less than about 8 deg, and the corresponding lift and drag coefficients. This flow model is based on irrotational flow and source singularities which are determined indirectly from experiment. The bubble length is shown to be proportional to alpha squared with a slope which depends on the rate of growth of the separated shear layer. A thin double-wedge aerofoil has been tested in a wind tunnel. It is concluded that these and previous measurements agree fairly well with the theory for chord Reynolds numbers greater than about 0.5 x 10 exp 6. Author

A92-28949
THE MEAN POWER OF FORCES AND MOMENTS IN UNSTEADY AERODYNAMICS
WOLFGANG SEND (DLR, Institut fuer Aeroelastik, Goettingen, Federal Republic of Germany) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 72, no. 2, 1992, p. 113-132. refs
Copyright

A unified approach to propulsion and flutter is developed that is based on the balance of mechanical energy. The inherent mechanisms related to unsteady aerodynamics, propulsion, and flutter are described by means of the mean power of the oscillations. Propulsion and flutter are interchangeable in the formulation by varying the reduced frequency by means of the half chord length and the undisturbed onset velocity. Two types of kinematic velocity fields are generated in the analysis which describe specific rates of change with respect to time or to a comoving observer. Attention is given to the forces and moments for specific wing cross sections and to the effects of a pure pitching motion. The present theory is examined in the light of Katzmayr's (1922) experiment, and the unified approach is shown to be of interest for explaining the significant measurements of animal flight as well as aerospace wing configurations. C.C.S.

A92-29355
TWO-PARAMETER BIFURCATION ANALYSIS OF AXIAL FLOW COMPRESSOR DYNAMICS
DER-CHERNG LIAW, RAYMOND A. ADOMAITIS, and EYAD H. ABED (Maryland, University, College Park) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2955-2960. Research supported by General Electric Co. refs
(Contract NSF ECS-86-57561; NSF CDR-88-03012; NSF ECD-88-03012; AF-AFOSR-90-0015)
Copyright

An analysis is presented of the dynamics of a representative axial flow compressor model, emphasizing the influence of two important control parameters. These are a nondimensional parameter, B, as a primary determinant of poststall behavior and the setting of the throttle line. Greitzer's lumped-parameter model (1976) is employed in this study, with a specific choice of compressor and throttle characteristics. The analysis shows the presence of a rich variety of global as well as local bifurcations as the two control parameters are varied. The analysis leads to a characterization of compressor operation into three major zones: the stalled zone, the prestall zone, and the normal (unstalled) zone. Simulation results demonstrate the qualitatively different dynamical behaviors within each regime of parameter space. I.E.

A92-29472
THE UNRESOLVED UNSTEADY FLOW IN MULTISTAGE COMPRESSOR BLADE ROWS
STEVEN R. MANWARING and SANFORD FLEETER (Purdue University, West Lafayette, IN) Experimental Thermal and Fluid Science (ISSN 0894-1777), vol. 5, March 1992, p. 225-234. refs
(Contract F49620-88-C-0022)
Copyright

A series of experiments are described that are directed at the quantitative investigation of turbomachine rotor blade row unsteady unresolved velocities and blade surface pressures generated by the wakes from upstream blade and vane airfoil rows. The ensemble-averaged velocities and pressures quantify the vane wake generated periodic and aperiodic unsteadiness, with the unresolved unsteadiness defined by the variance. The vane wake generated aperiodic, periodic, and unresolved axial and tangential unsteady velocities and correlations are quantified at the inlet to each rotor row of a three-stage axial flow research compressor by means of a rotating cross hot-wire probe. The rotor blade surface unresolved unsteady pressure-time distributions and time-averaged values are also quantified for each rotor row, accomplished by means of ultraminiature high-response pressure transducers. Author

A92-29517
ANALYSIS OF A 2-D AIRFOIL MOTION FLYING IN-PROXIMITY-TO A WAVY-WALL SURFACE - FINITE DIFFERENCE METHOD
KYOKO NITTA and SHIGENORI ANDO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 457, 1992, p. 85-91. In Japanese. refs

The lift on an airfoil flying over a wavy wall surface is calculated using a finite difference method, which was developed by Nakamichi (1984) to improve LTRAN2 evolved by Ballhaus and Goorjian (1977). In order to apply this LTRAN2 version to the present problem, some manipulation on grid-making-system is needed. First, cases of a flat plate over a flat solid wall are calculated to check the coding prior to the cases of a moving wavy wall. Second, aerodynamic characteristics of a flat plate over a moving wavy wall are calculated, and third, its motion is investigated. The calculated results are compared with those obtained by the lifting surface theory. The agreements are quite satisfactory. Author

A92-29521
ERROR CHARACTERISTICS OF A VORTEX PANEL METHOD IN TWO-DIMENSIONAL FLOW
AKIO ICHIKAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 457, 1992, p. 119-126. In Japanese. refs

A numerical investigation is performed on the error analysis of a vortex panel method in the 2D flow. The method uses step or linear vortex distributions on straight line elements. The airfoil is divided into a set of elements by three ways: semicircular method, equispaced method, and quartercircular method. The following results are obtained: (1) the location of the optimum control point is the center of the elements for the step vortex distributions and the edge for the linear vortex distributions; (2) for dividing the way of the airfoil, the semicircular-method is the best which is followed by the quartercircular method and then by the equispaced method; (3) when the airfoil is divided by the best way, the accuracy of the solution is first order in the element size for the step vortex distributions and is second order for the linear vortex distributions. Author

A92-29595#
NUMERICAL SIMULATION OF SLOT INJECTION INTO A TURBULENT SUPERSONIC STREAM

DONALD P. RIZZETTA (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0827)

Steady flowfields resulting from slot injection at the surface of a flat plate in a freestream with a Mach number of 3.7 and a unit Reynolds number of 5.83 x 10 exp 6/m were simulated numerically by integrating the time-dependent compressible mass-averaged Navier-Stokes equations. Effects of fine-scale turbulence were represented by a two-equation(k-epsilon) closure model which included a generalized formulation, low-Reynolds number terms, and a compressibility correction. A grid mesh step-size study is provided in order to assess resolution requirements of the numerical solutions, and the effect of the compressibility correction is examined. A total of 15 cases were computed, comprising a range of slot widths and slot total pressure ratios. Comparison is made with experimental data in terms of surface static pressure distributions, the length of the upstream separation region, and the height of the Mach surface. Author

A92-29596#
NUMERICAL ANALYSIS OF TECHNIQUES FOR EFFICIENT GENERATION OF VORTICITY IN SUPERSONIC FLOWS
D. L. DAVIS (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0828)

An explicit Parabolized Navier-Stokes computer code was used to investigate the generation of axial vorticity by fuel injection ramps of various configurations. The code was calibrated with two different sets of data for this class of injector. A particular configuration of ramp with a concave side wall was found to generate significant vorticity with very little additional total pressure loss over that of a straight ramp. Combustor simulations for five fuel injector configurations were conducted which indicated that combustor performance was enhanced by axial vorticity. Author

A92-29603#
APPLICATIONS OF AN IMPLICIT, UPWIND NAVIER-STOKES CODE, CRAFT, TO STEADY/UNSTEADY REACTING, MULTI-PHASE FLOWFIELDS
N. SINHA, S. M. DASH, and A. HOSANGADI (Science Applications International Corp., Fort Washington, PA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 22 p. refs
(AIAA PAPER 92-0837) Copyright

The CRAFT Navier-Stokes (NS) reacting, multiphase research code has been developed as an extension of the TUFF NS aerodynamic research code. CRAFT solves the 1D/2D/AXI/3D NS equations employing upwind/implicit (Roe/TVD) numerics in a finite-volume framework. Finite-rate chemistry, two-equation turbulence models, and gas-particle interactions have been incorporated in a strongly-coupled manner, with source terms treated implicitly. A new Eulerian particulate solver has been developed which implements identical upwind/implicit numerics, and dynamic grid capabilities have been added which permits treating problems with moving boundaries and/or adapting the grid to the transient flow structure. Applications of CRAFT have emphasized the analysis of transient flows, very 'severe' steady flow problems, and steady/transient flows where the accurate/nondiffusive simulation of waves is critical. Author

A92-29604#
NAVIER-STOKES COMPUTATION OF HYPERSONIC NEAR WAKES WITH FOREIGN GAS INJECTION
RAUL J. CONTI (Hypersonics, Inc., Palo Alto, CA) and ROBERT W. MACCORMACK (Stanford University, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 15 p. Research supported by Hypersonics, Inc. refs
(AIAA PAPER 92-0838) Copyright

Laminar axisymmetric near wakes of a blunt conical vehicle are computed for Mach 22 flow. The vehicle is a spherically blunted 7-deg. cone with nose radius of 2.97 cm and overall length of 0.935 m. An implicit numerical method for the full Navier-Stokes equations is used in an L-shaped domain extending 1.3 vehicle lengths downstream of the base. All shocks are 'captured' within this domain, including the vehicle bow shock, which is allowed to interact with the base expansion. Examples are presented for steady flow of a perfect gas, and for transient injection of a cool inert gas into equilibrium air. Computations are presented for two locations of the injection ports, on the vehicle side, and on the center of its base. After 200 ms of injection the side ports are more effective in dispersing the gas and reducing electron density by cooling the wake. After 600 ms, injectant concentration approaches the same steady state for side and base ports. Author

A92-29710
A NEW APPROACH TO SWIRL CONTROL IN AN S-DUCT
P. F. WENG and R. W. GUO (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 5-14. refs

The novel approach to swirl control in an S-duct is presented which employs a vortex-reduction device located near the duct inlet; the bulk vortex created by flow separation is substantially diminished by these means. Flow measurement results reveal detailed geometric influences of the vortex-reduction device on crossflow. The method is found to improve average total pressure recovery at the duct's exit. O.C.

A92-29714
CONTROL OF STRONG SHOCK-TURBULENT BOUNDARY LAYER INTERACTION IN RECTANGULAR CHANNELS
Z. W. HE and F. B. LI (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 47-57. refs

A systematic investigation is conducted of the controlling mechanisms of strong shock-turbulent boundary layer interactions in rectangular channels, under initial conditions of freestream Mach 1.63 and undisturbed boundary layer thickness of 5.65 mm. An effort is made to ascertain the bleed-mass flow and suction-slot position and width that most effectively maximize total pressure recovery, and minimize the turbulence level of flow, downstream of the shock-boundary layer interactions. O.C.

A92-29716
ANALYSIS OF EFFECTS OF FREESTREAM TURBULENCE ON CASCADE PERFORMANCE
GUOCHUAN WU (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 69-75. refs

A calculation method is presented for determining turbomachine blade-cascade performance variations under the influence of freestream turbulence. Attention is given to total pressure losses and fluid turning angles, and an expression of boundary layer thickness variation with freestream turbulence level is derived. The results obtained for the illustrative case of a double circular arc compressor tandem cascade are compared with experimental data; good agreement is noted. O.C.

A92-29719
CALCULATION OF 3D FLOW FIELD IN A SINGLE TRANSONIC COMPRESSOR STAGE
L. C. WANG (Nanjing Aeronautical Institute, People's Republic of China) and ZHI-FANG ZHANG (Shenyang Aeroengine Research Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 94-100. refs

A 3D Euler solver used for calculation of flow field within single

transonic compressor stage is described in this paper. The four-step Runge-Kutta explicit scheme is adopted for the calculation. The simplified multiple grid method is used to accelerate the convergence speed. Absolute flow variables are solved in a Cartesian reference frame which may be rotating with a uniform angular velocity around the x-axis. Boundary conditions are outlined. One transonic compressor stage is chosen as a sample solution. Various plots are shown in the paper, to demonstrate the validity of the code. Author

A92-29720
STUDYING METHOD OF MEASURING FLOW-FIELD BETWEEN STAGES IN AXIAL-FLOW COMPRESSOR
SONG L. ZHANG, YUE G. WU, and GUO H. GE (Liyang Machinery Co., Ping-Ba, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 101-111. refs

The results obtainable with the present five-aperture compound microprobe system for measuring the flowfield between the stages of an axial-flow compressor, in conjunction with a 2D placement mechanism, are compared with those derived by three-aperture wedge-integrated probes, boundary-layer probes, and normal five-point comb-shape total-pressure probes. The five-aperture microprobe is found to be excellent for both compressor matching and blade design-optimization studies. O.C.

A92-29972*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYSIS OF ICED WINGS
TUNCER CEBECI, H. H. CHEN, K. KAUPS, S. SCHIMKE (California State University, Long Beach), and JAIWON SHIN (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs (AIAA PAPER 92-0416) Copyright

A method for computing ice shapes along the leading edge of a wing and a method for predicting its aerodynamic performance degradation due to icing is described. Ice shapes are computed using an extension of the LEWICE code which was developed for airfoils. The aerodynamic properties of the iced wing are determined with an interactive scheme in which the solutions of the inviscid flow equations are obtained from a panel method and the solutions of the viscous flow equations are obtained from an inverse three-dimensional finite-difference boundary-layer method. A new interaction law is used to couple the inviscid and viscous flow solutions. The application of the LEWICE wing code to the calculation of ice shapes on a MS-317 swept wing show good agreement with measurements. The interactive boundary layer method is applied to a tapered iced wing in order to study the effect of icing on the aerodynamic properties of the wing at several angles of attack. Author

A92-29999
ASSESSMENT OF THREE MODELS OF TURBULENCE IN A SHOCK-BOUNDARY LAYER INTERACTION OF A HEATED WALL
R. BENAY (ONERA, Chatillon, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 5, 1991, p. 45-68. refs
Copyright

The interaction between an oblique shock wave and a boundary layer on an adiabatic or highly heated wall has been studied in the framework of fundamental research in the experimental facilities of ONERA for a freestream Mach number of 2.4. Using classical boundary layer approximations, a low-cost computing code was written that can be used in testing turbulence models, which are as yet still too complex for inclusion in Navier-Stokes codes (such as the Algebraic Stress Model). A detailed analysis is made of the flow by comparison with the experimental data, giving a preliminary justification of the theoretical approach adopted. The capabilities of the models tested are assessed by comparing computed results with experimental data provided. These models, currently established in the incompressible domain, have given better results than expected, confirming the weakness of the compressibility effect at this Mach number. Author

A92-30000
GENERALIZED EXPRESSION OF CHOROCHRONIC PERIODICITY IN TURBOMACHINERY BLADE-ROW INTERACTION
G. A. GEROLYMOS and V. CHAPIN (Paris VI, Universite, Paris, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 5, 1991, p. 69-73. refs
Copyright

The unsteady flow which is generated when 2 turbomachinery blade-rows are in relative angular motion is periodic in time, with a different period in the frame of reference associated with each blade row, and is characterized by a pitchwise traveling wave chorochronic periodicity. This periodicity is studied for arbitrary angular velocities and pitch-ratio of the 2 blade-row and simple formulas for the corresponding interblade-phase angles are given. Author

A92-30126
CONTROL OF THE DEVELOPMENT OF BOUNDARY LAYER DISTURBANCES [UPRAVLENIE RAZVITIEM VOZMUSHCHENII V POGRANICHNOM SLOE]
V. P. ERMOLAEV, IU. V. KIRINOV, V. N. OZEROV, G. P. SVISHCHEV, V. M. FOMIN, and A. A. SHUROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 1-10. In Russian. refs
Copyright

The state of the boundary layer on the wing of the TsAGI airborne laboratory glider and the propagation of disturbances in the form of Tollmien-Schlichting waves in a laminar boundary layer, the development of which results in a transition to the turbulent state, were investigated. It is shown that it is possible to suppress the boundary-layer disturbances by using an acoustic out-of-phase effect to displace the transition boundary to the trailing edge and to extend the laminar-flow region on tne wing. I.S.

A92-30127
EXPERIMENTAL INVESTIGATION OF THE COEFFICIENTS OF THE NORMAL-FORCE DERIVATIVES FOR RECTANGULAR WINGS WITH TRANSLATIONAL OSCILLATIONS [EKSPERIMENTAL'NOE ISSLEDOVANIE KOEFFITSIENTOV PROIZVODNYKH NORMAL'NOI SILY PRIAMOUGOL'NYKH KRYL'EV PRI POSTUPATEL'NYKH KOLEBANIIAKH]
G. V. MAKHORTYKH and M. G. SHCHEGLOVA TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 11-20. In Russian. refs
Copyright

Results are presented from an experimental determination of the two normal-force coefficients for rectangular wings with aspect ratios of 5 and 3, which move along the chord at a constant speed and which oscillate perpendicularly to the chord. Measurements were conducted in the oscillation facility in the TsAGI test tank. The Strouhal numbers were varied from 0.2 to 4.6 for the wing with an aspect ratio of 5, and from 0.15 to 2.1 for the wing with an aspect ratio of 3. I.S.

A92-30128
COMPUTATIONS OF A TRANSONIC FLOW ABOUT AN AIRFOIL IN A WIND TUNNEL WITH POROUS WALLS [RASCHET OKOLOZVUKOVOGO OBTEKANIIA PROFILIA V TRUBE S PERFORIROVANNYMI STENKAMI]
V. M. NEILAND TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 21-26. In Russian. refs
Copyright

Based on the integration technique developed by Neiland (1988) for two-dimensional transonic flows, a method is developed for integrating Euler equations for a flow about an airfoil in a wind tunnel with porous-wall test sections. The salient features of this method include its high speed (which is about 2 orders faster than existing methods) and small RAM capacity required to maintain

an adequate calculation capacity. Results of computations for a 10-percent parabolic airfoil are compared with experimental measurements and with computations performed by other methods. I.S.

A92-30129
THE EFFECT OF WING TWIST OPTIMIZED IN THE FRAMEWORK OF THE PLANE CROSS SECTION HYPOTHESIS ON THE AERODYNAMIC CHARACTERISTICS OF A WING-BODY COMBINATION AT HYPERSONIC SPEEDS [VLIIANIE KRUTKI KRYLA, OPTIMIZIROVANNOI V RAMKAKH GIPOTEZY PLOSKIKH SECHENII, NA AERODINAMICHESKIE KHARAKTERISTIKI KOMBINATSII KRYLA S KORPUSOM PRI GIPERZVUKOVYKH SKOROSTIAKH]
IU. I. LOBANOVSKII and M. E. NESTEROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 27-35. In Russian. refs
Copyright
The effect of wing twist on the aerodynamic characteristics of a wing-body combination at hypersonic speeds is investigated. An approximate optimization procedure is proposed for the wing-body surface optimization, which is based on a combination of the numerical solution of Euler equations and the 'strip' technique. Results are presented of calculations of aerodynamic characteristics of the wing-body combinations with different scales of wing twist, together with a comparison with results obtained for a plane wing. It is shown that, due to a wing twist, it is possible to increase the maximum lift/drag ratio of a hypersonic vehicle by Delta K(max) = 0.1-0.2 and to reduce the absolute pitching moment by (0.25-0.40) x 10 exp -2. I.S.

A92-30135
BODIES OF REVOLUTION WITH MINIMAL WAVE DRAG AT TRANSONIC GAS FLOW VELOCITIES [TELA VRASHCHENIIA S MINIMAL'NYM VOLNOVYM SOPROTIVLENIEM PRI TRANSZVUKOVYKH SKOROSTIAKH TECHENIIA GAZA]
S. A. VELICHKO, V. V. VYSHINSKII, and E. N. KUZNETSOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 89-93. In Russian. refs
Copyright
Results are presented from calculations of the forebody wave drag for bodies of revolution with a parabolic generatrix for different forebody lengths in a transonic gas flow. The generatrix shapes for bodies of revolution with minimal wave drag are given. I.S.

A92-30136
GENERATION OF SEVERAL WAVE PACKETS IN THE BOUNDARY LAYER OF A WING PROFILE [VOZNIKNOVENIE NESKOL'KIKH VOLNOVYKH PAKETOV V POGRANICHNOM SLOE NA PROFILE KRYLA]
B. IU. ZANIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 94-97. In Russian. refs
Copyright
The paper examines the conditions for the occurrence and development of instability waves (Tollmien-Schlichting waves) in the boundary layer on an upper wing surface. The occurrence of these wave packets under the effect of the acoustic background in a low-turbulence wind tunnel is shown. I.S.

A92-30138
NUMERICAL MODELING OF SELF-OSCILLATIONS FOR A SMALL-ASPECT-RATIO DELTA WING USING MEASUREMENTS OF ROLL MOTION AT LARGE ANGLES OF ATTACK [CHISLENNOE MODELIROVANIE AVTOKOLEBANII TREUGOL'NOGO KRYLA MALOGO UDLINENIIA PO KRENU NA BOL'SHIKH UGLAKH ATAKI]
G. M. SHUMSKII TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 102-106. In Russian. refs
Copyright
Amplitude values of a self-oscillating delta wing in a separated flow of an ideal incompressible fluid were computed using simultaneous solutions of the equations of unsteady aerodynamics and dynamics. The results of calculations obtained for the free-oscillation regimes were found to agree well with test data. The characteristics of the damping function were obtained along with the features of its formation in the first oscillation cycle. It is shown that the amplitude of self-oscillations depends on the dimensionless frequency and the moment of inertia of the wing. I.S.

A92-30144
DEVELOPMENT OF A METHOD FOR CALCULATING THE EFFECT OF THE PROPELLER SLIPSTREAM ON TRANSONIC FLOW OVER THE WING [RAZRABOTKA METODA RASCHETA VLIIANIIA STRUI VINTA NA TRANSZVUKOVOE OBTEKANIE KRYLA]
A. V. SMIRNOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 20-26. In Russian. refs
Copyright
A method is presented for calculating transonic flow of an ideal gas over a swept wing of finite span with allowance for the effect of the propeller slipstream. The solution is obtained in the form of a superposition of the shear and three-dimensional potential flows. Examples of calculations of the flow field in the propeller regions and aerodynamic characteristics of the wing are presented. The calculations are shown to be in satisfactory agreement with experimental data. V.L.

A92-30145
BREAKDOWN OF AN AXISYMMETRIC LAMINAR WAKE [O RAZRUSHENII OSESIMMETRICHNOGO LAMINARNOGO SLEDA]
VIK. V. SYCHEV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 27-42. In Russian. refs
Copyright
An analysis is made of flow of a viscous incompressible fluid near the breakdown point of a wake formed at high Re numbers behind a thin axisymmetric body. Based on an asymptotic analysis of Navier-Stokes equations for Re approaching infinity, it is shown that the breakdown of the wake occurs as a result of the generation of a large local self-induced pressure gradient in the mixing region. The breakdown point is located a small distance downstream of this region. V.L.

A92-30146
FLOW OF A VISCOUS TWISTED FLUID FILM ON THE SURFACE OF A BLUNT BODY IN SUPERSONIC FLOW OF A GAS [TECHENIE VIAZKOI ZAKRUCHENNOI PLENKI ZHIDKOSTI NA POVERKHNOSTI ZATUPLENNOGO TELA V NABEGAIUSHCHEM SVERKHZVUKOVOM POTOKE GAZA]
P. E. BABIKOV, IU. N. ERMAK, and D. V. IANISHEVSKII TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 43-49. In Russian. refs
Copyright
The flow of a liquid evaporating film on the surface of a centrifugal nozzle in supersonic flow of a viscous gas is investigated numerically. The principal flow regions are identified, and boundary value problems are formulated. The similarity parameters are presented, and a numerical solution is obtained for the composite problem. V.L.

A92-30153
AN EXPERIMENTAL STUDY OF TRANSONIC FLOW OF A GAS PAST WEDGES [EKSPERIMENTAL'NOE ISSLEDOVANIE OBTEKANIIA KLIN'EV TRANSZVUKOVYM POTOKOM GAZA]
T. M. SAKHNENKO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 111-114. In Russian. refs
Copyright
Systematic experimental data are presented on pressure distributions over infinite-span wedges with a half-angle of taper of 10, 20, and 45 deg at velocities corresponding to free-stream Mach 0.4-1.3. Changes in the drag of the wedges with the Mach number and the half-angle of taper are determined. V.L.

A92-30154
EFFECT OF VISCOSITY ON THE DRAG OF SLENDER AXISYMMETRIC BODIES IN HYPERSONIC FLOW [VLIIANIE VIAZKOSTI NA SOPROTIVLENIE TONKIKH OSESIMMETRICHNYKH TEL PRI GIPERZVUKOVYKH SKOROSTIAKH OBTEKANIIA]
P. I. GORENBUKH and V. P. PROVOTOROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 115-117. In Russian. refs
Copyright
The effect of viscosity on the drag of sharp and slightly blunt slender axisymmetric bodies in hypersonic flow is investigated analytically. Based on the results of numerical calculations, an approximate expression is obtained for the relative drag coefficient as a function of a modified parameter of viscous interaction. V.L.

A92-30157
A PRESSURE-DRAG-DETERMINATION METHOD FOR AERODYNAMIC-INTERFERENCE PROBLEMS [METOD OPREDELENIIA SOPROTIVLENIIA DAVLENIIA V ZADACHAKH AERODINAMICHESKOI INTERFERENTSII]
L. L. TEPERIN and A. IU. UDZHUKHU TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 3, 1990, p. 3-10. In Russian. refs
Copyright
A convenient formula is developed for calculating aerodynamic forces on the surface of a body in a flow without integrating the pressure distribution on the body surface. The efficiency of the formula is demonstrated in several applications to aerodynamic-interference problems. Special consideration is given to the problem of the interaction between an ideal propeller with aircraft elements. I.S.

A92-30158
A COMPUTATIONAL STUDY OF FLOW PAST BODIES AND HEAT TRANSFER FOR ISENTROPIC COMPRESSION FLOWS [RASCHETNOE ISSLEDOVANIE OBTEKANIIA I TEPLOOTDACHI DLIA IZOENTROPICHESKIKH TECHENII SZHATIIA]
G. N. GLUSHCHENKO, N. P. KOLINA, G. G. NERSESOV, and N. N. SHKIRIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 3, 1990, p. 11-18. In Russian. refs
Copyright
A method is developed for computing the flow past plane (and axisymmetric) bodies with isentropic compression surfaces, taking into account the displacement effect of the boundary layer and equilibrium dissociation. The results of calculations are compared with experimental results and with calculations performed using the programs written by Kolina and Solodkin (1980) and Ponomarev and Glushenko (1985). A correlation is obtained between the maximal heat transfer (at the end of the isentropic compression segment) and static pressure, for nonseparated flow past the body. I.S.

A92-30159
AN ASYMPTOTIC TRANSONIC THEORY AND OPTIMAL POROSITY OF WIND TUNNEL WALLS AT M GREATER THAN ABOUT 1 [ASIMPTOTICHESKAIA TRANSZVUKOVAIA TEORIIA I OPTIMAL'NAIA PRONITSAEMOST' STENOK AERODINAMICHESKOI TRUBY PRI M GREATER THAN ABOUT 1]
V. M. NEILAND TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 3, 1990, p. 19-27. In Russian. refs
Copyright
A novel approach is proposed for deriving equations of the transonic thin-profile theory, which enables the development for constructing any approximation. These algorithms were used to determine the optimal porosity of the porous walls of a wind tunnel at values of M greater than about 1. The theoretical results are compared with experimental data. I.S.

A92-30160
AN EXPERIMENTAL STUDY OF TONE-LIKE NOISE IN THE FLOW PAST A WING AT LOW FLOW VELOCITIES [EKSPERIMENTAL'NOE ISSLEDOVANIE TONAL'NOGO SHUMA OBTEKANIIA KRYLA PRI MALYKH SKOROSTIAKH POTOKA]
A. G. MUNIN, A. G. PROZOROV, and A. V. TOPOROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 3, 1990, p. 28-38. In Russian. refs
Copyright
The causes of the appearance of tone-like noise in the flow past a wing are analyzed. A correlation is found between the tonal components of the noise and the hydrodynamic pulsations in the region of laminar-to-turbulent boundary layer transition and in the aerodynamic wake. Different ways to prevent intense narrow-band hydrodynamic and acoustical disturbances are indicated. It was found that the frequency and the level of the observed disturbances depend on the Reynolds number and the angle of attack. I.S.

A92-30167
THE FEASIBILITY OF REDUCING INDUCED WING DRAG BY USING CRESCENT PLANFORM WINGS [O VOZMOZHNOSTI UMEN'SHENIIA INDUKTIVNOGO SOPROTIVLENIIA KRYLA ZA SCHET PRIDANIIA EMU SERPOVIDNOI FORMY V PLANE]
V. I. BABKIN, E. E. BOBYR', and N. I. ZHELEZNIAK TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 3, 1990, p. 104-108. In Russian. refs
Copyright
The paper analyzes the results of van Dam (1987) suggesting that the crescent planform wings result in a reduction of the induced wing drag, compared with the wind drag induced by elliptical wings. It is shown that the results of present calculations using well-known analytical methods do not support van Dam's conclusion. I.S.

A92-30171
EXPERIMENTAL STUDY OF THE CHARACTERISTICS OF BOUNDARY-LAYER DEVELOPMENT ON AN AIRFOIL [EKSPERIMENTAL'NOE ISSLEDOVANIE OSOBENNOSTEI RAZVITIIA POGRANICHNOGO SLOIA NA PROFILE]
V. D. BOKSER and S. V. ZHIGULEV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 4, 1990, p. 3-10. In Russian. refs
Copyright
The behavior of the surface boundary layer in the tail section of a supercritical profile was investigated using local noncontact velocity measurements in this region. Data are presented on the characteristic boundary-layer thicknesses and form parameters for angles of attack between 0.4 and 3.3 deg, at M = 16 and Re = 1.7 x 10 exp 6. A correlation was carried out between the measured velocity profiles and the integral characteristics of the boundary layer for the experimental profile and the results of appropriate calculations for a flat plate. The magnitude of the surface friction was estimated, and the region of lowest surface friction was identified. Experimental methods for estimating the region of low surface friction on the profile are proposed. I.S.

A92-30172
THE LIFT-DRAG RATIO OF A SLENDER CONE IN VISCOUS HYPERSONIC GAS FLOW [AERODINAMICHESKOE KACHESTVO TONKOGO KONUSA V VIAZKOM GIPERZVUKOVOM POTOKE GAZA]
P. I. GORENBUKH, A. S. KOROLEV, S. E. MOIZIS, and V. I. SHUSTOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 4, 1990, p. 18-22. In Russian. refs
Copyright
Using experimental data and results of calculations, the effects of the Mach number and the Reynolds number on the lift-drag ratio of a slender cone in viscous hypersonic gas flow were investigated. For the relative value of Kmax of sharp and blunt cones, a unified approximate dependence on a modified criterion on hypersonic viscous interaction is obtained. I.S.

A92-30173
EXPERIMENTAL STUDY OF AN ADJUSTABLE PLANE SUPERSONIC DIFFUSOR [EKSPERIMENTAL'NOE ISSLEDOVANIE REGULIRUEMOGO PLOSKOGO SVERKHZVUKOVOGO DIFFUZORA]
I. V. BABCHENKO, L. V. REDIN, V. A. TIMONIN, and N. A. SHUSHIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 4, 1990, p. 23-32. In Russian. refs
Copyright
The separation characteristics of a plane wind tunnel with adjustable exhaust diffuser were investigated at M = 5; the separation zones as viewed from the narrow walls were suppressed by supersonic tangential air injection. The influence of the diffuser inlet shape and the sizes and locations of the injection nozzles on the flow was investigated. An engineering technique was developed for calculating the limiting characteristics of the flow in the diffusor taking into account the effect of the boundary layer. The experimental results are compared with calculations. I.S.

A92-30180
THE EFFECT OF THE ANGLE-OF-ATTACK ON LAMINAR-TURBULENT BOUNDARY TRANSITION NEAR THE LOWER SURFACE OF TRIANGULAR PLATES IN A SUPERSONIC GAS FLOW [VLIIANIE UGLA ATAKI NA PEREKHOD LAMINARNOGO POGRANICHNOGO SLOIA V TURBULENTNYI NA NIZHNEI POVERKHNOSTI TREUGOL'NYKH PLASTIN V SVERKHZVUKOVOM POTOKE GAZA]
N. A. KOVALEVA, N. P. KOLINA, and A. IA. IUSHIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 4, 1990, p. 92-95. In Russian. refs
Copyright
The laminar-turbulent boundary layer transition near the lower surface of a triangular plate with the leading-edge sweep angles chi between 65 and 75 deg was investigated in shock-tunnel experiments. Results are presented in the form of a single dependence of the Reynolds-number transition on the Mach number, the unit Reynolds number, and the angle of attack. I.S.

A92-30181
CALCULATING THE STEADY-STATE NONLINEAR AERODYNAMIC CHARACTERISTICS OF THIN WINGS NEAR THE INTERFACE BETWEEN TWO FLUIDS [RASCHET STATSIONARNYKH NELINEINYKH AERODINAMICHESKIKH KHARAKTERISTIK TONKIKH KRYL'EV VBLIZI ZHIDKOI GRANITSY RAZDELA DVUKH SRED]
O. N. SOKOLOVA TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 4, 1990, p. 96-99. In Russian. refs
Copyright
A method is presented for calculating steady-state aerodynamic characteristics of an arbitrarily shaped thin wing, for the cases of separated, unseparated, and combined flows, near the interface between two fluids with different densities and velocities in steady motion. The problem is solved by the method of discrete vortices in a nonlinear formulation by fulfilling the boundary condition on the wing, and in a linear formulation for the boundary condition on the fluid interface. I.S.

A92-30185
NUMERICAL METHODS IN THE THEORY OF BOUNDARY LAYER INTERACTION WITH NONVISCOUS FLOW [CHISLENNYE METODY V TEORII VZAIMODEISTVIIA POGRANICHNOGO SLOIA S NEVIAZKIM POTOKOM]
A. I. RUBAN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 5, 1990, p. 3-25. In Russian. refs
Copyright
Numerical methods for solving the problem of interaction between a boundary layer and an external nonviscous flow, which are used in the investigation of separated flows of liquids and gases near a solid surface, are reviewed. Consideration is given to the main principles of the construction of difference schemes and organization of the computational process for subsonic, transonic, and supersonic velocities at the outer edge of the boundary layer. Particular attention is given to marching, iteration, and spectral methods. The methods discussed can be used for the model statement of the interaction problem and for solving asymptotic equations in interaction theory in the framework of the well-known three-layer flow scheme. V.L.

A92-30186
CALCULATION OF THE ROLLING MOMENT FOR A WING WITH A SUPERSONIC LEADING EDGE IN THE PRESENCE OF SIDESLIP [RASCHET MOMENTA KRENA KRYLA SO SVERKHZVUKOVYMI PEREDNIMI KROMKAMI, DVIZHUSHCHEGOSIA SO SKOL'ZHENIEM]
T. M. PRITULO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 5, 1990, p. 26-34. In Russian.
Copyright
A perturbation method developed in an earlier study (Pritulo, 1983) is extended to flow past wings with sideslip. Analytical expressions are obtained which make it possible to calculate, in explicit form, the rolling moment of a wing for different flow parameters. The rolling moment of an isolated delta wing is shown to change in an essentially nonlinear manner with the angle of attack and to decrease with the increasing free-stream Mach number. V.L.

A92-30187
TRANSVERSE CORRELATION OF THE SPECTRAL COMPONENTS OF PRESSURE FLUCTUATIONS ON A PLATE AHEAD OF A STEP [POPERECHNAIA KORRELIATSIIA SPEKTRAL'NYKH SOSTAVLIAIUSHCHIKH PUL'SATSII DAVLENIIA NA PLASTINE PERED VYSTUPOM]
V. N. BIBKO, B. M. EFIMTSOV, and V. G. KORKACH TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 5, 1990, p. 35-43. In Russian. refs
Copyright
Results of parametric experimental studies of the transverse correlation of pressure fluctuations in the case of two-dimensional supersonic flow past a straight step on a plate are presented. It is shown that the extent of the three-dimensional coupling of the pressure fluctuations along a coordinate orthogonal to the flow direction can be described in terms of dimensionless transverse correlation scales represented in the form of Strouhal number functions which are dependent on the Mach number, the dimensionless step height, and longitudinal coordinate as parameters. The effect of these parameters on the transverse correlation scales is estimated. V.L.

A92-30188
COOLING OF A SHARP NOSE BY EXTRANEOUS GAS INJECTION INTO THE VISCOUS SHOCK LAYER [OKHLAZHDENIE OSTROGO NOSKA VDUVOM INORODNOGO GAZA V TONKII VIAZKII UDARNYI SLOI]
A. L. ANKUDINOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 5, 1990, p. 44-50. In Russian. refs
Copyright
The problem of viscous flow near the nose of a tapered body in a thin shock layer is investigated analytically for a binary mixture of gases in the presence of cooling through the injection of an extraneous gas through a porous surface. The problem is solved in the framework of a model of a two-dimensional thin viscous shock layer. Formulas are obtained which make it possible to determine the effect of various flow parameters and conditions on the temperature of the cooled surface. V.L.

A92-30196
A STUDY OF THE BASE PRESSURE BEHIND CIRCULAR STEPS [ISSLEDOVANIE DONNOGO DAVLENIIA ZA KOL'TSEVYMI USTUPAMI]
E. M. NETSVETAILOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 5, 1990, p. 124-127. In Russian. refs
Copyright
The base pressure behind axisymmetric circular steps is investigated experimentally for ratios of cylindrical surface diameters before and after the step of 0.74 to 0.99 and free-stream

Mach numbers of 0.6-2.5. It is shown that, for free-stream Mach numbers greater than 1, the pressure behind the circular step increases with the diameter ratio. For Mach number less than 1, the pressure does not change with the diameter ratio and depends only on the free-stream Mach number of the external flow. V.L.

A92-30197
EFFECT OF COMPRESSIBILITY ON THE VALUE OF THE ACCEPTABLE ROUGHNESS REYNOLDS NUMBER [VLIIANIE SZHIMAEMOSTI NA ZNACHENIE DOPUSTIMOGO CHISLA REINOLDSA SHEROKHOVATOSTI]
E. U. REPIK TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 5, 1990, p. 128-133. In Russian. refs
Copyright
Results of an experimental study of the effect of compressibility on the acceptable Reynolds number of roughness are reported. A relationship is established between the acceptable roughness height and the characteristics of velocity distribution in a boundary layer on an aerodynamically smooth surface in the viscous sublayer region. Expressions are proposed for calculating the acceptable height of roughness as a function of the Re and M numbers. V.L.

A92-30199
ASYMPTOTIC SOLUTION OF THE PROBLEM OF IDEAL-FLUID FLOW PAST THE VERTICES OF BODIES AND WINGS [ASIMPTOTICHESKOE RESHENIE ZADACHI OB OBTEKANII IDEAL'NOI ZHIDKOST'IU VERSHIN TEL I KRYL'EV]
G. G. SUDAKOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 3-9. In Russian. refs
Copyright
The problem of ideal vortex-free fluid flow near the vertices of a conical body or a wing is examined, taking the tangent of the characteristic vertex half-angle of the body as the small parameter. The solution for the flow potential contains a power multiplier of the longitudinal coordinate. An analytical dependence of the exponent on the characteristic vertex half-angle of the body is obtained using the method of matched asymptotic expansions. L.M.

A92-30200
COMBINED METHOD FOR THE SOLUTION OF PLANE DIRECT PROBLEMS OF FLOW PAST BODIES WITH JETS [KOMBINIROVANNYI METOD RESHENIIA PLOSKIKH PRIAMYKH ZADACH OBTEKANIIA TEL SO STRUIAMI]
V. M. SHURYGIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 10-21. In Russian. refs
Copyright
A combined method for calculating the plane flows of an ideal incompressible fluid near bodies with jets is proposed. This method is based on a preliminary conformal mapping of n-sheet flow regions corresponding to the bodies with jets onto one-sheet regions, and the subsequent application of the vortex layer method or the singularity method. The proposed functions for smoothing angular points and the reduced integral equations accounting for the flow uniqueness conditions enhance the possibilities of solving direct problems in the case of specified arbitrary bodies, boundaries, and Bernoulli numbers. L.M.

A92-30201
THE AERODYNAMIC CHARACTERISTICS OF GRID FIN WINGS [OB AERODINAMICHESKIKH KHARAKTERISTIKAKH RESHETCHATYKH KRYL'EV]
K. P. PETROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 22-30. In Russian. refs
Copyright
Experimental results obtained in large wind tunnels are presented on the aerodynamic characteristics of honeycomb grid fin wings, both isolated and mounted on bodies of revolution. Results were obtained in the freestream Mach number range of 0.6-3.6 and in the angle-of-attack range of -4 deg to +12 deg. L.M.

A92-30202
THEORETICAL ANALYSIS OF THE EFFECT OF THE POROUS WALLS OF A WIND TUNNEL ON TRANSONIC FLOW PAST BODIES OF CONE-CYLINDER TYPE [RASCHETNOE ISSLEDOVANIE VLIIANIIA PERFORIROVANNYKH STENOK AERODINAMICHESKOI TRUBY NA TRANSZVUKOVOE OBTEKANIIE TEL TIPA KONUS-TSILINDR]
S. A. VELICHKO and I. A. SOLNTSEV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 31-40. In Russian. refs
Copyright
The flow past cone-cylinder-type bodies of revolution in a transonic wind tunnel was investigated using a numerical method for solving the boundary value problem for the potential equation. The main effects of the porous wind-tunnel walls are identified. The calculation results are presented in accordance with the similarity laws that follow from an analysis of the asymptotic properties of axisymmetric transonic flows. L.M.

A92-30203
A METHOD FOR CALCULATING THE SEPARATED FLOW PAST A CIRCULAR CONE, TAKING VISCOUS-INVISCID INTERACTION INTO ACCOUNT [METOD RASCHETA OTRYVNOGO OBTEKANIIA KRUGOVOGO KONUSA S UCHETOM VIAZKO-NEVIAZKOGO VZAIMODEISTVIIA]
A. M. GAIFULLIN and S. B. ZAKHAROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 41-49. In Russian. refs
Copyright
A method is developed for the simultaneous solution of the Laplace equations for the velocity potential and the boundary layer equations, making it possible to account for viscous-inviscid interaction in the case of global separation from a smooth surface. A calculation of the symmetrical separated flow past a slender circular cone is presented. L.M.

A92-30204
ASYMPTOTIC FORM OF THE LOWER BRANCH OF THE NEUTRAL CURVE IN A TRANSONIC BOUNDARY LAYER [ASIMPTOTICHESKAIA FORMA NIZHNEI VETVI NEITRAL'NOI KRIVOI V TRANSZVUKOVOM POGRANICHNOM SLOE]
S. N. TIMOSHIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 50-57. In Russian. refs
Copyright
A special version of the transonic theory of the unsteady interaction of the laminar boundary layer on a flat plate with an external flow at high Reynolds numbers is developed. It is shown that this theory describes the asymptotic form of the lower branch of the neutral stability curve in the transonic range of the freestream Mach number. L.M.

A92-30206
AERODYNAMIC CHARACTERISTICS OF SLENDER SHARP-LEADING-EDGE DELTA WINGS WITH AIR SCOOPING THROUGH THE AIR INTAKE AT HYPERSONIC VELOCITIES. I [AERODINAMICHESKIE KHARAKTERISTIKI TONKIKH ZAOSTRENNYKH TREUGOL'NYKH KRYL'EV S OTBOROM VOZDUKHA CHEREZ VOZDUKHOZABORNIK PRI GIPERZVUKOVYKH SKOROSTIAKH. I]
S. A. BAKHAREV, V. G. GURYLEV, and A. P. KOSYKH TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 67-77. In Russian. refs
Copyright
Based on numerical calculations of flow near infinitely slender delta wings with an attached shock wave at hypersonic velocities (M = 6-10, alpha = 5 and 10 deg), the lift and drag coefficients and the lift/drag ratio of wings with air scooping through a rectangular 'frame' of the intake entry are determined. Simple formulas are derived which make it possible to take into account the effect of the air scooping on the aerodynamic characteristics of delta wings. It is shown that the air scooping leads to a reduction in the lift and drag coefficients and the lift/drag ratio. L.M.

A92-30207
THEORETICAL ANALYSIS OF A SUCTION DIFFUSER IN THE POROUS TEST SECTION OF A WIND TUNNEL [RASCHETNYE ISSLEDOVANIIA RASKHODNOGO DIFFUZORA V PERFORIROVANNOI RABOCHEI CHASTI AERODINAMICHESKOI TRUBY]
A. N. TOLMACHEV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 78-89. In Russian. refs
Copyright
A one-dimensional mathematical model is used to study steady gas flow in the porous test section of a wind tunnel. In this approach, the main conservation laws are written in integral form for the test section components; as a result, a numerical method is obtained that makes it possible to carry out calculations for arbitrary Mach numbers, including those very close to unity. It is shown that this model makes it possible to describe such effects as the appearance of a 'suction nozzle' and a 'suction diffuser' in a porous test section. L.M.

A92-30210
EFFECT OF THE LONGITUDINAL AND TRANSVERSE RIBLETS OF A FLAT PLATE ON LAMINAR-TO-TURBULENT TRANSITION [VLIIANIE PRODOL'NOGO I POPERECHNOGO OREBRENIIA PLOSKOI PLASTINY NA LAMINARNO-TURBULENTNYI PEREKHOD]
I. A. BELOV, G. V. ENIUTIN, and V. M. LITVINOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 107-111. In Russian. refs
Copyright
Experimental results are presented on the effect of the riblets of a flat plate on laminar-to-turbulent transition. Tests were carried out in a subsonic wind tunnel in a wide velocity range (6-43 m/s) on various small riblet surfaces with different riblet shapes and geometrical dimensions. It is shown that the moment of the appearance of the transition depends not only on the geometric parameters of the riblets and flow conditions but also on the riblet orientation with respect to the direction of the free-stream flow. L.M.

A92-30211
NUMERICAL DETERMINATION OF THE REGIONS OF EXISTENCE OF TWO TYPES OF SHOCK-WAVE INTERACTION [CHISLENNOE OPREDELENIE OBLASTEI SUSHCHESTVOVANIIA DVUKH TIPOV VZAIMODEISTVIIA UDARNYKH VOLN]
S. M. BOLDYREV and S. E. MOIZIS TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 112-116. In Russian. refs
Copyright
The paper presents results of the numerical determination of the regions of the existence of the first and second types of shock-wave interaction. The effect of the adiabatic index and the Mach number on the dimensions of these regions is demonstrated. Regions of regular and irregular reflection of the incident refracted wave from the surface of a body are identified. L.M.

A92-30212
ITERATIVE ALGORITHMS FOR SOLVING PROBLEMS OF THE SHAPING OF THREE-DIMENSIONAL DUCTS [OB ITERATSIONNYKH ALGORITMAKH RESHENIIA ZADACH PROFILIROVANIIA PROSTRANSTVENNYKH KANALOV]
IU. V. KURILENKO and M. P. LEVIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 117-122. In Russian. refs
Copyright
The paper examines the shaping of 3D supersonic ducts which are to provide either a uniform inlet flow or a specified distribution of gasdynamic functions over a central body. The corresponding ill-posed problems are reduced to a sequence of subproblems of flow past a parameterized wall. Values of the parameters governing the wall shape are determined from the solution of a system of nonlinear equations. Two iterative algorithms for solving these systems are considered; the first is based on the relaxation method, while the second is based on the Broyden method. L.M.

A92-30319
UNIQUENESS OF SOLUTIONS OF THE GENERALIZED TRICOMI PROBLEM ARISING IN THE THEORY OF THE LAVAL NOZZLE [O EDINSTVENNOSTI RESHENII OBOBSHCHENNOI ZADACHI TRIKOMI, VOZNIKSHEI V TEORII SOPLA LAVALIA]
N. IU. KAPUSTIN (Moskovskii Gosudarstvennyi Universitet, Moscow, Russia) and K. B. SABITOV (Sterlitamakskii Gosudarstvennyi Pedagogicheskii Institut, Sterlitamak, Russia) Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 321, no. 6, 1991, p. 1151-1154. In Russian. refs
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A92-30371
DYNAMICS OF THE THREE-DIMENSIONAL ANGULAR MOTIONS OF ROTATING FLIGHT VEHICLES IN THE PRESENCE OF THE AERODYNAMIC HYSTERESIS OF THE MOMENT CHARACTERISTIC [DINAMIKA PROSTRANSTVENNYKH UGLOVYKH DVIZHENII VRASHCHAIUSHCHIKHSIA LETATEL'NYKH APPARATOV PRI NALICHII AERODINAMICHESKOGO GISTEREZISA MOMENTNOI KHARAKTERISTIKI]
S. S. BOGODISTOV and V. G. SITNIKOV Moskovskii Gosudarstvennyi Tekhnicheskii Universitet, Vestnik, Seriia Mashinostroenie (ISSN 0236-3941), Jan.-Mar. 1991, p. 29-35. In Russian. refs
Copyright
The three-dimensional angular motions of a uniformly rotating axisymmetric flight vehicle characterized by aerodynamic hysteresis are analyzed as a function of the three-dimensional angle of attack. Bifurcation surfaces are constructed which separate the parameter space of the dynamic system considered into regions with qualitatively different regimes of angular motion. The results provide an estimate of the possible motions of rotating flight vehicles with a hysteresis of aerodynamic characteristics in the case of the piecewise linear approximation of the moment. V.L.

A92-30373
AN APPROXIMATE METHOD FOR CALCULATING FLOW PAST SOLID WINGS OF SMALL ASPECT RATIO BASED ON A NONLINEAR THEORY OF A CONTINUOUS VORTEX SURFACE [PRIBLIZHENNYI METOD RASCHETA OBTEKANIIA TELESNYKH KRYL'EV MALOGO UDLINENIIA NA OSNOVE NELINEINOI TEORII NEPRERYVNOI VIKHREVOI POVERKHNOSTI]
A. I. PASTUKHOV and E. K. GALEMIN Moskovskii Gosudarstvennyi Tekhnicheskii Universitet, Vestnik, Seriia Mashinostroenie (ISSN 0236-3941), Jan.-Mar. 1991, p. 55-60. In Russian. refs
Copyright
A method for calculating load distributions over the surfaces of cylindrical bodies of small aspect ratios and their force and moment characteristics is proposed which is based on the nonlinear vortex theory of lifting surfaces. Results of calculations of the wing root pressure coefficient for an angle of attack of 20 deg are presented for the NACA-0018 airfoil. A comparison with experimental data indicates that the method provides satisfactory estimates of distributed aerodynamic characteristics. V.L.

A92-30375
CALCULATION OF THE AERODYNAMIC CHARACTERISTICS OF BODIES OF REVOLUTION IN INCOMPRESSIBLE FLOW BY THE VORTEX SURFACE METHOD [VYCHISLENIE AERODINAMICHESKIKH KHARAKTERISTIK TEL VRASHCHENIIA V NESZHIMAEMOM POTOKE METODOM VIKHREVOI POVERKHNOSTI]
A. I. PASTUKHOV, A. D. DERIABIN, and V. F. VERETENNIKOV Moskovskii Gosudarstvennyi Tekhnicheskii Universitet, Vestnik, Seriia Mashinostroenie (ISSN 0236-3941), Jan.-Mar. 1991, p.

110-116. In Russian. refs
Copyright

An approximate method for calculating the distributed and integral aerodynamic characteristics of bodies of revolution of arbitrary shape is proposed which is based on a nonlinear vortex theory. The method has been developed for separated flows past bodies moving in an incompressible medium at large angles of attack and is intended for use in CAD systems for the design of flight vehicles. V.L.

A92-30502
OBSERVATION AND TESTING ON SUPERSONIC MULTIPHASE FLOW
MICHIO NISHIOKA (Osaka Prefecture, University, Sakai, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. S-6 to S-14. In Japanese. refs

The development of supersonic combustion engines is presented. The convective Mach number is used and supersonic multiphase flow mixing control is discussed. A series of flow visualization images is presented. Y.P.Q.

A92-30517
NUMERICAL COMPUTATION OF COMPRESSIBLE FLOW AROUND AN OBJECT OF COMPLEX SHAPE
TETSU OGAWA, YASUHIRO WADA, NORIYOSHIKO ISHIGURO (Institute of Space and Astronautical Science, Sagamihara, Japan), and HAKO TAKAKURA (Fujitsu, Ltd., Tokyo, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 52-55. In Japanese. refs

Computer-aided models for the calculation of compressible flow around an object of complex shape are presented. Computational grids and the appropriate difference method are given. The total variation diminishing (TVD) scheme is emphasized. Y.P.Q.

A92-30520
OPTIMIZED CONTROL OF STRUCTURED GRIDS
K. NAKAHASHI (Osaka Prefecture, University, Sakai, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 64-67. In Japanese. refs

A computational fluid dynamics method for objects of complex shape is presented. The optimized control of marching structured grids and transverse structured grids are discussed. Y.P.Q.

A92-30522
THE UNSTRUCTURED UPWIND METHOD
EIJI SHIMA (Kawasaki Heavy Industries, Ltd., Chofu Technical Institute, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 72-75. In Japanese. refs

Numerical analysis involving the Euler equations and Navier-Stokes equations is discussed. The upwind method of the two-dimensional Euler equation for unstructured grids is examined. Unstructured mesh is also discussed. Y.P.Q.

A92-30523
MULTI-BLOCK AIRFOIL PROFILE OF GRID FORMATION
KENICHI MATSUNO (Institute of Space and Astronautical Science, Sagamihara, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 76-79. In Japanese. refs

Numerical computation for structured and unstructured grids is presented. Grid formation is discussed and transfinite interpolation techniques are addressed. A series of diagrams on airfoil profiles is presented. Y.P.Q.

A92-30526
AERODYNAMIC PERFORMANCES OF SPOILER MOTION
HIDEAKI TAKAHASHI, YASUYOSHI AIBARA (Tokyo, University, Japan), and XIEZHEN YIN (Chinese Science and Technology University, Anhui, People's Republic of China) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 92-95. In Japanese. refs

Test equipment and methods of flow visualization are presented. The distribution of spoiler motion is calculated, and the pressure distribution is determined. Y.P.Q.

A92-30527
EXPERIMENT ON PITCHING MOMENTS OF SEPARATED FLOW AROUND AIRFOIL PROFILES
SHIGERU ASO and TOKUNO KANCHIRA (Kyushu University, Fukuoka, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 96-99. In Japanese. refs

Experimental equipment and methods for investigating the pitching moments of separated flow around airfoil profiles are presented. Calculation and experimental results for the separated flow are compared. Y.P.Q.

A92-30528
AIR FLOW UNDER A FLIGHT-VEHICLE ENGINE
EIICHIRO NAKANO and HIROTO KUBOTA (Tokyo, University, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 100-103. In Japanese. refs

Experimental equipment and methods for investigating the air flow under a flight-vehicle engine are presented. Schlieren photographs of the flow are presented. Y.P.Q.

A92-30530
STUDY ON TWO-DIMENSIONAL JET MIXING WITH A VERTICAL SUPERSONIC FLOW
SHIGERU ASO, TETSU OKUYAMA (Kyushu University, Fukuoka, Japan), MASAFUMI KAWAI, and SHUNRO FUJIMORI (Ishikawajima-Harima Heavy Industries Co., Ltd., Yokohama, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 108-111. In Japanese. refs

Two-dimensional jet mixing with a vertical supersonic flow is studied experimentally. The wall pressure distribution is analyzed and schlieren photographs the flow fields are presented. Y.P.Q.

A92-30531
STUDY ON NOZZLE FLOW DIFFUSION
MOTOAKIRA KIMURA and KIYOAKI ONO (Nihon University, Tokyo, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 112-115. In Japanese. refs

Studies on diffusion structures from potential cores are presented. Static pressure is measured and schlieren photographs of a jet in the near nozzle region are presented. The average velocity distribution and static pressure distribution are discussed. Y.P.Q.

A92-30532
THE BAUER-GARABEDIAN-KORN AIRFOIL TEST IN A TWO-DIMENSIONAL WIND TUNNEL
S. SUYA and HIROSHI KANDA (Institute of Space and Astronautical Science, Sagamihara, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 116-119. In Japanese. refs

Pressure distribution measurements and visualization tests are presented for tests conducted in a two-dimensional transonic wind tunnel. Schlieren photographs of the pressure distribution are presented. Y.P.Q.

A92-30538
STUDY OF CAVITY PUMPING IN SUPERSONIC INTERNAL FLOW
TETSU MURAKAMI, K. SAKATA (Institute of Space and Astronautical Science, Sagamihara, Japan), and FUMIO

OMIYAYAMA (Tokyo, University, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 140-143. In Japanese. refs

The fundamental structure of cavity pumping flows is presented. The intake slot section simulated for hypersonic flow is designed. The pressure distribution of the diffuser outlet is addressed. Y.P.Q.

A92-30539
NUMERICAL COMPUTATION OF SUPERSONIC INTAKES
SHINICHI KURODA (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan) and KOZO FUJII (Institute of Space and Astronautical Science, Sagamihara, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 144-147. In Japanese. refs

The engine air intakes for the next-generation supersonic transport are discussed. The Lu-ADI method, Roe's flux difference splitting, and the MUSCL are used for analysis of the supersonic intake. The Concorde intake inlet is considered as an example. Y.P.Q.

A92-30540
NUMERICAL SIMULATION OF SUPERSONIC NOZZLE FLOW
T. HIRATA, T. MIYAUCHI, and M. KITAJIMA (Tokyo Industrial University, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 148-151. In Japanese. refs

Supersonic nozzle design is considered. The M6 axisymmetric nozzle is emphasized, and the Navier-Stokes equations are given. Y.P.Q.

A92-30541
COMPUTATION OF SCRAMJET INLET FLOW
NORIYOSHUIKO ISHIGURO, S. OGAWA, and Y. WADA (Institute of Space and Astronautical Science, Sagamihara, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 152-155. In Japanese. refs

Scramjet engines for supersonic or hypersonic flying vehicles are presented. The Navier-Stokes equations are given for computation of the inlet flow. Y.P.Q.

A92-30542
NUMERICAL COMPUTATION AND EXPERIMENTAL STUDY OF SHOCK WAVE REFLECTION
TENRYUKI NAKAJIMA, SHIGERU ASO, and M. NISHIDA (Kyushu University, Fukuoka, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 156-159. In Japanese. refs

Investigation of shock wave reflection in connection with hypersonic flight is examined. Two-dimensional Euler equations and Piecewise Linear methods (PLM) are given for numerical computation and testing. Schlieren photographs and density contours are presented. Y.P.Q.

A92-30550
MEASUREMENT ON HYPERSONIC DYNAMIC STABLE COEFFICIENTS OF A WINGED VEHICLE
SHIGEYA WATANABE, A. YOSHINAGA, and AKIRA YOSHIZAWA (Institute of Space and Astronautical Science, Sagamihara, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 188-191. In Japanese. refs

The measurement of dynamic stability for a flight vehicle is presented. A computational method for dynamic stability and static stability coefficients is reported. The basic mode of the pitching free vibration is discussed. Y.P.Q.

A92-30551
APPROXIMATE ANALYSIS OF AERODYNAMIC HEATING AT HYPERSONIC SPEED
KEIICHI KARASHIMA and KIYOSHI SATO (National Aerospace Laboratory, Tokyo, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 192-195. In Japanese. refs

A plate thermal sensor is used in a wind tunnel test. The thermal video system TVS-2000 is presented for the measurement of the surface temperature distribution of the hypersonic flow past a plate. An algorithm for the evaluation of heat transfer is presented. Y.P.Q.

A92-30552
STUDY ON EFFECTIVENESS OF THE FRONT WEDGE SHAPE IN HYPERSONIC FLOW
TOSHIO MATSUI and ETSUO MORISHITA (Tokyo, University, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 196-199. In Japanese.

A hypersonic thermal wind tunnel test for the effectiveness of the front wedge shape is presented. Schlieren photographs of spikes are presented and the drag coefficients of spikes are measured. Y.P.Q.

A92-30557
NUMERICAL ANALYSIS ON LAMINAR FLOW CONTROL OF TRANSONIC AIRFOILS
N. KAWAI and Y. ISHIDA (Institute of Space and Astronautical Science, Sagamihara, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 216-219. In Japanese. refs

The use of Navier-Stokes equations in laminar flow control theory is discussed. The boundary conditions and flow model are given and an analysis of the distribution of pressure and friction coefficients is presented. Y.P.Q.

A92-30558
NUMERICAL ANALYSIS OF HELICOPTER ROTOR BLADES
SHIGERU SAITO (Institute of Space and Astronautical Science, Sagamihara, Japan), G. AOYAMA, and K. KAWAUCHI (Tokyo, University, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 220-223. In Japanese. refs

An analysis on helicopter vortex flow is presented. The Chakravathy-Osher typed TVD scheme is used to investigate the pressure distribution on the helicopter blade tips. The blade shape design for high speed is also discussed. Y.P.Q.

A92-30559
LOW SPEED AERODYNAMIC PERFORMANCE OF A CAPSULE-SHAPED FLYING OBJECT
TADAHARU WATANUKI, H. KUBOTA, SHINICHI MIKAMI (Tokyo, University, Japan), H. SUZUKI (Institute of Space and Astronautical Science, Sagamihara, Japan), and JUNICHI SATO (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 224-227. In Japanese.

The measurement of the flow field around a capsule-shaped flying object is presented. The duct wall pressure distribution is examined and the velocity distribution inside the duct is computed. Y.P.Q.

A92-30560
BOUNDARY LAYER FLOWS AROUND AN AIRSHIP
N. TSUBOKAWA and MITSUO MAKINO (Nihon University, Tokyo, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 228-231. In Japanese. refs

Navier-Stokes analysis for boundary layer flows is presented. The Legendre equation and the Pohlhausen method are used for the outlet and inlet flows of the boundary layer. The inertia coefficient is determined from Laplace's equation. Y.P.Q.

A92-30624#
EXPERIMENTAL AND COMPUTATIONAL INVESTIGATION OF WIND TUNNEL EFFECTS ON AIRFOIL FLOW FIELDS
MICHAEL PAPADAKIS and L. S. MILLER (Wichita State University, KS) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(AIAA PAPER 92-0672) Copyright

An experimental and computational investigation has been conducted to evaluate a new procedure which can be used to account for wind tunnel effects on the flow field about airfoils. This new approach provides the necessary data for more precise simulation of wind tunnel boundary conditions in computational fluid dynamic (CFD) codes. Detailed experimental and computational data for a NACA 0011 airfoil section are compared and include force, pressure and boundary layer data. The results of this investigation indicate that correlation between experiment and analysis improves when the wind tunnel boundaries are correctly accounted for in CFD solutions. Author

A92-30850
HIGH ANGLE OF ATTACK AERODYNAMICS - SUBSONIC, TRANSONIC, AND SUPERSONIC FLOWS
JOSEF ROM (Technion - Israel Institute of Technology, Haifa) Research supported by El-Dee Foundation, USAF, and U.S. Army. New York, Springer-Verlag, 1992, 409 p. refs
(ISBN 0-387-97672-8) Copyright

Many aspects of flow phenomena associated with the aerodynamics of high angle of attack (AOA) are discussed, emphasizing methods for analysis and numerical calculations. The general topics discussed are: flows at high AOAs, the topology of separating and reattaching vortical flows, linear and nonlinear aerodynamics of wings and bodies at high AOAs, vortex flows and the rolled up vortex wake, nonlinear panel methods for aircraft and missile configurations at high AOAs, and solutions of the Euler and Navier-Stokes equations for flows over configurations at high AOAs. C.D.

A92-31151
FLOW NEAR THE TRAILING EDGE OF AN AIRFOIL
LUCIEN Z. DUMITRESCU (Institute of Aeronautics, Bucharest, Romania) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 865-870. refs
Copyright

Some theorems are established for the slope and curvature radius of an airfoil contour obtained by conformal mapping, the velocity gradient along it, and the curvature of streamlines. Following a discussion on some general features of the conformal mapping for a wide range of airfoil shapes, the flow behavior near the trailing edge is carefully examined. It is shown that, in potential flow, the emerging streamline there has infinite curvature, except at a singular angle of attack. One infers that the interplay between the external flow and the boundary layer will produce, at each flow regime, an equivalent airfoil contour (with the displacement thickness added), having such a shape at the trailing edge that its singular angle of attack, rendering the streamline curvature finite, would coincide with the actual incidence. This might require a certain amount of separation; therefore, by suitably shaping the trailing edge of the real airfoil, e.g., with a small moving tab, one may alter the contour to avoid detachment, and thereby reduce cruise drag by a few percent. Author

A92-31152
NUMERICAL SIMULATION OF THREE-DIMENSIONAL SUPERSONIC FREE SHEAR LAYERS
ISMAIL H. TUNCER and LAKSHMI N. SANKAR (Georgia Institute of Technology, Atlanta) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 871, 872. Abridged. Previously cited in issue 02, p. 139, Accession no. A91-12472. refs
Copyright

A92-31154
OPTIMIZATION OF BLUFF BODY FOR MINIMUM DRAG IN GROUND PROXIMITY
T. HAN, D. C. HAMMOND, JR., and C. J. SAGI (General Motors Research Laboratories, Warren, MI) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 882-889. Previously cited in issue 21, p. 3286, Accession no. A90-45869. refs
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A92-31155* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STRUCTURE OF SUPERSONIC TURBULENT FLOW PAST A SWEPT COMPRESSION CORNER
DOYLE D. KNIGHT (Rutgers University, New Brunswick, NJ), C. C. HORSTMAN (NASA, Ames Research Center, Moffett Field, CA), and SEYMOUR BOGDONOFF (Princeton University, NJ) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 890-896. Research supported by NASA and NSF. refs
(Contract AF-AFOSR-86-0266; F49620-86-C-0094)
Copyright

The structure of the shock wave/turbulent boundary-layer interaction generated by a 3D swept compression corner has been investigated through a combined experimental and theoretical research program. The flowfield geometry is defined by the streamwise compression angle alpha and the sweep angle lambda of the corner. The present study examines two different configurations, namely (alpha, lambda) = (24 deg, 40 deg) and (24 deg, 60 deg) at Mach 3 and Re sigma infinity about 9 x 10 exp 5. The theoretical model is the 3D Reynolds-averaged compressible Navier-Stokes equations with turbulence incorporated using a turbulent eddy viscosity. The calculated flowfields display general agreement with experimental data for surface pressure and good agreement with experimental flowfield profiles of pitot pressure and yaw angle. The principal feature of the flowfield is a large vortical structure approximately aligned with the corner. The entrainment of incoming fluid into the vortical structure is strongly affected by the sweep angle lambda. Viscous (turbulent and molecular) effects appear to be important only in the immediate vicinity of the surface and in an isolated region within the interaction and near the corner. Author

A92-31156* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NONADIABATIC AND THREE-DIMENSIONAL EFFECTS IN COMPRESSIBLE TURBULENT BOUNDARY LAYERS
RICHARD W. BARNWELL (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 897-904. Previously cited in issue 06, p. 800, Accession no. A91-19345. refs
Copyright

A92-31157* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LINEAR STABILITY OF THREE-DIMENSIONAL BOUNDARY LAYERS OVER AXISYMMETRIC BODIES AT INCIDENCE
R. E. SPALL and M. R. MALIK (High Technology Corp., Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 905-913. Previously cited in issue 17, p. 2856, Accession no. A91-42540. refs
(Contract NAS1-18240)
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A92-31158
FLUX-DIFFERENCE SPLIT ALGORITHM FOR UNSTEADY THIN-LAYER NAVIER-STOKES SOLUTIONS
L. B. SIMPSON (USAF, Wright Laboratory, Eglin AFB, FL) and DAVID L. WHITFIELD (Mississippi State University, Mississippi State) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 914-922. Previously cited in issue 18, p. 2752, Accession no. A89-41838. refs

A92-31160
ORTHOGONAL GRIDS AROUND DIFFICULT BODIES
GINO MORETTI (GMAF, Inc., Freeport, NY) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 933-938. refs
(Contract NSF DMS-89-10679)
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The paper presents an easy-to-implement modification of the classical Theodorsen and Garrick (1933) technique for mapping quasicircles onto circles, making it possible to generate orthogonal grids as a matter of simple routine. The new technique consists of a simple addition of an auxiliary contour, linearly related to the original contour and a circle, allowing the mapping of the former onto the latter; the consequent generation of an orthogonal grid is achieved by applying the Theodorsen mapping to the auxiliary contour. The technique is contained in a short program (including the auxiliary subroutines for splining, interpolating, and an FFT). Application examples are presented. I.S.

A92-31163* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SOLUTION-ADAPTIVE GRID PROCEDURE FOR THE PARABOLIZED NAVIER-STOKES EQUATIONS
ALBERT D. HARVEY, III, SUMANTA ACHARYA (Louisiana State University, Baton Rouge), and SCOTT L. LAWRENCE (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 953-962. Previously cited in issue 06, p. 794, Accession no. A91-19137. refs
(Contract NCA2-326)
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A92-31165* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TWO- AND THREE-DIMENSIONAL EFFECTS IN THE SUPERSONIC MIXING LAYER
N. T. CLEMENS and M. G. MUNGAL (Stanford University, CA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 973-981. Research supported by USAF, Stanford University, and NASA. Previously cited in issue 19, p. 2976, Accession no. A90-42708. refs
Copyright

A92-31167* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HELICAL-PERTURBATION DEVICE FOR CYLINDER-WING VORTEX GENERATORS
PROMODE R. BANDYOPADHYAY, JOHN E. RIESTER, and ROBERT L. ASH (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 988-992. Previously cited in issue 16, p. 2485, Accession no. A90-38756. refs
(Contract NAS1-18599; NAG1-530)
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A92-31169* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CALCULATION OF REAL-GAS EFFECTS ON BLUNT-BODY TRIM ANGLES
CHUL PARK (NASA, Ames Research Center, Moffett Field, CA) and SEOKKWAN YOON (MCAT Institute, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 999-1007. Previously cited in issue 10, p. 1432, Accession no. A89-28447. refs
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A92-31172
EXPERIMENTAL INVESTIGATIONS OF THE VORTEX FLOW ON DELTA WINGS AT HIGH INCIDENCE
W. H. STAHL (DLR, Goettingen, Federal Republic of Germany), M. MAHMOOD, and A. ASGHAR (King Fahad University of Petroleum and Minerals, Dhahran, Saudi Arabia) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 1027-1032. refs
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The early reports concerning the occurrence of strongly asymmetric vortex flow on the lee side of slender delta wings at high incidence (Polhamus, 1971; Wardlaw, 1979; Stallings, 1986) were reexamined by carrying out dye flow-visualization tests in a water tunnel, on two slender sharp-edged delta wings of aspect ratios A = 0.56 and 0.28, up to high incidences. Another delta wing, with A = 0.56 was studied in a wind tunnel, using a smoke flow-visualization techique. Reynolds numbers for the water and the wind tunnels were 3.4 x 10 exp 4 and 1.32 x 10 exp 5, respectively. In both types of tunnels, no asymmetric vortex flow was found to occur on the lee side of a wing until vortex breakdown reached the wing. I.S.

A92-31183
HIGH AERODYNAMIC LOADS ON AN AIRFOIL SUBMERGED IN AN UNSTEADY STREAM
ISMET GURSUL and CHIH-MING HO (Southern California, University, Los Angeles, CA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 1117-1119. refs
(Contract F49620-88-C-0061)
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Experimental results are presented for a NACA 0012 airfoil at an angle of attack of 20 deg, which is higher than the static stall angle. Experiments were conducted in a specially designed vertical unsteady water channel, in which the flow between the upper and the lower reservoirs is gravity fed. The freestream velocity was varied over a large range of amplitudes and frequencies. Results of velocity and lift measurements showed that, at an optimum reduced frequency, the phase-averaged lift coefficient could be one order of magnitude higher than are the conventional values. I.S.

A92-31185 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
USE OF FINITE VOLUME SCHEMES FOR TRANSITION SIMULATION
CHARLES C. FENNO, JR. (North Carolina State University, Raleigh), CRAIG L. STREETT (NASA, Langley Research Center, Hampton, VA), and H. A. HASSAN (North Carolina State University, Raleigh) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 1122-1125. Research supported by USAF and U.S. Navy. Previously cited in issue 06, p. 803, Accession no. A91-19444. refs
(Contract NCC1-22; NAGW-1022; NAGW-1331)
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A92-31186* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FREESTREAM CAPTURING FOR MOVING COORDINATES IN THREE DIMENSIONS
SHIGERU OBAYASHI (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 1125-1128. refs
(Contract NCC2-605)
Copyright

A detailed formula is developed that can be used in both finite-volume (FV) and finite-difference (FD) methods for constructing freestream capturing metrics in space and time. It is shown that, considering an FV cell on the FD grid, the freestream capturing metrics in space and time can be constructed from the FD formulation. The approach is costly but guarantees the global conservation for an arbitrary motion of the grid. I.S.

A92-31187
SEMI-INVERSE MARCHING CHARACTERISTICS SCHEME FOR SUPERSONIC FLOWS
JOSEPH FALCOVITZ and ALLEN E. FUHS (U.S. Naval Postgraduate School, Monterey, CA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 1128-1130. refs

A modification of the inverse marching characteristics scheme for compressible flows was developed, designed to yield an exact computation of centered rarefaction waves such as the Prandtl-Meyer corner expansion flow (PMF). The new scheme combines a semiinverse marching scheme (where grid points near

corner are located on continuous characteristics emanating from the corner) with the designation of Riemann invariants as flow variables. It is shown that the resulting semiinverse marching algorithm (SIMA) scheme accurately replicates a Prandtl-Meyer flow, while yielding the solution on a relatively regular grid. The accuracy of the SIMA scheme was tested on a case of the reflection of a PMF (delta = 0) from a symmetry plane (x = 0), which represents a planar plume flow. I.S.

A92-31188
CYLINDER-INDUCED SHOCK-WAVE BOUNDARY-LAYER INTERACTION
OKTAY OZCAN and BULENT K. YUCEIL (Istanbul Technical University, Turkey) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 1130-1132. Research supported by Istanbul Technical University. refs
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The shock-wave/turbulent boundary-layer interaction generated by a cylindrical protuberance mounted on a flat plate was investigated in a trisonic wind tunnel, at Mach numbers 1.7 and 2.2, using oil flow visualization technique to observe flow characteristics. Data are presented for flow regions both upstream and downstream of the cylinder, demonstrating various physical aspects of the flow, including the static pressure contours and the skin-friction lines on the flat plate. I.S.

A92-31425
ON HYPERSONIC FLOW OVER TWO-DIMENSIONAL AEROFOILS
HAMDI T. HEMDAN (King Saud University, Riyadh, Saudi Arabia) Communications in Applied Numerical Methods (ISSN 0748-8025), vol. 8, March 1992, p. 179-191. refs
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This paper considers the problem of hypersonic flow past two-dimensional thin aerofoils with sharp leading edges and attached shock waves. The analysis relies on another recent formulation of the hypersonic small disturbance theory, HSDT. The equations are reduced to a complicated functional-differential equation for which an iterative numerical scheme is employed. In each iteration both the functional and differential parts of the functional-differential equation are eliminated, thus reducing it to an algebraic equation. The iterative scheme is found to be stable and rapidly convergent, and the results obtained for the surface pressure and shock wave compare well with other exact and approximate methods. Author

A92-31468
NUMERICAL INVESTIGATION OF THE HIGH-SPEED CONICAL FLOW PAST A SHARP FIN
ARGYRIS G. PANARAS (DLR, Goettingen, Federal Republic of Germany) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 236, March 1992, p. 607-633. refs
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The supersonic flow past a fin mounted on a flat plate is simulated numerically by solving the Reynolds averaged Navier-Stokes equations. The results agree well with the experimental data. Postprocessing of the numerical solution provides the missing flowfield evidence for confirming the currently accepted flow model, whose conception was based mainly on surface data. It is found that the flow is dominated by a large vortical structure, which lies on the plate and whose core has a remarkably conical shape with flattened elliptical cross section. Along the fin and close to the corner, a slowly growing smaller vortex develops. On top of the conical vortex and along it a lambda-shock is formed. Quantitative data are presented, which show that the flow is not actually purely conical but that a small deviation exists, especially at the part between the separation shock and the plate. This deviation is detected when the streamwise extent of the flow is more than 20-30 initial boundary-layer thicknesses. Owing to the rather quasi-conical nature of the flow, the various flow variables do not remain constant along rays that start at the origin of the conical flowfield, but they vary slowly. Data are presented which support the view that this deviation from conical behavior is mainly due to the effect of the smaller rate of development of the boundary layer of the plate, compared to the conical vortex. Author

A92-31487* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A NON-LINEARLY STABLE IMPLICIT FINITE ELEMENT ALGORITHM FOR HYPERSONIC AERODYNAMICS
G. S. IANNELLI and A. J. BAKER (Tennessee, University, Knoxville) (International Association for Computational Mechanics, World Congress of Computational Mechanics, 2nd, Stuttgart, Federal Republic of Germany, Aug. 27-31, 1990) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 34, March 30, 1992, p. 419-441. refs
(Contract NAS2-12568)
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A generalized curvilinear coordinate Taylor weak statement implicit finite element algorithm is developed for the two-dimensional and axisymmetric compressible Navier-Stokes equations for ideal and reacting gases. For accurate hypersonic simulation, air is modeled as a mixture of five perfect gases, i.e., molecular and atomic oxygen and nitrogen as well as nitric oxide. The associated pressure is then determined via Newton solution of the classical chemical equilibrium equation system. The directional semidiscretization is achieved using an optimal metric data Galerkin finite element weak statement, on a developed 'companion conservation law system', permitting classical test and trial space definitions. Utilizing an implicit Runge-Kutta scheme, the terminal algorithm is then nonlinearly stable, and second-order accurate in space and time on arbitrary curvilinear coordinates. Subsequently, a matrix tensor product factorization procedure permits an efficient numerical linear algebra handling for large Courant numbers. For ideal- and real-gas hypersonic flows, the algorithm generates essentially nonoscillatory numerical solutions in the presence of strong detached shocks and boundary layer-inviscid flow interactions. Author

A92-31489
TIME MARCHING INTEGRAL EQUATION METHOD FOR UNSTEADY TRANSONIC FLOWS AROUND AIRFOILS
JICHAO SU (Beijing University of Aeronautics and Astronautics, People's Republic of China) (International Association for Computational Mechanics, World Congress of Computational Mechanics, 2nd, Stuttgart, Federal Republic of Germany, Aug. 27-31, 1990) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 34, March 30, 1992, p. 455-467. refs
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A time marching integral equation method has been proposed here which does not have the limitation of the time linearized integral equation method in that the latter method cannot satisfactorily simulate the shock wave motions. Firstly, a model problem - one-dimensional initial and boundary value wave problem is treated to clarify the basic idea of the new method. Then the method is implemented for two-dimensional unsteady transonic flow problems. The introduction of the concept of a quasi-velocity-potential simplifies the time marching integral equations and the treatment of trailing vortex sheet condition. The numerical calculations show that the method is reasonable and reliable. Author

A92-31491* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NAVIER-STOKES SIMULATION OF FLOW THROUGH A HIGHLY CONTOURED SUBSONIC DIFFUSER
W. J. CHYU and D. P. BENCZE (NASA, Ames Research Center, Moffett Field, CA) (International Association for Computational Mechanics, World Congress of Computational Mechanics, 2nd, Stuttgart, Federal Republic of Germany, Aug. 27-31, 1990) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 34, March 30, 1992, p. 473-483. refs
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The flow through a highly offset subsonic diffuser with

cross-sectional profiles that varied from rectangular at the duct entrance to circular at the engine face was numerically simulated. A multizonal approach combined with a two-grid topology was used to represent both the internal and external flowfields, and an implicit, approximately-factored, partially flux-split finite-difference algorithm was used to solve the three-dimensional thin-layer Navier-Stokes equations. The computed static pressures along the inlet wall and total pressures on the engine face were compared with experimental data. In addition, the overall flowfield within the duct was examined in detail. Good agreement is shown between experiment and computations, with the limiting factor being the lack of a reliable turbulence model for internal flow problems. Author

A92-31492
NUMERICAL SIMULATION OF THREE-DIMENSIONAL SUPERSONIC FLOW AROUND AERODYNAMIC CONFIGURATIONS

P. I. CHUSHKIN (AN SSSR, Vychislitel'nyi Tsentr, Moscow, USSR) and G. P. VOSKRESENSKII (AN SSSR, Institut Prikladnoi Matematiki, Moscow, USSR) (International Association for Computational Mechanics, World Congress of Computational Mechanics, 2nd, Stuttgart, Federal Republic of Germany, Aug. 27-31, 1990) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 34, March 30, 1992, p. 485-506. refs

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The present report deals with many applications of different numerical methods to calculations of three-dimensional stationary supersonic flows around aerodynamic configurations. Both an inviscid non-heat-conducting perfect gas and a real high-temperature gas with physical-chemical processes are considered. The results of some investigations carried out during recent years in the USSR are reviewed. A brief description of applicable numerical methods is presented. A number of results are discussed both for separate parts of a flying vehicle and for whole configurations. Some gasdynamic effects, and aerodynamic and thermal characteristics are analyzed. Among the aerodynamic elements considered are pointed and blunted nose parts of configurations, air intakes, wing, and stabilizers. Also more complicated cases are considered such as compound aerodynamic objects and configurations modeling different kinds of whole flying vehicles (missile, aircraft, spacecraft). Author

A92-31495
IMPROVING THE CONVERGENCE RATE OF THE PETROV-GALERKIN TECHNIQUES FOR THE SOLUTION OF TRANSONIC AND SUPERSONIC FLOWS

C. E. BAUMANN, M. A. STORTI, and S. R. IDELSOHN (INTEC, Santa Fe, Argentina) (International Association for Computational Mechanics, World Congress of Computational Mechanics, 2nd, Stuttgart, Federal Republic of Germany, Aug. 27-31, 1990) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 34, March 30, 1992, p. 543-568. Research supported by CONICET. refs

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Attention is given to the progress made on a technique to accelerate the convergence to steady solutions when the streamline-upwind/Petrov-Galerkin (SUPG) technique is used. A SUPG formulation is described, and the documentation of the development of a code for the finite element solution of transonic and supersonic flows is reported. A formulation is presented for treating domains of any configuration and for using the appropriate physical boundary conditions, together with an appropriate convergence rate to the steady solution. It is shown that the velocities at which error is absorbed in and ejected from the domain are strongly affected by the time step used, and that damping gives an O(N2) algorithm contrasting with the O(N) one given by absorption at the boundaries. A new mass matrix is presented that provides a scheme having the highest group velocity attainable in all the components. P.D.

A92-31496
SIMULATION OF HYPERSONIC FLOWS ON UNSTRUCTURED GRIDS

V. SELMIN and L. FORMAGGIA (Alenia S.p.A., Turin, Italy) (International Association for Computational Mechanics, World Congress of Computational Mechanics, 2nd, Stuttgart, Federal Republic of Germany, Aug. 27-31, 1990) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 34, March 30, 1992, p. 569-606. Previously announced in STAR as N91-30102. refs

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The study of high speed flows is receiving attention by aerospace industries in connection with the design of high supersonic transport aircrafts and reentry vehicles. The development of effective numerical solvers is of particular interest due to the difficulties and high costs associated with experimental work at this flow regime. High speed flow is characterized by the importance of forms of energy which are normally neglected at lower speed, namely the excitation of vibrational degrees of freedom, dissociation and ionization. The solution algorithm must take into account, to some degree, all or some of these mechanisms of energy transfer. In addition, the flow solution normally presents strong shocks and shock interactions. The code must be able to capture those features without spurious oscillations. Simulation systems taking all these factors into consideration are presented. Author

A92-31547
A NEW ADAPTIVE ALGORITHM FOR TURBULENT FLOWS

YANNIS KALLINDERIS (Texas, University, Austin) and JUDSON R. BARON (MIT, Cambridge, MA) Computers and Fluids (ISSN 0045-7930), vol. 21, Jan. 1992, p. 77-96. refs

(Contract AF-AFOSR-82-0136; AF-AFOSR-87-0218)

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A novel adaptive algorithm for turbulent flows introduces a combination of grid embedding and grid redistribution techniques, as appears to be necessary for efficient resolution of the small scales involved in viscous flows. A method for implementing an algebraic (Baldwin-Lomax) turbulence model with unstructured embedded meshes is developed also. The adaptive algorithm is applied to airfoil flow fields at relatively high Re values of order 10 exp 6, and comparisons are made with experimental data. Two airfoil geometries are considered: a single-element NACA 0012 section in both subsonic and transonic flow; and a two-element NLR section in subsonic flow for two distinct flap deflection settings. The latter simulations appear to be the first Navier-Stokes computations presented. Essential flow physics, such as shock-boundary layer interactions and small separation bubbles, are 'captured' by the new adaptive algorithm with considerable detail. In addition, the algorithm appears to provide flexibility in generating a mesh around relatively complicated geometries, such as multielement airfoils. Author

A92-31549
IMPLICIT SOLUTIONS OF THREE-DIMENSIONAL VISCOUS HYPERSONIC FLOWS

W. SCHROEDER and G. HARTMAN (MBB GmbH, Munich, Federal Republic of Germany) Computers and Fluids (ISSN 0045-7930), vol. 21, Jan. 1992, p. 109-132. refs

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An upwind relaxation method to solve the three-dimensional Navier-Stokes equations for hypersonic flows is presented. In the steady-state operator the flux-vector splitting concept is used for the Euler terms. The implicit solution matrix is based on a linearization which reduces the work to compute the elements of the Jacobians and provides a more robust scheme. Additionally, it contains simplified Jacobians of the split inviscid fluxes. A 'subgrid' procedure for the viscous layer adjacent to body surfaces is introduced to save computer time. Results are presented for some laminar and turbulent viscous hypersonic flows. Author

A92-31639* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SECONDARY INSTABILITIES IN COMPRESSIBLE BOUNDARY LAYERS
LIAN L. NG and GORDON ERLEBACHER (NASA, Langley Research Center, Hampton, VA) Physics of Fluids A (ISSN 0899-8213), vol. 4, April 1992, p. 710-726. refs
(Contract NAS1-18599)
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The secondary instability mechanisms in a two-dimensional (2-D) compressible boundary layer over a flat plate have been examined for a range of Mach numbers up to 4.5. For subsonic and low supersonic flows, fundamental resonance dominates when the amplitude of the (2-D) primary disturbance is high, while subharmonic resonance prevails in an environment with a low primary disturbance. At a high supersonic Mach number of 4.5, the secondary instability of the second-mode primary is stronger than that of the first-mode primary. Further, the subharmonic and the combination resonance modes, which are slightly detuned from the subharmonic, are the dominant instabilities. The influence of the propagation direction of the primary disturbance on secondary instabilities is investigated at Mach 1.6. Whereas the fundamental and the subharmonic disturbances propagate synchronously with a 2-D primary wave, this is not true for an oblique primary. A subset of the secondary instability results is verified against direct numerical simulations. Some comparisons between spatial and temporal secondary instabilities have been made at Mach 1.6. Author

A92-31640* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SECONDARY INSTABILITY OF HIGH-SPEED FLOWS AND THE INFLUENCE OF WALL COOLING AND SUCTION
NABIL M. EL-HADY (NASA, Langley Research Center; Analytical Services and Materials, Inc., Hampton, VA) Physics of Fluids A (ISSN 0899-8213), vol. 4, April 1992, p. 727-743. refs
(Contract NAS1-19320)
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The periodic streamwise modulation of the supersonic and hypersonic boundary layers by a two-dimensional first-mode or second-mode wave makes the resulting base flow susceptible to a broadband spanwise-periodic three-dimensional type of instability. The principal parametric resonance of this instability (subharmonic) has been analyzed using Floquet theory. The effect of Mach number and the effectiveness of wall cooling or wall suction in controlling the onset, the growth rate, and the vortical structure of the subharmonic secondary instability are assessed for both a first-mode and a second-mode primary wave. Results indicate that the secondary subharmonic instability of an insulated wall boundary layer is weakened as Mach number increases. Cooling of the wall destabilizes the secondary subharmonic of a second-mode primary wave, but stabilizes it when the primary wave is a first mode. Suction stabilizes the secondary subharmonic at all Mach numbers. Author

A92-31652#
TURBULENT FLOW IN THE WAKE OF AN IDEALIZED WING-BODY JUNCTION
D. CRAWFORD, A. BORME, H. R. RAHAI (California State University, Long Beach), and A. NAKAYAMA (Kobe University, Japan) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(AIAA PAPER 92-0282) Copyright

Simultaneous time resolved measurements of stream-wise and lateral components of turbulent velocity and their cross moments are obtained behind a wing mounted normal to a flat plate(body). The leading edge of the wing is placed downstream of the leading edge of the body. Survey of the pressure coefficient on the body show that the pressure coefficient is high near the wing tip and decreases in the streamwise and spanwise direction. The mean velocity variations show the presence of skew-induced secondary flow which transports the fluid away from the corner and toward the body causing a decrease and then an increase in the magnitude of the skin friction coefficient. Author

A92-31653#
NAVIER-STOKES COMPUTATIONS OF A VISCOUS OPTIMIZED WAVERIDER
NARUHISA TAKASHIMA and MARK J. LEWIS (Maryland, University, College Park) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(AIAA PAPER 92-0305) Copyright

The on-design and off-design performance of a Mach 6 viscous optimized waverider was calculated by solving the 3D Navier-Stokes equations. The numerical calculation was done using CFL3D, an implicit upwind-biased finite volume algorithm. The waverider geometry was generated for the design condition of Mach 6 flight at an altitude of 30 km using MAXWARP. MAXWARP is a waverider generating code which can either use cone-flow or power-law body-flow as a generating flow and optimize the shape including the viscous effects for maximum L/D or minimum drag for given design condition. A conical-flowfield was used as the generating flow field and the waverider shape was optimized for maximum L/D. The MAXWARP design code was validated by comparing it with the results from the Navier-Stokes calculation. Author

A92-31661#
A NUMERICAL INVESTIGATION OF VORTEX FLOW CONTROL THROUGH SMALL GEOMETRY MODIFICATIONS AT THE STRAKE/WING JUNCTION OF A CROPPED DOUBLE-DELTA WING
STEVEN B. KERN (U.S Navy, Naval Air Development Center, Warminster, PA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 17 p. refs
(AIAA PAPER 92-0411)

Results are presented from a subsonic numerical investigation of the effects of geometry modifications at the junction of the leading edge extension and wing of a flat-plate cropped double-delta wing at moderate to high angles of attack. A hyperbolic grid generation method was developed and used in conjunction with an existing interactive grid generation system to create high-quality C-O type multiblock grids about the configurations studied. The Euler and Reynolds averaged Navier-Stokes (RANS) equations were solved numerically using two finite-volume production flow solvers. The baseline configuration numerical results correlated well with existing published experimental data. Grid refinement using the RANS revealed vortex sheet tearing on the wing. Fillets enhanced the lift by 13.6 percent at low angle of attack and 17.9 percent at high angle of attack with a slight improvement in lift-to-drag ratio. P.D.

A92-31663#
EFFECTS OF SWEEPBACK ON UNSTEADY SEPARATION IN MACH 5 COMPRESSION RAMP INTERACTIONS
M. E. ERENGIL and D. S. DOLLING (Texas, University, Austin) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 15 p. refs
(Contract AF-AFOSR-86-0112; DAAL03-91-G-0023)
(AIAA PAPER 92-0430) Copyright

To examine the effects of sweepback on the unsteady separation in Mach 5 compression ramp interactions, fluctuating wall pressure measurements have been made upstream of the corner line in interactions generated by unswept, and 10, 20, 25, 30, 40, and 50 deg swept models. In highly swept interactions, the rms distributions of pressure fluctuations as well as the mean distributions are quasi-conically symmetric. The rms levels decrease globally with increasing sweep as does the maximum rms generated by the translating separation shock. The length of the intermittent region, over which the separation shock foot translates, decreases with increasing sweep. In a given interaction, the length of the intermittent regions grows spanwise. Dominant separation shock frequencies, observed in both surface pressure fluctuations and separation shock foot histories, increase from about 0.3-0.5 kHz for unswept flow to about 2-7 kHz in highly swept flows. In a given interaction, shock frequencies decrease spanwise. Separation

shock dynamics defined in terms of the shock foot history and its statistics are essentially the same in all interactions. The separation shock foot position is normally distributed, and the mean shock velocities are essentially equal. Author

A92-31677#
A PRELIMINARY STUDY OF THE TURBULENT STRUCTURES ASSOCIATED WITH UNSTEADY SEPARATION SHOCK MOTION IN A MACH 5 COMPRESSION RAMP INTERACTION
R. A. GRAMANN and D. S. DOLLING (Texas, University, Austin) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 16 p. refs
(Contract DAAL03-91-G-0023)
(AIAA PAPER 92-0744) Copyright

Measurements of fluctuating wall and pitot pressures are made in the undisturbed boundary layer well upstream of a 28-deg unswept compression-ramp interaction at Mach 5 in order to examine the turbulent structures associated with separation-shock turnarounds. The data were examined to determine whether the characteristic wall-pressure signatures observed in the incoming boundary layer near the interaction are also present at locations further upstream and whether these signatures are generated by boundary-layer turbulence. The results show that signatures are seen as far as 20 boundary-layer thicknesses upstream of the ramp corner, although their clarity decreases significantly with distance. This is indicative of turbulent structures which evolve and have finite lifetimes. Preliminary results from the fluctuating pitot-pressure measurements show that the separation shock motion correlates with the pitot pressure fluctuations at around one-half the boundary-layer thickness but does not correlate with fluctuations at the mean boundary layer edge. Author

A92-31678*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
UNSTEADY SEPARATION IN SHARP FIN-INDUCED SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTION AT MACH 5
J. D. SCHMISSEUR and D. S. DOLLING (Texas, University, Austin) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 19 p. Research supported by USAF. refs
(Contract NAG2-1005)
(AIAA PAPER 92-0748) Copyright

Fluctuating wall-pressure measurements are made in shock-wave/turbulent-boundary-layer interactions generated by sharp/unswept fins at angles of attack of 16, 18, 20, 22, 24, 26, and 28 degrees at Mach 5. The experiment was conducted under approximately adiabatic wall temperature conditions. The mean and rms pressure distributions can be collapsed in conical coordinates. The wall-pressure signal near separation is intermittent for all angles of attack (16-28 deg) and is qualitatively similar to that measured in unswept flows. However, the shock frequencies are higher - about 5 kHz compared to 0.5-1 kHz. Over the range of sweepbacks examined, from 25-55 deg, the spectral content of the fluctuating pressures does not change. Thus, the increase in separation-shock frequency from 1 to 5 kHz occurs at lower interaction sweepback and is not a continuous process with increasing sweepback. Power spectra at the position of maximum rms in the intermittent region for interactions in different incoming boundary layers have the same center frequency. The maximum rms in the intermittent region correlates with interaction sweepback, not with overall inviscid pressure rise. Author

A92-31679*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN IMPROVED PNS SCHEME FOR PREDICTING COMPLEX THREE-DIMENSIONAL HYPERSONIC FLOWS
BILAL A. BHUTTA and CLARK H. LEWIS (VRA, Inc., Blacksburg, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 25 p. refs
(Contract NAS3-25450)
(AIAA PAPER 92-0753) Copyright

Upwinding is incorporated into a numerical technique for predicting hypersonic viscous flows over lifting configurations at moderate angles of attack. A general real-gas flux-vector-splitting technique based on Van Leer's (1982) approach is employed to model upwinding, and three techniques are examined for flux-vector differencing. The three methods are evaluated by applying them to an axisymmetric configuration with a 10-deg afterbody flare. The results indicate that an oscillation-free shock front can be described by using first-order full upwinding across the embedded shock and central-differencing for the other zones. This combined approach is found to be highly convergent for the near-wall region, and its performance is examined for predicting a Mach 15 flow over a finned missile. Attention is given to the effects of gas chemistry which can significantly affect the flows over the missile configurations. C.C.S.

A92-31680*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMBINED EFFECT OF NOSE BLUNTNESS AND ANGLE OF ATTACK ON SLENDER BODIES IN VISCOUS HYPERSONIC FLOWS
S. N. TIWARI (Old Dominion University, Norfolk, VA), D. J. SINGH (Analytical Services and Materials, Inc., Hampton, VA), and A. K. SEHGAL (Old Dominion University, Norfolk, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 24 p. Previously announced in STAR as N91-21117. refs
(Contract NAG1-363; NAG1-423)
(AIAA PAPER 92-0755) Copyright

Hypersonic flows over cones and straight biconic configurations are calculated for a wide range of free stream conditions in which the gas behind the shock is treated as perfect. Effect of angle of attack and nose bluntness on these slender cones in air is studied extensively. The numerical procedures are based on the solution of complete Navier-Stokes equations at the nose section and parabolized Navier-Stokes equations further downstream. The flow field variables and surface quantities show significant differences when the angle of attack and nose bluntness are varied. The complete flow field is thoroughly analyzed with respect to velocity, temperature, pressure, and entropy profiles. The post shock flow field is studied in detail from the contour plots of Mach number, density, pressure, and temperature. The effect of nose bluntness for slender cones persists as far as 200 nose radii downstream. Author

A92-31687*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATIONS OF HOT-FILM ANEMOMETERS IN HYPERSONIC SHEAR LAYERS
J. P. GRUBB (NASA, Langley Research Center; Lockheed Corp., Hampton, VA) and W. T. STRIKE (Calspan Corp., Arnold AFB, TN) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 13 p.
(AIAA PAPER 91-5028)

A wind tunnel test was conducted on a flat plate at zero angle of attack with a rearward facing 2D cooling film injector nozzle. The freestream Mach number was 8 and the injector Mach number was 3. The freestream Reynolds number varied from 0.43 to 3.3 million per ft during the test, and the injector flow rate was such that the jet exit and freestream static pressures were matched. The analysis reported herein will focus on data obtained at a freestream Reynolds number of 0.85 million per ft. The data consists of heat-transfer measurements obtained upstream and downstream of the injector nozzle and flowfield surveys obtained downstream of the injector nozzle with a pitot, total temperature, hot-film anemometer and hot-wire anemometer probes. The flowfield surveys were made at stations 0.1 to 9 in. downstream of the injector nozzle from near the model surface to approximately 2 in above the model surface. The hot-film anemometer was used to define the fluctuations in the shear layer separating the flows. The hot-film results are integrated with conventional measurement techniques to obtain a more complete description of the complicated shear layer separating hypersonic and supersonic flows. Author

A92-31688#
FLOWPATH OPTIMIZATION FOR HYPERSONIC VEHICLES
P. J. ORTWERTH, A. B. MATHUR, and C. J. BROWN (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 10 p.
(AIAA PAPER 91-5043) Copyright

A hypersonic similarity parameter has been determined for internal flows that can be employed to correlate a given class of compression surfaces over a wide range of initial conditions and contraction ratios. Direction connection with geometry drag and heat transfer has been attained for hypersonic internal flow useful for flowpath optimization. Flowpath optimization can be conducted that can simultaneously find minimum wave drag, friction drag, and fuel required. R.E.P.

A92-31690*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ENGINEERING METHOD FOR AERO-PROPULSIVE CHARACTERISTICS AT HYPERSONIC MACH NUMBERS
SURESH GORADIA (Vigyan, Inc., Hampton, VA), ABEL O. TORRES, SHARON H. STACK, and JOEL L. EVERHART (NASA, Langley Research Center, Hampton, VA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 19 p. refs
(AIAA PAPER 91-5061) Copyright

An engineering method has been developed for the rapid analysis of external aerodynamics and propulsive performance characteristics of airbreathing vehicles at hypersonic Mach numbers. This method, based on the theory of characteristics, has been developed to analyze fuselage-wing body combinations and body flaps with blunt or sharp leading/trailing edges. Arbitrary ratio of specific heat for the flowing medium can be specified in the program. Furthermore, the capability exists in the code to compute the inviscid inlet mass capture and momentum flux. The method is under development for computations of pressure distribution, and flow characteristics in the inlet, along with the effect of viscosity. Correlative studies have been performed for representative hypersonic configurations using the current method. The results of these correlations for various aerodynamics parameters are encouraging. Author

A92-31853
OPTIMIZATION OF A LIFTING SURFACE FOR MINIMUM INDUCED DRAG [OPTIMIZATSIIA NESUSHCHEI POVERKHNOSTI PO MINIMUMU INDUKTIVNOGO SOPROTIVLENIIA]
A. N. KOLOBKOV and M. I. NIKOLAEV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 27-31. In Russian. refs
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The lifting surface theory is used to solve the inverse aerodynamic problem of determining the middle surface shape of a wing corresponding to a minimum induced drag. A matrix equation is derived which makes it possible to obtain a solution without representing the aerodynamic load in the form of double Fourier series. Calculation results are presented for a swept wing with a nondeformable section. V.L.

A92-31854
ANALYTICAL AND EXPERIMENTAL STUDIES OF THE AERODYNAMIC CHARACTERISTICS OF A DELTA WING AT A SLIP ANGLE AT HIGH SUPERSONIC VELOCITIES [RASCHETNO-EKSPERIMENTAL'NYE ISSLEDOVANIIA AERODINAMICHESKIKH KHARAKTERISTIK TREUGOL'NOGO KRYLA POD UGLOM SKOL'ZHENIIA PRI BOL'SHIKH SVERKHZVUKOVYKH SKOROSTIAKH]
P. I. GORENBUKH and V. S. NIKOLAEV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 32-38. In Russian. refs
Copyright

Analytical expressions are obtained for the coefficients of the aerodynamic forces and moments of a delta wing with cylindrical leading edges and plane lower and upper surfaces consisting of two plane halfs. The path stability characteristics and the possibility of slip angle nonlinearity are investigated. An experimental study is made of the lateral moment characteristics of a delta wing with flat leading edges. V.L.

A92-31855
AERODYNAMIC CHARACTERISTICS OF A BLUNT DELTA WING WITH AIR BLEED THROUGH AN INTAKE AT SUPERSONIC AND HYPERSONIC VELOCITIES. II [AERODINAMICHESKIE KHARAKTERISTIKI ZATUPLENNOGO TREUGOL'NOGO KRYLA S OTBOROM VOZDUKHA CHEREZ VOZDUKHOZABORNIK PRI SVERKH- I GIPERZVUKOVYKH SKOROSTIAKH. II]
S. A. BAKHAREV, V. G. GURYLEV, and A. P. KOSYKH TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 39-47. In Russian. refs
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Results of numerical calculations of aerodynamic characteristics are reported for a blunt-leading-edge 81-degree-sweep delta wing with air bleed through an intake on the upwind side at supersonic and hypersonic velocities (M = 2-20), without any allowance made for viscosity and changes in the thermodynamic properties of the air. The effect of the high-entropy layer and air bleed on the air flow rate and drag coefficients, lift force, and lift-drag ratio of the wing is examined. V.L.

A92-31857
SINGULARITY BYPASS ALGORITHMS IN THE NUMERICAL SOLUTION OF EQUATIONS OF BODY MOTION RELATIVE TO A CENTER OF MASS IN THE ATMOSPHERE IN THE PRESENCE OF DISTURBANCES [ALGORITMY OBKHODA OSOBENNOSTI PRI CHISLENNOM RESHENII URAVNENII DVIZHENIIA TEL OTNOSITEL'NO TSENTRA MASS V ATMOSFERE PRI DEISTVII VOZMUSHCHENII]
G. M. LOKHOV and S. I. PODZOROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 54-60. In Russian. refs
Copyright

An efficient algorithm for bypassing the singularity in kinematic equations is proposed which can be used in the numerical solution of the equations using fast combined methods for studying the three-dimensional motion of rigid bodies around a center of mass in the atmosphere in the presence of disturbances. Based on a system of equations using the Rodrigues-Hamilton parameters as kinematic variables and therefore containing no singularities, an algorithm is proposed for the conversion of the relative motion parameters from the quaternion representation to angles of attack and bank and vice versa. V.L.

A92-31860
A PARAMETRIC STUDY OF THE LIFT-DRAG RATIO OF BLUNT CONES [PARAMETRICHESKOE ISSLEDOVANIE AERODINAMICHESKOGO KACHESTVA ZATUPLENNYKH KONUSOV]
G. G. VORONOVA, A. V. LIMANSKII, and V. I. TIMOSHENKO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 77-81. In Russian. refs
Copyright

Results of a parametric study of the dependence of the lift-drag ratio of blunt cones on the principal geometric and physical parameters are reported. The results were obtained by solving the supersonic flow problem in the nonviscous and viscous gas approximations. Expressions are derived which relate the lift-drag ratio and the additional viscous terms to the aspect ratio and the half-angle of taper. V.L.

A92-31861
A SUPPLEMENT TO THE SECOND-ORDER SHOCK-EXPANSION METHOD [DOPOLNENIE K METODU SKACHKOV - RASSHIRENII VTOROGO PORIADKA TOCHNOSTI]

A. I. SARANTSEV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 82-88. In Russian. refs
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The shock-expansion method is simplified by using different functions for pressure approximation. As a result, the method can be used in applications where its use has been associated with certain difficulties. The new functions contain a free parameter which affects the accuracy of the calculations. Although this parameter has not been determined exactly, the use of certain assumptions about its value makes it possible to achieve satisfactory accuracy. V.L.

A92-31862
A HEAT FLOW PEAK ON THE UPWIND SURFACE OF A BLUNT-LEADING-EDGE DELTA WING [PIK TEPLOVOGO POTOKA NA NAVETRENNOI STORONE TREUGOL'NOGO KRYLA S ZATUPLENNYMI PEREDNIMI KROMKAMI]
I. A. KONDRAT'EV and A. IA. IUSHIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 89-92. In Russian. refs
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Results of an experimental study of heat transfer on the upwind side of a blunt-leading-edge delta wing are reported for a free-stream Mach of 5. It is shown that, at small angles of attack (less than 5 deg), the bluntness of the leading edge leads to a local increase in the heat transfer coefficient near the line of symmetry of the wing. It is believed that the increase results from the effect of entropic layer absorption by the laminar boundary layer. V.L.

A92-31863
POSSIBILITY OF REDUCING THE WAVE DRAG OF A HYPERSONIC FLIGHT VEHICLE (WAVE RIDER) [VOZMOZHNOSTI UMEN'SHENIIA VOLNOVOGO SOPROTIVLENIIA GIPERZVUKOVOGO LETATEL'NOGO APPARATA /VOLNOLETA/]
G. I. MAIKAPAR TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 93-100. In Russian. refs
Copyright

The lift-drag ratio is calculated for a specific lift force prescribed on a surface of gas flow behind plane shocks which may represent fragments of a flight vehicle surface. The effects of the leading edge sweep, longitudinal profile, and interference of vehicle components is considered. Prospects for reducing the wave drag are discussed. V.L.

A92-31867
SUBSONIC FLOW PAST A THIN AIRFOIL IN A CHANNEL WITH POROUS WALLS [DOZVUKOVOE OBTEKANIE TONKOGO PROFILIA V KANALE S PERFORIROVANNYMI STENKAMI]
S. A. GLAZKOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 3-12. In Russian. refs
Copyright

A solution to the problem of ideal incompressible flow past an airfoil is obtained for a channel whose upper and lower walls can have different porosities depending on the direction of gas flow. Calculations are made of the pressure coefficient distributions over the channel walls and the airfoil, located at a certain angle of attack along the symmetry axis of the channel. L.M.

A92-31868
FLOW PAST A HIGHLY CURVED WING WITH TANGENTIAL JET EJECTION [OBTEKANIE KRYLA BOL'SHOI KRIVIZNY S TANGENTSIAL'NYM VYDUVOM STRUI]
A. V. PETROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 13-22. In Russian. refs
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Experimental and calculated total and distributed aerodynamic characteristics are presented for a rectangular wing with a profile of high relative curvature average (f-max = 30 percent) when the jet is ejected from a slotted nozzle tangentially to its upper surface. The effect of the jet ejection from one or several nozzles on the lift coefficient and wing pressure distribution is shown when the jet momentum coefficient is varied from 0 to 0.7 and the wing angle of attack is varied from -10 to 30 deg. L.M.

A92-31869
INTERACTION OF JETS EJECTED FROM TWO-DIMENSIONAL NOZZLES WITH A CURVED SURFACE [VZAIMODEISTVIE STRUI, VYDUVAEMYKH IZ PLOSKIKH SOPL, S KRIVOLINEINOI POVERKHNOST'IU]
N. M. MITROKHIN and A. V. PETROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 23-30. In Russian. refs
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Characteristics of the interaction of jets ejected from 2D and slotted nozzles with a cylindrical surface were investigated experimentally. The effects of excess nozzle exit pressure, nozzle extension, and relative distance between the nozzles and the cylindrical surface on the jet deflection angle are shown. Attention is given to the possibility of improving the jet deflection by eliminating the gap between the nozzle and the surface in the flow, by mounting walls near the lateral boundaries of the jet, and the ejection of additional control jets. L.M.

A92-31870
CALCULATION OF THREE-DIMENSIONAL SEPARATED FLOWS IN THE FRAMEWORK OF THE UNSTEADY EULER EQUATIONS [RASCHET PROSTRANSTVENNYKH OTRYVNYKH TECHENII V RAMKAKH NESTATSIONARNYKH URAVNENII EILERA]
V. V. VYSHINSKII and S. A. KRAVCHENKO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 31-42. In Russian. refs
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The possibility of using the unsteady Euler equations for the computation of 3D separated flows is examined. Within the framework of these equations, a method for calculating 3D transonic flow past bodies including zones of separation with reverse flow is developed. Solutions are given for the following cases: a sphere with flow separation and a fixed shock wave; a low-aspect-ratio wing at a high angle of attack; and a straight high-aspect ratio wing with formation of a vortex structure over the wing tip area. L.M.

A92-31871
FLIGHT STUDIES OF THE RIBLET EFFECT ON DRAG VARIATION [LETNYE ISSLEDOVANIIA VLIIANIIA MIKRORIFLENIIA POVERKHNOSTI NA IZMENENIE SOPROTIVLENIIA]
I. D. BUTYLIN, V. P. ERMOLAEV, V. N. OZEROV, and V. M. FOMIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 43-50. In Russian. refs
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Experimental results were obtained with the TSaGI glider laboratory concerning the riblet effect on drag. Investigations carried out in flight on the cuff of a large-scale wing profile have demonstrated a drag reduction for a flow with a pressure gradient due to control of boundary layer turbulence by longitudinal triangular grooves with a specified step. L.M.

A92-31872
COMPUTATIONAL STUDIES OF TRANSONIC FLOW PAST A SWEPT WING AND THE BOUNDARY LAYER CHARACTERISTICS [RASCHETNYE ISSLEDOVANIIA TRANSZVUKOVOGO OBTEKANIIA STRELOVIDNOGO KRYLA I KHARAKTERISTIK POGRANICHNOGO SLOIA]
N. A. VLADIMIROVA TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 51-56. In Russian. refs
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The differential calculation method of Vladimirova et al. (1988) is used to determine the local characteristics of the 3D boundary layer in the laminar and turbulent regions of a transonic flow with a shock wave past a swept wing (chi = 30 deg). The local friction coefficients and velocity profiles are calculated for different wing

surface sections in separated flow (Re = 1 x 10 to the 6th; M = 0.84). It is shown that in the laminar and turbulent regions the transverse (spanwise) velocity component can have an s-shaped profile. L.M.

A92-31873
THE TOTAL DRAG OF A BODY IN THE FLOW OF A VISCOUS HEAT-CONDUCTING GAS [O POLNOM SOPROTIVLENII TELA V POTOKE VIAZKOGO, TEPLOPROVODNOGO GAZA]
A. S. PETROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 57-65. In Russian. refs
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The main term of the expression for the total drag of a body in a viscous heat-conducting gas at transonic and low supersonic velocities is obtained on the basis of the momentum theorem. The well-known expressions for profile, wave, and induced drag are derived as particular cases. The drag due to the heat transfer between the body and the surrounding medium is also investigated. L.M.

A92-31874
COMPUTATIONAL STUDIES OF THE AERODYNAMIC CHARACTERISTICS OF DELTA WINGS WITH A SUBSONIC LEADING EDGE [RASCHETNYE ISSLEDOVANIIA AERODINAMICHESKIKH KHARAKTERISTIK TREUGOL'NYKH KRYL'EV S DOZVUKOVOI PEREDNEI KROMKOI]
R. A. BREUSOVA, V. V. KELDYSH, and V. V. KOVALENKO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 66-72. In Russian. refs
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The aerodynamic characteristics of delta wings at supersonic velocities as determined by solving the Euler equations and on the basis of linear theory are compared. Flow regimes with a subsonic leading edge are examined. It is shown that for wings with a nonplanar middle surface the wave drag in the vicinity of the flow regime with zero lift force as determined by the linear theory is significantly greater than that determined by solving the Euler equations. L.M.

A92-31875
DETERMINATION OF THE MASS-FLOW-RATE CHARACTERISTICS OF POROUS PANELS [OPREDELENIE RASKHODNYKH KHARAKTERISTIK PERFORIROVANNYKH PANELEI]
S. A. GLAZKOV, A. R. GORBUSHIN, and N. N. KHOZIAENKO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 73-81. In Russian. refs
Copyright
A method is proposed for the analytical and experimental determination of the porosity parameter of the porous walls of a wind tunnel at subsonic velocities in the case of gas flow from the test section. A comparison is made with previous results on similar porous panels. It is shown that an increase in the Reynolds number from 10 exp 7 (corresponding to experimental conditions in long-action supersonic wind tunnels) to about 3.5 x 10 exp 8 (corresponding to the flight conditions of certain supersonic vehicles) leads to a significant increase in the maximum lift/drag ratio of the wings considered. L.M.

A92-31877
EXPERIMENTAL INVESTIGATION OF THE AIR BYPASS EFFECT IN THE SHOCK-WAVE REGION ON THE AERODYNAMIC CHARACTERISTICS OF A WING PROFILE [EKSPERIMENTAL'NOE ISSLEDOVANIE VLIIANIIA PEREPUSKA VOZDUKHA V RAIONE SKACHKA UPLOTNENIIA NA AERODINAMICHESKIE KHARAKTERISTIKI PROFILIA]
S. A. KOVAL'NOGOV and G. K. SHAPOVALOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 95-99. In Russian. refs
Copyright
The paper examines results of transonic-wind tunnel investigations of the air bypass effect in the shock wave region on the aerodynamic coefficients sub x, c sub y, and K of a wing profile. A reduction of the drag coefficient of the wing profile and an increase in its maximum lift-drag ratio were observed. L.M.

A92-31879
EXPERIMENTAL INVESTIGATION OF THE OPTIMAL DEFLECTION OF A SINGLE-SLOTTED FLAP WITH DIFFERENT DEGREES OF EXTENSION ON A MODERN SUPERCRITICAL PROFILE [EKSPERIMENTAL'NOE ISSLEDOVANIE OPTIMAL'NOGO OTKLONENIIA ODNOSHCHELEVOGO ZAKRYLKA S RAZLICHNOI STEPEN'IU VYDVIZHENIIA NA SOVREMENNOM SVERKHKRITICHESKOM PROFILE]
A. N. VISKOV, S. G. IGNAT'EV, and E. V. PISANOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 105-108. In Russian.
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A92-31880
AERODYNAMIC CHARACTERISTICS OF THE COMBINATION OF A WING WITH A CAMBERED MIDDLE SURFACE WITH A FUSELAGE [AERODINAMICHESKIE KHARAKTERISTIKI KOMBINATSII KRYLA S NEPLOSKOI SREDINNOI POVERKHNOST'IU S FIUZELIAZHEM]
A. B. BONDARENKO and V. G. IUDIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 109-112. In Russian.
Copyright
The main aerodynamic characteristics of a combination of a wing of complex shape with a cambered middle surface with a fuselage were previously calculated on the basis of a numerical method of linear theory. This paper presents results of experimental studies carried out to verify these calculation results. L.M.

A92-31882
CHARACTERISTICS OF TRANSONIC FLOW PAST A CONFIGURATION COMPRISING A WING AND A FUSELAGE WITH A LARGE MIDSECTION RATIO [OSOBENNOSTI OKOLOZVUKOVOGO OBTEKANIIA KOMBINATSII KRYLO-FIUZELIAZH BOL'SHOGO OTNOSITEL'NOGO MIDELIA]
O. V. KARAS' and S. F. KONOVALOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 117-121. In Russian.
Copyright
The effect of the midsection ratio on the characteristics of the subcritical and supercritical flow past a wing-body configuration is examined on the basis of the simultaneous application of experimental data and calculation results in the framework of circulation flow, taking into account viscosity on the wing in the boundary-layer approximation. The efficiency of a straight-wall fairing is investigated. The advantage of the high-wing monoplane layout is demonstrated for configurations with a body with a large midsection ratio. L.M.

A92-31883
EFFECT OF THE FUSELAGE MIDSECTION RATIO ON THE CHARACTER OF WING-FUSELAGE AERODYNAMIC INTERFERENCE [VLIIANIE OTNOSITEL'NOGO MIDELIA FIUZELIAZHA NA KHARAKTER AERODINAMICHESKOI INTERFERENTSII S KRYLOM]
S. F. KONOVALOV and A. M. TIMERBULATOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 122, 123. In Russian.
Copyright
The characteristics of the aerodynamic interference of a high-aspect-ratio wing with a fuselage of large midsection ration are investigated on the basis of both experimental data and calculations. It is shown that a significant increase in the midsection ratio of the fuselage of a transport aircraft produces practically no increase in losses due to interference with the wing in the subsonic range, and has a significant effect only in the transonic range due to an adverse change in the load in the central plane of the wing. L.M.

A92-31884
INVESTIGATION OF THE AERODYNAMIC FEATURES OF FLOWS PAST MODELS USING THIN-FILM CAPACITANCE-TYPE SENSORS OF PRESSURE OSCILLATIONS [ISSLEDOVANIE AERODINAMICHESKIKH OSOBENNOSTEI OBTEKANIIA MODELEI S POMOSHCH'IU TONKOPLENOCHNYKH EMKOSTNYKH DATCHIKOV PUL'SATSII DAVLENIIA]
S. A. KOVAL'NOGOV, V. IU. TER-GRIGORIAN, and G. K. SHAPOVALOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 124-129. In Russian. refs
Copyright
The development of thin-film capacitance-type sensors of pressure oscillations is described. Attention is then given to the application of these sensors to the measurement of pressure oscillations on the test-section wall of a low-turbulence transonic wind tunnel as well as on the surface of a supercritical profile at transonic speeds. L.M.

A92-31885
SOME CHARACTERISTICS OF TRANSONIC FLOW PAST AN AIRFOIL IN THE CASE OF DEVELOPED SEPARATION [NEKOTORYE OSOBENNOSTI OKOLOZVUKOVOGO OBTEKANIIA PROFILIA V USLOVIIAKH RAZVITOGO OTRYVA]
V. D. BOKSER TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 130-132. In Russian. refs
Copyright
The aerodynamic characteristics of a thick supercritical airfoil in the developed separation regime at transonic speeds have been investigated. The behavior of the maximum value of the lift coefficient as a function of freestream Mach number was studied along with the pressure distribution over the surface. L.M.

A92-31886
BOUNDARY-LAYER-SEPARATION CONTROL [UPRAVLENIE OTRYVOM POGRANICHNOGO SLOIA]
I. D. BUTYLIN, V. M. FOMIN, and A. A. SHCHUROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 133-138. In Russian. refs
Copyright
Results of studies performed in the TsAGI T-124 low-turbulence wind tunnel as well as of real flights on TsAGI glider testbeds are presented. The results have confirmed the possibility of drag reduction by weakening the diffuser-flow separation due to the effect of vortex generation on boundary layer development and separation on the wing profile. L.M.

A92-31887
CONSIDERATION OF THE EFFECT OF VISCOSITY IN THE PROBLEM OF POROUS-WALL INDUCTION [UCHET VLIIANIIA VIAZKOSTI V ZADACHE OB INDUKTSII PERFORIROVANNYKH STENOK]
A. I. IVANOV, A. V. SEMENOV, and O. K. SEMENOVA TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 139-142. In Russian. refs
Copyright
The paper examines the problem of the simultaneous calculation of turbulent boundary layer parameters on porous wind-tunnel walls and the potential core flow in the presence of a lifting model. It is demonstrated that refinement of the local values of the wall porosity parameter can significantly change the wall-induced flow field near the model. L.M.

A92-31890
MATHEMATICAL MODELING OF NONSTATIONARY VISCOUS FLOW OVER A SOLID ANGLE OF FINITE SPAN [MATEMATICHESKOE MODELIROVANIE NESTATSIONARNOGO OBTEKANIIA VIAZKIM POTOKOM TELESNOGO KRYLA KONECHNOGO RAZMAKHA]
I. A. GUR'IANOV, V. N. KOTOVSKII, and M. I. NISHT TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 3, 1991, p. 35-42. In Russian. refs
Copyright
A nonlinear mathematical model of nonstationary viscous flow over a solid wing of finite span is developed using an approach combining several methods. The aerodynamic characteristics of the wing are calculated over a wide range of angles of attack using the discrete vortex method (in the potential flow region beyond the wing and in the boundary layer) and the integral method (in the three-dimensional turbulent boundary layer region). The results are found to be in fair agreement with experimental data. V.L.

A92-31897
LIFT CHARACTERISTICS OF AN INFINITE-SPAN CYLINDRICAL WING OF A THICK SYMMETRIC PROFILE AT LOW SUBSONIC VELOCITIES [OSOBENNOSTI NESUSHCHIKH SVOISTV TSILINDRICHESKOGO KRYLA BESKONECHNOGO RAZMAKHA S TOLSTYM SIMMETRICHNYM PROFILEM PRI MALYKH DOZVUKOVYKH SKOROSTIAKH]
N. I. ARKHIPOV, D. S. GORSHENIN, A. V. ZHITKO, and A. A. KURKOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 3, 1991, p. 106-109. In Russian. refs
Copyright
Wind and hydrodynamic tunnel test results are presented for an infinite-span cylindrical wing with a symmetric profile characterized by a large relative thickness (C = 42 percent). It is found that a negative lifting force is generated during tests at positive angles of attack 0-8 deg and low flow velocities. An attempt is made to explain the observed phenomenon using results of flow visualization in a hydrodynamic tunnel. V.L.

A92-31898
AERODYNAMIC EFFECT OF COMPRESSION SHOCKS ON AN OSCILLATING AILERON IN TRANSONIC FLOW [AERODINAMICHESKOE VOZDEISTVIE SKACHKOV UPLOTNENIIA NA KOLEBLIUSHCHIISIA V OKOLOZVUKOVOM POTOKE ELERON]
A. V. SAFRONOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 3, 1991, p. 110-117. In Russian. refs
Copyright
The interaction of an oscillating aileron with compression shocks on its surface is investigated analytically using an approach based on an analysis of the Prandtl-Mayer flow and on the dynamic curvature hypothesis. The resulting analytical relations are used for the estimation of aerodynamic forces and hinge moments due to compression shocks. V.L.

A92-31899
STRUCTURE OF A BOUNDARY LAYER ON THE LOWER SURFACE OF A WING IN FLIGHT AND IN A WIND TUNNEL [STRUKTURA POGRANICHNOGO SLOIA NA NIZHNEI POVERKHNOSTI KRYLA V POLETE I V AERODINAMICHESKOI TRUBE]
B. IU. ZANIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 3, 1991, p. 118-122. In Russian. refs
Copyright
Results of experimental studies of the structure of the boundary layer on the lower wing surface conducted on a glider and in a wind tunnel are reported. It is found that flow over the windward side of the wing leads to the laminar-turbulent transition in the boundary layer despite the increased static pressure. The mechanism of the transition is similar to that observed earlier on the upper downwind side of the wing. V.L.

A92-31961
A SHOCK AND AN EXPANSION WAVE IN TRANSONIC FLOW [SKACHOK I VOLNA RASSHIRENIIA V TRANSZVUKOVOM POTOKE]
A. S. FONAREV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626), Jan.-Feb. 1992, p. 62-65. In Russian. refs
Copyright
The problem of the propagation of a shock wave and a simple

expansion wave in transonic flow is investigated analytically. Approximate expressions are obtained for the flow parameters, and the resulting asymptotic relations are analyzed for small parameters approaching zero. It is shown that for Mach equal to 1 or less, the universal relation between the optimal permeability coefficient and the Mach number is no longer valid. For each individual experiment this coefficient is different and changes along the pipe wall. V.L.

A92-31962
AN EXACT SOLUTION TO EDGE EFFECT PROBLEM FOR A FINITE-SPAN WING IN SUPERSONIC FLOW [OB ODNOM TOCHNOM RESHENII ZADACHI O KONTSEVOM EFFEKTE KRYLA KONECHNOGO RAZMAKHA V SVERKHZVUKOVOM POTOKE]
N. F. VOROB'EV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626), Jan.-Feb. 1992, p. 65-70. In Russian. refs
Copyright
Formulas are presented for calculating the gasdynamic parameters of flow in the case where the velocity potential is determined in terms of the first and second derivatives in the basis plane. The solution proposed here provides for shedding at subsonic edges, which corresponds to separated flow over a finite-span wing. V.L.

A92-31963
BOUNDARY LAYER ON SLENDER WINGS OF SMALL ASPECT RATIO [POGRANICHNYI SLOI NA TONKIKH KRYL'IAKH MALOGO UDLINENIIA]
V. I. SHALAEV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626), Jan.-Feb. 1992, p. 71-78. In Russian. refs
Copyright
Equations of flow over slender wings of small aspect ratio at high Reynolds numbers are analyzed asymptotically. A regular solution to the problem of nonvortex flow is obtained which is accurate to within values that are linear with respect to small parameters (angle of attack and wing thickness). It is shown that in this case the three-dimensional boundary value problem is reduced to that of solving a set of two-dimensional problems. Results of calculations of laminar and turbulent boundary layers on a delta wing are presented and compared with experimental data. V.L.

A92-31969
A METHOD OF BOUNDARY LAYER LAMINARIZATION ON AN OSCILLATING WING [OB ODNOM METODE LAMINARIZATSII POGRANICHNOGO SLOIA NA VIBRIRUIUSHCHEM KRYLE]
S. V. MANUILOVICH (Tsentral'nyi Aerogidrodinamicheskii Institut, Zhukovski, Russia) Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 322, no. 1, 1992, p. 52-56. In Russian. refs
Copyright
A method of boundary layer laminarization on an oscillating wing is proposed, and it is shown that a proper choice of roughness can be used to suppress the entire packet of Tollmien-Schlichting (T-S) waves. It is noted that, for flow laminarization in the boundary layer, there is no need to suppress T-S waves of all frequencies; it is sufficient to treat the range that corresponds to the most 'dangerous' frequencies, e.g., the supercritical region. L.M.

A92-32178
VISCOUS SUPERSONIC FLOW COMPUTATIONS OVER A DELTA-RECTANGULAR WING WITH SLANTING SURFACES
JOHN S. CHAN (Boeing Aerospace and Electronics, Seattle, WA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Mar.-Apr. 1992, p. 159-165. Research supported by Boeing Independent Research and Development Program. Previously cited in issue 06, p. 758, Accession no. A90-19841. refs
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A92-32181* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATION OF NEAR-WAKE, AEROBRAKE FLOWFIELDS
PEPTER A. GNOFFO, JOSEPH M. PRICE, and ROBERT D. BRAUN (NASA, Langley Research Center, Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Mar.-Apr. 1992, p. 182-189. Previously cited in issue 18, p. 3051, Accession no. A91-43437. refs
Copyright

A92-32182* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF SHOCK WAVE PRECURSORS AHEAD OF HYPERSONIC ENTRY VEHICLES
SCOTT A. STANLEY (Lockheed Engineering and Sciences Co., Houston, TX) and LELAND A. CARLSON (Texas A & M University, College Station) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Mar.-Apr. 1992, p. 190-197. Previously cited in issue 17, p. 2855, Accession no. A91-42519. refs
(Contract NAG1-1003)
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A92-32184* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPARISON OF HEATING CALCULATIONS WITH EXPERIMENTAL DATA ON A MODIFIED SHUTTLE ORBITER
H. H. HAMILTON, II, FRANCIS A. GREENE, and K. J. WEILMUENSTER (NASA, Langley Research Center, Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Mar.-Apr. 1992, p. 208-215. Previously cited in issue 18, p. 3050, Accession no. A91-43416. refs
Copyright

A92-32196* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AXIAL COMPRESSION CORNER FLOW WITH SHOCK IMPINGEMENT
S. VENKATESWARAN (Lockheed Engineering and Sciences Co., Hampton, VA), DAVID W. WITTE, and L. R. HUNT (NASA, Langley Research Center, Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Mar.-Apr. 1992, p. 288, 289. Previously cited in issue 06, p. 799, Accession no. A91-19344. refs
Copyright

A92-32234
NUMERICAL COMPUTATION OF IMPROVED TRANSONIC POTENTIAL METHOD
ZI-QIANG ZHU and XUE-SONG BAI (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 180-184. refs
Copyright
Several points concerning the transonic potential method are briefly reviewed. Comparison of two correction orders - the nonisentropic jump conditions and the vorticity generated behind the shock - shows that the vorticity correction is indeed of higher order. An entropy shock point operator is introduced to account for entropy correction. Numerical examples in two- and three-dimensional cases show that nonisentropic formulation can simulate inviscid flow better than the traditional potential method, and it has the advantage of simplicity in its mathematical aspects, as does the potential method. Author

A92-32235* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EVALUATION OF A NAVIER-STOKES PREDICTION OF A JET IN A CROSSFLOW
KARLIN R. ROTH (NASA, Ames Research Center, Moffett Field, CA), RICHARD L. FEARN, and SIDDHARTH S. THAKUR (Florida, University, Gainesville) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 185-193. Previously cited in issue 09,

p. 1281, Accession no. A89-25366. refs
Copyright

A92-32236* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTERFERENCE FLOWS PAST CYLINDER-FIN-STING-CAVITY ASSEMBLIES
O. BAYSAL, K. FOULADI (Old Dominion University, Norfolk, VA), R. W. LEUNG, and J. S. SHEFTIC (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 194-202. Research supported by Lockheed Missiles and Space Co., Inc. Previously cited in issue 21, p. 3291, Accession no. A90-45924. refs
(Contract NAG1-664)
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A92-32237* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONAL STUDY OF INCIPIENT LEADING-EDGE SEPARATION ON A SUPERSONIC DELTA WING
S. N. MCMILLIN, JAMES L. PITTMAN, and JAMES L. THOMAS (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 203-209. Previously cited in issue 21, p. 3286, Accession no. A90-45871. refs
Copyright

A92-32239* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NAVIER-STOKES STUDY OF SUPERSONIC CAVITY FLOWFIELD WITH PASSIVE CONTROL
I. KIM and N. CHOKANI (North Carolina State University, Raleigh) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 217-223. Research supported by North Carolina Board of Science and Technology. Previously cited in issue 21, p. 3290, Accession no. A90-45913. refs
(Contract NCC1-46)
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A92-32241
EXPERIMENTAL STUDY OF A LOW REYNOLDS NUMBER TANDEM AIRFOIL CONFIGURATION
DANIEL F. SCHARPF and THOMAS J. MUELLER (Notre Dame, University, IN) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 231-236. Research supported by University of Notre Dame. Previously cited in issue 21, p. 3291, Accession no. A90-45923. refs
(Contract N00014-83-K-0239)
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A92-32243
NAVIER-STOKES METHODS TO PREDICT CIRCULATION CONTROL AIRFOIL PERFORMANCE
S. L. WILLIAMS (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) and M. E. FRANKE (USAF, Institute of Technology, Wright-Patterson AFB, OH) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 243-249. Previously cited in issue 06, p. 759, Accession no. A90-19924. refs

A92-32245
EFFECTS OF AMBIENT TURBULENCE ON THE DECAY OF A TRAILING VORTEX WAKE
H.-T. LIU (Quest Integrated, Inc., Applied Physics Div., Kent, WA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 255-263. Research sponsored by Quest Integrated, Inc. refs
(Contract DTRS57-87-C-00109)
Copyright

Experiments were conducted to investigate the effects of ambient turbulence on the evolution of a trailing vortex wake. The wake was generated by towing an NACA 0012 wing, with a span of 10.2 cm and a chord of 5.1 cm, at an incidence of -10 deg and a speed of 40 cm/s in a tow tank. The chord Reynolds number was 20,400. The ambient turbulence was generated by towing three grids, with square meshes of 1.45, 10.2, and 20.3 cm, upstream of the wing. Turbulence parameters were measured with crossed hot-film probes. The trailing vortex wake, tagged with a fluorescent dye, was visualized from different perspectives and its decay was derived from 16-mm movie records. For weak turbulence with large integral scales compared with the vortex separation, vortex linking is the dominant mode of instability. The dominant wavelength of the linking decreases with increasing turbulence intensity or dissipation rate. As the turbulence intensity increases, vortex bursting appears and eventually replaces linking as the dominant mode of instability. For turbulence with a small integral scale as compared with the vortex separation, vortex instability is predominantly of the bursting type. Author

A92-32251* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EARTH ATMOSPHERIC ENTRY STUDIES FOR MANNED MARS MISSIONS
M. E. TAUBER, G. E. PALMER (NASA, Ames Research Center, Moffett Field, CA), and LILY YANG (Sterling Software, Inc., Palo Alto, CA) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722), vol. 6, Apr.-June 1992, p. 193-199. Previously cited in issue 16, p. 2478, Accession no. A90-38402. refs
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A92-32323
THE SECOND GOLDSTEIN LECTURE: MODERN DEVELOPMENTS IN FLUID DYNAMICS - AN ADDENDUM
J. E. GREEN (Aircraft Research Association, Bedford, England) Aeronautical Journal (ISSN 0001-9240), vol. 96, March 1992, p. 69-86. refs
Copyright

A development history of wind tunnel test apparatus design and operation is presented, with a view to the characterization of state-of-the-art facilities and the currently critical wind tunnel factor of operational Reynolds number approximation. Attention is given to the fluid dynamics bases for scale effects. Two new aircraft categories, natural laminar flow designs and very large transonic transports, are identified as subject to more pronounced tunnel-to-flight scale effect than current aircraft; countermeasures applicable to these aircraft types are proposed. The nature of a fluid dynamic phenomenon associated with the loss of measurements-reproducibility is discussed. O.C.

A92-32324
NUMERICAL STUDIES OF SUPERSONIC FLOW OVER A COMPRESSION CORNER
S. C. HOLMES and L. C. SQUIRE (Cambridge, University, England) Aeronautical Journal (ISSN 0001-9240), vol. 96, March 1992, p. 87-95. Research supported by SERC. refs
Copyright

Numerical solutions of the Reynolds-averaged Navier-Stokes equations for the present near-adiabatic flow, which is formed by the shock/boundary-layer interaction of attached turbulent airflow over a 2D compression corner at Mach 2.5, yield isenthalpic and nonisenthalpic cases that are very similar with respect to velocity, pressure, and density fields. It is noted that the modeling of turbulent Prandtl number barely affects velocity, pressure and density fields; the primary effect is on the prediction of temperatures very close to the wall. Adiabatic wall-temperature variation in this shock/boundary-layer interaction is experimentally determined and compared with predictions. O.C.

A92-32500*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN AERODYNAMIC DESIGN STUDY OF A SERIES OF LIFTING BODIES AT ANGLES OF ATTACK FROM 10 TO 53 DEGREES AT MACH NUMBERS FROM 2.30 TO 4.62
M. L. SPEARMAN and ABEL O. TORRES (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Design Conference, Irvine, CA, Feb. 3-6, 1992, Paper. 8 p. refs
Copyright

The aerodynamic characteristics in the transition from high to low angles of attack at supersonic speeds have been experimentally

and theoretically studied for a series of lifting bodies with various upper and lower surface camber designs. The configurations under consideration have a 75-degree swept delta planform with a rounded nose. Data obtained indicate that changes in the camber design cause some distinct changes in the aerodynamic characteristics that shoud be taken into account in the selection of a lifting body shape. The flat bottom designs with upper surface camber are found to provide greater drag for retardation at high angles of attack but are considerably out of trim longitudinally. The flat top designs with lower surface camber provide less drag at high angles of attack but can be more easily trimmed. Calculated results are found to be in good agreement with the experimental data. O.G.

A92-32501
NUMERICAL ANALYSIS OF THREE-DIMENSIONAL UNSTEADY TURBULENT FLOWS IN A TURBINE STAGE
YOSHIO SHIKANO and MASAHIRO IKEGAWA Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016), vol. 56, Sept. 1990, p. 2570-2575. In Japanese. refs

A numerical method for analyzing 3D unsteady turbulent flows in a turbine stage is described. To calculate the unsteady interaction flow fields in a nozzle and bucket simultaneously, the bucket inlet elements and the nozzle outlet elements are overlapped in the axial direction and are employed for unsteady data transfer between flow regions. It is shown that unsteady flow phenomena such as the pressure field and nozzle wake interactions are well predicted, and the periodic aerodynamic forces acting on the buckets, including the effect of the axial distance difference, are obtained. R.E.P.

A92-32504
A NUMERICAL SOLUTION OF INVISCID TRANSONIC FLOW USING THE BOLTZMANN EQUATION
KATSUYA NAKAMURA, NOBUYUKI SATOFUKA, and KOJI MORINISHI Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016), vol. 56, Sept. 1990, p. 2597-2602. In Japanese. refs

An efficient numerical method of the Boltzmann equation is developed for inviscid transonic flow. The convective terms in the Boltzmann equation are approximated by the second-order upwind finite difference with limiter. The rational Runge-Kutta scheme is used for the corresponding time integration. The residual averaging technique is incorporated into the method so that the rate of convergence is improved to a steady-state solution. The solution of the collision integral is obtained as thermodynamic equilibrium states. The number of grid points in molecular velocity space is reduced to 4 for each direction to shorten the CPU time in the present approach. As an example, the 1D unsteady shock-tube problem is solved and the results are compared with the exact solution. The feasibility of the present method is demonstrated for the 2D transonic flow in a channel, and over the NACA0012 airfoil and the RAE2822 airfoil. Author

N92-20229# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
TEMPERATURE EFFECTS IN FFA HYP 500 AT M = 7 IN A FLOW WITH STRONG EXPANSION
MAGNUS LINDE Jul. 1991 19 p
(FFA-TN-1991-27; ETN-92-91059) Avail: NTIS HC/MF A03

The flow in a cold hypersonic wind tunnel was investigated at Mach 7 with respect to effects of condensation in flow with expansions. For the tests the flow on the upper side of a delta wing at angle of attack was investigated with a pressure probe and with oil surface flow technique. The testing was made with different stagnation temperatures. It was found that no effects could be found on the forward part of the wing. On the rear part some influence of the stagnation temperature on the flow structure was found. This could be due to the effects of condensation. It is believed that the finite time constant for the condensation process gives a delay in the onset of condensation and that this was the case in the present tests. The limited tests do, however, not allow definite conclusions to be drawn. ESA

N92-20283*# Complere, Inc., Palo Alto, CA.
MEASUREMENT OF VORTEX FLOW FIELDS Final Report
T. KEVIN MCDEVITT, TODD A. AMBUR, GARY M. ORNGARD, and F. KEVIN OWEN Jan. 1992 100 p
(Contract NAS1-18667)
(NASA-CR-189543; NAS 1.26:189543) Avail: NTIS HC/MF A05 CSCL 01A

A 3-D laser fluorescence anemometer (LFA) was designed, built, and demonstrated for use in the Langley 16 x 24 inch Water Tunnel. Innovative optical design flexibility combined with compact and portable data acquisition and control systems were incorporated into the instrument. This will allow its use by NASA in other test facilities. A versatile fiber optic system facilities normal and off-axis laser beam alignment, removes mirror losses and improves laser safety. This added optical flexibility will also enable simple adaptation for use in the adjacent jet facility. New proprietary concepts in transmitting color separation, light collection, and novel prism separation of the scattered light was also designed and built into the system. Off-axis beam traverse and alignment complexity led to the requirement for a specialized, programmable transverse controller, and the inclusion of an additional traverse for the off-axis arm. To meet this challenge, an 'in-house' prototype unit was designed and built and traverse control software developed specifically for the water tunnel traverse applications. A specialized data acquisition interface was also required. This was designed and built for the LFA system. Author

N92-20332 Case Western Reserve Univ., Cleveland, OH.
AN INVISCID STABILITY ANALYSIS OF UNBOUNDED SUPERSONIC MIXING LAYER FLOWS Ph.D. Thesis
FANG-PEI LIANG 1991 186 p
Avail: Univ. Microfilms Order No. DA9137033

An analysis is performed of the inviscid linear stability of unbounded supersonic mixing layer flows. The general stability characteristics of subsonic and supersonic solutions and the unstable eigen spectrum are discussed. The existence of neutral solutions supersonic to either or both free streams is verified. Two unstable supersonic modes, which can be supersonic to either or both of the free streams, are found and the transition from the supersonic modes to that associated with generalized inflection point is investigated. Systematical study is made of the unstable eigen spectrum using a number of numerical methods, including the method of the principle of argument and the method of multi-domain Chebyshev collocation with the QZ algorithm. The method of the principle of argument is robust and theoretically neat. The Chebyshev collocation method, however, is very expensive when applied to supersonic stability computation because of the presence of the critical point singularity and the slow damping of the eigenfunction at free streams. It is concluded that for unbounded flows there are only a small number of supersonic unstable modes (two modes in our cases) and the exact number for a given supersonic flow is generally not known. To determine the number of unstable modes requires detailed investigation by, e.g. the method of the principle of argument. Dissert. Abstr.

N92-20378 Purdue Univ., West Lafayette, IN.
AEROELASTIC BEHAVIOR OF AN ADAPTIVE LIFTING SURFACE Ph.D. Thesis
STEVEN MICHAEL EHLERS 1991 187 p
Avail: Univ. Microfilms Order No. DA9201321

The use of an adaptive structure to control the static aeroelastic behavior of a lifting surface is examined. The wing structure is modeled as a laminated beam with bending and torsional deformation freedom. Actuation is provided by piezoelectric materials embedded in the wing structural laminate. The structure is made adaptive by using a feedback control system that applies a voltage to the piezoelectric material layers in direct proportion to the wing root loads. Lift effectiveness, static stability, and rolling behavior of the wing are controlled by varying the feedback gain. Both differential equation and discrete model approaches are used in the analysis. It is shown that the lift effectiveness of a wing can be increased or decreased with respect to its nonadaptive

behavior by controlling the feedback gain. The adaptive structure may also be used to increase the divergence dynamic pressure of the wing. The adaptive structure approach is also used to alter the rolling power, damping in roll, and steady state roll effectiveness of a uniform wing by varying the feedback gain. It is shown that the adaptive structure may be used to increase or decrease the rolling power of a wing with a control surface. Damping in roll can also be actively controlled. Simultaneously controlling rolling power and roll damping can be used to modify the steady state roll rate. Dissert. Abstr.

N92-20468# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

MATGRID: A PROGRAM FOR GENERATION OF C-H AND C-O TOPOLOGY GRIDS AROUND WING/BODY CONFIGURATIONS. MATHEMATICAL DEFINITION DOCUMENT

SVEN G. HEDMAN and LARS G. TYSELL Oct. 1991 34 p Sponsored by National Swedish Board for Technical Development (FFA-TN-1990-19; ETN-92-91058) Avail: NTIS HC/MF A03

MATGRID is a computer program for generation of C-H or C-O topology grids for the discretization of flow fields around configurations consisting of a wing alone or a wing and a fuselage. It was developed within the cooperative program MATGRID/MATRICS primarily for use together with the full potential flow solver MATRICS (Multi Component Aircraft Transonic Inviscid Computation System). The mathematical principles used in the construction of the grid generation procedure are described. ESA

N92-20473# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

INVISCID DRAG PREDICTION FOR TRANSONIC TRANSPORT WINGS USING A FULL-POTENTIAL METHOD

J. VANDERVOOREN and A. J. VANDERWEES 8 Nov. 1989 23 p Presented at the 28th AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, 8-11 Jan. 1990
(Contract NIVR-01501N)
(NLR-TP-89365-U; ETN-92-90961; AD-B158639L) Avail: NTIS HC/MF A03

A theory of drag analysis in full potential flow, based on generalization and extension of Garabedian's and McFadden's idea of determining wave drag by volume integration of the artificial viscosity, is summarized. An illustrative example demonstrates that the theory predicts the change in wave drag on a wing between a fully conservative and a nonconservative solution qualitatively correct and quantitatively realistic. A series of mesh definement experiments on nested grids was carried out for a DFVLR F4 wing in transonic flow, using CH as well as CO topology grids, with the purpose of providing insight into the accuracy of inviscid drag prediction for transonic transport wings. The MATRICS code used in the experiments is first order accurate in the mesh size throughout supersonic flow regions. In particular in CO topology grids, where the improved wing tip resolution generally resolves the tip vortex much better than on CH topology grids, the velocities in the core of this requires a local modification of the flow model. CO topology grids are concluded to be better suited for drag analysis than are CH topology grids. Another conclusion is that the accuracy of each individual drag component can be improved by extrapolating to the limit of vanishing mesh size. In order to avoid excessively fine grids in an engineering environment, the need for artificial viscosity terms that are second order small in the mesh size in supersonic flow regions, except for the immediate vicinity of the shock waves, is stressed. Extrapolation procedures are believed then however to remain necessary for accurate drag prediction. ESA

N92-20480*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

QUALITY ASSESSMENT OF TWO- AND THREE-DIMENSIONAL UNSTRUCTURED MESHES AND VALIDATION OF AN UPWIND EULER FLOW SOLVER

PAUL R. WOODARD, HENRY T. Y. YANG (Purdue Univ., West Lafayette, IN.), and JOHN T. BATINA Feb. 1992 15 p Presented at the AIAA 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992
(NASA-TM-104215; NAS 1.15:104215) Avail: NTIS HC/MF A03 CSCL 01/1

Quality assessment procedures are described for two-dimensional and three-dimensional unstructured meshes. The procedures include measurement of minimum angles, element aspect ratios, stretching, and element skewness. Meshes about the ONERA M6 wing and the Boeing 747 transport configuration are generated using an advancing front method grid generation package of programs. Solutions of Euler's equations for these meshes are obtained at low angle-of-attack, transonic conditions. Results for these cases, obtained as part of a validation study demonstrate the accuracy of an implicit upwind Euler solution algorithm. Author

N92-20494*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPARISON OF A TWO-DIMENSIONAL ADAPTIVE-WALL TECHNIQUE WITH ANALYTICAL WALL INTERFERENCE CORRECTION TECHNIQUES

RAYMOND E. MINECK Apr. 1992 73 p
(NASA-TP-3132; L-16911; NAS 1.60:3132) Avail: NTIS HC/MF A04 CSCL 01/1

A two dimensional airfoil model was tested in the adaptive wall test section of the NASA Langley 0.3 meter Transonic Cryogenic Tunnel (TCT) and in the ventilated test section of the National Aeronautical Establishment Two Dimensional High Reynold Number Facility (HRNF). The primary goal of the tests was to compare different techniques (adaptive test section walls and classical, analytical corrections) to account for wall interference. Tests were conducted over a Mach number range from 0.3 to 0.8 at chord Reynolds numbers of 10 x 10(exp 6), 15 x 10(exp 6), and 20 x 10(exp 6). The angle of attack was varied from about 12 degrees up to stall. Movement of the top and bottom test section walls was used to account for the wall interference in the HRNF tests. The test results are in good agreement. Author

N92-20498# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.

NUMERICAL SIMULATION OF VORTICAL FLOW OVER A DELTA WING AT SUBSONIC AND TRANSONIC SPEEDS

H. W. M. HOEIJMAKERS, J. M. J. W. JACOBS, and J. I. VANDENBERG 1 May 1990 19 p Presented at the 17th ICAS Congress, 9-14 Sep. 1990. Stockholm, Sweden Sponsored by Netherlands Agency for Aerospace Programs and Ministry of Defence
(NLR-TP-90029-U; ETN-92-90962; AD-B158645L) Avail: NTIS HC/MF A03

The flow about a 65 degree sharp edged cropped delta wing is simulated by solving the Euler equations. Solutions are obtained for the wing at a subsonic, free stream Mach number and high angle of attack, where a strong vortex forms above the wing upper surface as well as for the wing at a transonic free stream Mach number and high incidence resulting in shocks and strong vortices. For the latter case the development of the flow field with the incidence is studied, while for both cases the formation of the wake downstream of the trailing edge is investigated. The influence of the mesh resolution on the details of the solution is analyzed utilizing a mesh of 0-0 topology, which on its finest level has more than one million grid points in the half space around the starboard side of the delta wing. ESA

N92-20545*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DIFFRACTED AND HEAD WAVES ASSOCIATED WITH WAVES ON NONSEPARABLE SURFACES

RAYMOND L. BARGER Apr. 1992 17 p
(NASA-TP-3169; L-16968; NAS 1.60:3169) Avail: NTIS HC/MF A03 CSCL 01/1

A theory is presented for computing waves radiated from waves on a smooth surface. With the assumption that attention of the

surface wave is due only to radiation and not to dissipation in the surface material, the radiation coefficient is derived in terms of the attenuation factor. The excitation coefficient is determined by the reciprocity condition. Formulas for the shape and the spreading of the radiated wave are derived, and some sample calculations are presented. An investigation of resonant phase matching for nonseparable surfaces is presented with a sample calculation. A discussion of how such calculations might be related to resonant frequencies of nonseparable thin shell structures is included. A description is given of nonseparable surfaces that can be modeled in the vector that facilitates use of the appropriate formulas of differential geometry. Author

N92-20654*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
UNSTEADY-PRESSURE AND DYNAMIC-DEFLECTION MEASUREMENTS ON AN AEROELASTIC SUPERCRITICAL WING
DAVID A. SEIDEL, MAYNARD C. SANDFORD, and CLINTON V. ECKSTROM Washington Dec. 1991 315 p
(NASA-TM-4278; L-16906; NAS 1.15:4278) Avail: NTIS HC/MF A14 CSCL 01/1

Transonic steady and unsteady pressure tests were conducted on a large elastic wing. The wing has a supercritical airfoil, a full span aspect ratio of 10.3, a leading edge sweepback angle of 28.8 degrees, and two inboard and one outboard trailing edge control surfaces. Only the outboard control surface was deflected statically and dynamically to generate steady and unsteady flow over the wing. The unsteady surface pressure and dynamic deflection measurements of this elastic wing are presented to permit correlations of the experimental data with theoretical predictions. Author

N92-20797# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel Working Group 13.
AIR INTAKES FOR HIGH SPEED VEHICLES
Sep. 1991 263 p
(AGARD-AR-270; ISBN-92-835-0637-5) Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The results of a study by Working Group 13 of the AGARD Fluid Dynamics Panel are presented. The scope of the investigation included intake aerodynamics, intake/engine compatibility, and intake/airframe integration for both aircraft and missiles. The present capability of Computational Fluid Dynamics (CFD) methods was assessed through a comparative analysis of both CFD predictions and experimental data. This analysis was conducted for eight different flow field test cases designed to produce critical features of air-intake flow fields. Flow field results and comparisons are presented both in the report and in a microfiche appendix. Air-inlet wind tunnel testing techniques and limitations were also investigated and reported. Results from measurements of inlet performance from three European wind tunnels using a common axisymmetric pitot intake are also presented. The participants in Working Group 13 represented Belgium, France, Germany, Italy, the United Kingdom, and the United States. Author

N92-20934*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FLOW STUDIES IN CLOSE-COUPLED VENTRAL NOZZLES FOR STOVL AIRCRAFT
JACK G. MCARDLE and C. FREDERIC SMITH (Sverdrup Technology, Inc., Cleveland, OH.) 1990 23 p Presented at the Aerospace Atlantic Conference, Dayton, OH, 23-26 Apr. 1990; sponsored by SAE Previously announced in IAA as A91-21242
(NASA-TM-102554; E-5369; NAS 1.15:102554; SAE-901033)
Avail: NTIS HC/MF A03 CSCL 01/1

Flow in a generic ventral nozzle system was studied experimentally and analytically with the PARC3D computational fluid dynamics program in order to evaluate the program's ability to predict system performance and internal flow patterns. A generic model of a tailpipe with a rectangular ventral nozzle, about 1/3 of full size, was tested with unheated air at steady state pressure ratios up to 4.0. The end of the tailpipe was closed to simulate a blocked exhaust nozzle. Flow behavior into and through the ventral duct is discussed and illustrated with paint streak flow visualization photographs. PARC3D graphic images are shown for comparison with the experimental photographs. The program successfully predicted internal flow patterns; it also computed thrust and discharge coefficients within 1 pct. of measured values. Author

N92-21012# Naval Postgraduate School, Monterey, CA.
A QUANTITATIVE STUDY OF UNSTEADY COMPRESSIBLE FLOW ON AN OSCILLATING AIRFOIL
L. W. CARR, M. S. CHANDRASEKHARA, and N. J. BROCK Jun. 1991 18 p Presented at the 22nd AIAA Fluid Dynamics, Plasma Dynamics, and Lasers Conference, Honolulu, HI, 24-26 Jun. 1991 Previously announced in IAA as A91-43590
(Contract MIPR-ARO-114-91)
(AD-A244572; ARO-27894.7-EG) Avail: NTIS HC/MF A03 CSCL 01/1

Detailed interferometric measurements of the flow near the leading edge of an oscillating airfoil offer the first detailed experimental quantification of the locally compressible flow field that surrounds an oscillating airfoil at moderate subsonic Mach numbers. Interferograms obtained by a specially adapted real-time point-diffraction interferometry technique have revealed significant characteristics of this complex, and very rapidly varying, locally supersonic flow. Instantaneous pressure distributions determined from these interferograms document the effect of unsteadiness on the leading-edge flow environment. GRA

N92-21188*# Nielsen Engineering and Research, Inc., Mountain View, CA.
POSTFLIGHT AEROTHERMODYNAMIC ANALYSIS OF PEGASUS(TM) USING COMPUTATIONAL FLUID DYNAMIC TECHNIQUES Final Contractor Report
GARY D. KUHN Mar. 1992 88 p Prepared in cooperation with PRC Kentron, Inc., Edwards, CA
(Contract NAS2-12722)
(NASA-CR-186017; H-1765; NAS 1.26:186017) Avail: NTIS HC/MF A05 CSCL 01/1

The objective was to validate the computational capability of the NASA Ames Navier-Stokes code, F3D, for flows at high Mach numbers using comparison flight test data from the Pegasus (tm) air launched, winged space booster. Comparisons were made with temperature and heat fluxes estimated from measurements on the wing surfaces and wing-fuselage fairings. Tests were conducted for solution convergence, sensitivity to grid density, and effects of distributing grid points to provide high density near temperature and heat flux sensors. The measured temperatures were from sensors embedded in the ablating thermal protection system. Surface heat fluxes were from plugs fabricated of highly insulative, nonablating material, and mounted level with the surface of the surrounding ablative material. As a preflight design tool, the F3D code produces accurate predictions of heat transfer and other aerodynamic properties, and it can provide detailed data for assessment of boundary layer separation, shock waves, and vortex formation. As a postflight analysis tool, the code provides a way to clarify and interpret the measured results. Author

N92-21287# National Aerospace Lab., Tokyo (Japan). Aircraft Aerodynamics Div.
EVALUATION OF NACA0012 AIRFOIL TEST RESULTS IN THE NAL TWO-DIMENSIONAL TRANSONIC WIND TUNNEL
NORIKAZU SUDANI, HIROSHI KANDA, MAMORU SATO, HITOSHI MIWA, KENICHI MATSUNO, and SUSUMU TAKANASHI May 1991 18 p
(NAL-TR-1109T; ISSN-0389-4010) Avail: NTIS HC/MF A03

Surface pressure and drag measurements on the NACA0012 airfoil were conducted in the NAL Two-Dimensional Transonic Wind Tunnel. Using a comparison with other wind tunnel data, the wall interference effects are discussed, especially those from the sidewall. The results suggest that the Mach number of the actual flow around the airfoil is lower than the setting Mach number.

The Mach number correction for the sidewall boundary layer effects based on the similarity rule was applied to the present measurements, thereby showing that the shock positions, the pressure distributions, and the minimum drag coefficients are in good agreement with both other wind tunnel results and the Navier-Stokes calculation. It is shown that the evaluation indicates satisfactory transonic airfoil test results in the NAL Two-Dimensional Transonic Wind Tunnel. Author

N92-21333# JAI Associates, Inc., Mountain View, CA.
FLOWFIELD ANALYSIS OF MODERN HELICOPTER ROTORS IN HOVER BY NAVIER-STOKES METHOD
G. R. SRINIVASAN, V. RAGHAVAN, and E. P. DUQUE 17 Oct. 1991 20 p
(AD-A245011; ARO-27752.2-EG) Avail: NTIS HC/MF A03
CSCL 01/1

The viscous, three-dimensional, flowfields of UH60 and BERP rotors are calculated for lifting hover configurations using a Navier-Stokes computational fluid dynamics method with a view to understand the importance of planform effects on the airloads. In this method, the induced effects of the wake, including the interaction of tip vortices with successive blades, are captured as a part of the overall flowfield solution without prescribing any wake models. Numerical results in the form of surface pressures, hover performance parameters, surface skin friction and tip vortex patterns, and vortex wake trajectory are presented at two thrust conditions for UH60 and BERP rotors. Comparison of results for the UH60 model rotor show good agreement with experiments at moderate thrust conditions. Comparison of results with equivalent rectangular UH60 blade and BERP blade indicates that the BERP blade, with an unconventional planform, gives more thrust at the cost of more power and a reduced figure of merit. The high thrust conditions considered produce severe shock-induced flow separation for UH60 blade, while the BERP blade develops more thrust and minimal separation. The BERP blade produces a tighter tip vortex structure compared with the UH60 blade. These results and the discussion presented bring out the similarities and differences between the two rotors. GRA

N92-21356*# Eloret Corp., Palo Alto, CA.
INTERFEROGRAMS, SCHLIEREN, AND SHADOWGRAPHS CONSTRUCTED FROM REAL- AND IDEAL-GAS, TWO- AND THREE-DIMENSIONAL COMPUTED FLOWFIELDS
LESLIE A. YATES 1992 10 p
(Contract NCC2-583)
(NASA-CR-190054; NAS 1.26:190054) Avail: NTIS HC/MF A02
CSCL 01/1

The construction of interferograms, schlieren, and shadowgraphs from computed flowfield solutions permits one-to-one comparisons of computed and experimental results. A method for constructing these images from both ideal- and real-gas, two- and three-dimensional computed flowfields is described. The computational grids can be structured or unstructured, and multiple grids are an option. Constructed images are shown for several types of computed flows including nozzle, wake, and reacting flows; comparisons to experimental images are also shown. In addition, the sensitivity of these images to errors in the flowfield solution is demonstrated, and the constructed images can be used to identify problem areas in the computations. Author

N92-21429 Rensselaer Polytechnic Inst., Troy, NY.
PRESSURE AND VELOCITY MEASUREMENTS ABOUT AN AIRFOIL DURING A PARALLEL BLADE-VORTEX INTERACTION Ph.D. Thesis
JOHN STRAUS 1991 208 p
Avail: Univ. Microfilms Order No. DA9202213

Unsteady surface pressure and boundary layer velocity measurements were taken about an airfoil during a parallel blade-vortex interaction. It was necessary that the pressures and velocities were ensemble averaged. The pressures were integrated about the surface such that the effects of the blade-vortex interaction on the airfoil aerodynamics could be revealed. It was found that the total change in lift increased as the interaction distance decreased. It was also found that the effect of the interacting airfoil angle of attack had little effect when the vortex trajectory was taken into account. Furthermore, little difference was found between the results of an interaction with a clockwise vortex and a counter-clockwise vortex with the exception of sign change in the variation of lifts and moments. It was concluded that a leading edge separation occurred for the stronger interactions. Boundary layer velocity measurements were taken of a blade-vortex interaction of moderate intensity. It was found that the response of the boundary layer to the passing vortex was highly dependent upon the type of boundary layer. It was found that a boundary layer that is near transition in the steady-state will become fully turbulent during the interaction. A 'stable' laminar profile was found to remain laminar, though an excessive amount of turbulent energy was still generated. Dissert. Abstr.

N92-21432*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CURRENT STATUS OF COMPUTATIONAL METHODS FOR TRANSONIC UNSTEADY AERODYNAMICS AND AEROELASTIC APPLICATIONS
JOHN W. EDWARDS and JOHN B. MALONE Jan. 1992 26 p Presented at the AGARD Structures and Materials Panel Specialist's Meeting on Transonic Unsteady Aerodynamics and Aeroelasticity, San Diego, CA, 9-11 Oct. 1991
(NASA-TM-104191; NAS 1.15:104191; AGARD-PAPER-1) Avail: NTIS HC/MF A03 CSCL 01/1

The current status of computational methods for unsteady aerodynamics and aeroelasticity is reviewed. The key features of challenging aeroelastic applications are discussed in terms of the flowfield state: low-angle high speed flows and high-angle vortex-dominated flows. The critical role played by viscous effects in determining aeroelastic stability for conditions of incipient flow separation is stressed. The need for a variety of flow modeling tools, from linear formulations to implementations of the Navier-Stokes equations, is emphasized. Estimates of computer run times for flutter calculations using several computational methods are given. Applications of these methods for unsteady aerodynamic and transonic flutter calculations for airfoils, wings, and configurations are summarized. Finally, recommendations are made concerning future research directions. Author

N92-21456*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
FLOW ANALYSIS AND DESIGN OPTIMIZATION METHODS FOR NOZZLE AFTERBODY OF A HYPERSONIC VEHICLE
OKTAY BAYSAL Washington NASA. Langley Research Center Apr. 1991 57 p
(Contract NAG1-811; NAG1-1188)
(NASA-CR-4431; NAS 1.26:4431) Avail: NTIS HC/MF A04
CSCL 01/1

This report summarizes the methods developed for the aerodynamic analysis and the shape optimization of the nozzle-afterbody section of a hypersonic vehicle. Initially, exhaust gases were assumed to be air. Internal-external flows around a single scramjet module were analyzed by solving the three dimensional Navier-Stokes equations. Then, exhaust gases were simulated by a cold mixture of Freon and Argon. Two different models were used to compute these multispecies flows as they mixed with the hypersonic airflow. Surface and off-surface properties were successfully compared with the experimental data. In the second phase of this project, the Aerodynamic Design Optimization with Sensitivity analysis (ADOS) was developed. Pre and post optimization sensitivity coefficients were derived and used in this quasi-analytical method. These coefficients were also used to predict inexpensively the flow field around a changed shape when the flow field of an unchanged shape was given. Starting with totally arbitrary initial afterbody shapes, independent computations were converged to the same optimum shape, which rendered the maximum axial thrust. Author

N92-21465*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
AN ALTERNATIVE TO UNSTRUCTURED GRIDS FOR COMPUTING GAS DYNAMIC FLOWS AROUND ARBITRARILY COMPLEX TWO-DIMENSIONAL BODIES Final Report
JAMES J. QUIRK Feb. 1992 32 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-189612; NAS 1.26:189612; ICASE-92-7) Avail: NTIS HC/MF A03 CSCL 01/1

In this paper we describe an approach for dealing with arbitrary complex, two dimensional geometries, the so-called cartesian boundary method. Conceptually, the cartesian boundary method is quite simple. Solid bodies blank out areas of a background, cartesian mesh, and the resultant cut cells are singled out for special attention. However, there are several obstacles that must be overcome in order to achieve a practical scheme. We present a general strategy that overcomes these obstacles, together with some details of our successful conversion of an adaptive mesh algorithm from a body-fitted code to a cartesian boundary code. Author

N92-21504# Kansas Univ., Lawrence. Flight Research Lab.
ACTIVE FLOW CONTROL FOR TWENTY-FIRST CENTURY HIGH-PERFORMANCE AIRCRAFT WITH APPLICATIONS TO LAND AND SEA VEHICLES Abstract Only
SAEED FAROKHI *In* Wichita State Univ., Techfest 18 Proceedings 1 p Jan. 1992
Avail: NTIS HC/MF A03 CSCL 01/2

Future high-performance aircraft will be designed as an integrated system of 'smart components' with massive, distributed active-flow-control units. Here, the smart components are referred to as elements of an aircraft system with adaptive logic capability. These components will then perform 'optimally' under the most severe flight conditions. A few examples seem in order at this point. A delta wing at high angle of attack or yaw which can dictate its vortex burst locations; a subsonic diffuser which actively controls flow separation and engine-face distortion levels in a maneuvering aircraft; a compressor equipped with an active surge control unit; a propulsion installation in a multi-engined aircraft which can minimize its boattail and base drag in subsonic, transonic, and supersonic flight corridors; and active control of three-dimensional separation on bodies of revolution in yaw represent just a few applications of adaptive logic philosophy. To realize the aforementioned advances in a practical operating unit, one must establish the following: (1) distributed flow sensors at 'critical' locations; (2) a central processing unit with data link to A/C flight computer; (3) 'suitable' active flow manipulators: e.g., type, frequency response, amplitude; and (4) a self-optimizing, closed-loop (feedback) control of the active flow devices. This is a formidable and challenging task with tremendous payoffs for aeronautics as well as spin-off applications to land and sea vehicles. Active flow control units integrated into cars and trucks will reduce vehicle drag and enhance stability at highway speeds. Similarly, submarines will be able to maneuver with enhanced stability, quietly, and with minimum propulsive requirements. Author

N92-21514# Lear Jet Industries, Inc., Wichita, KS. Aerodynamics Div.
AERODYNAMIC DESIGN WITH CFD Abstract Only
REUBEN M. CHANDRASEKHARAN *In* Wichita State Univ., Techfest 18 Proceedings 1 p Jan. 1992
Avail: NTIS HC/MF A03 CSCL 01/2

The application of computational fluid dynamics (CFD) to practical aerodynamic design is described. It is shown how an advanced CFD tool such as the Tranair transonic code can be used to shape airplane components, subject to structural constraints. Some aerodynamic improvements achieved on the Learjet Model 60 business jet using CFD are presented. Author

N92-21528*# General Electric Co., Cincinnati, OH.
INLET TECHNOLOGY
PAUL KUTSCHENREUTER *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 6 p 1992
Avail: NTIS HC/MF A12 CSCL 01/1

At hypersonic flight Mach numbers, particularly above Mo = 10, the inlet compression process is no longer adiabatic, real gas chemistry takes on extra importance, and the combined effects of entropy layer and viscous effects lead to highly nonuniform flow profile characteristics at the combustor entrance. Under such conditions, traditional inlet efficiency parameters can be unnecessarily cumbersome and/or lacking in the ability to appropriately characterize the inlet flow and to provide insight into propulsion system performance. Recent experience suggests that the use of inlet entropy increases inlet efficiency in hypersonic applications. Author

N92-21588* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MULTI-COLORED LAYERS FOR VISUALIZING AERODYNAMIC FLOW EFFECTS Patent
RONALD N. JENSEN, inventor (to NASA) 10 Dec. 1991 3 p Filed 3 Dec. 1990 Supersedes N91-16999 (29 - 9, p 1273)
(NASA-CASE-LAR-13742-1; US-PATENT-5,070,729; US-PATENT-APPL-SN-621144; US-PATENT-CLASS-73-147; US-PATENT-CLASS-116-201; US-PATENT-CLASS-116-207; INT-PATENT-CLASS-G01M-9/00) Avail: US Patent and Trademark Office CSCL 01/1

A method is provided for visualizing aerodynamic flow effects on a test surface. First, discrete quantities of a sublimating chemical such as naphthalene are distinctively colored via appropriate dyes or paints. Next, a uniform layer of the sublimating chemical having a particular color is applied to the test surface. This layer is covered with a second uniform layer of a different colored sublimating chemical, and so on until a composite of multi-colored layers is formed having a discrete thickness. Friction caused by an airflow results in the distinctly colored layers being removed in proportion to such aerodynamic flow characteristics as velocity and temperature, resulting in a multi-colored portrait which approximates the air flow on the underlying test surface.
Official Gazette of the U.S. Patent and Trademark Office

N92-21703# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
THREE-DIMENSIONAL SIMULATIONS OF HYPERSONIC FLOWS
MICHAEL PFITZNER, W. SCHROEDER, S. MENNE, and CLAUS WEILAND 4 Sep. 1991 15 p Presented at International Conference on Hypersonic Aerodynamics, Manchester, England, 4-6 Sep. 1989 Previously announced in IAA as A91-21184
(MBB-UK-0155-89-PUB; ETN-92-90998) Avail: NTIS HC/MF A03

Flow codes for the simulation of three dimensional hypersonic flows are presented. The equilibrium real gas flow about a reentry configuration and about a two stage reusable launch vehicle is simulated by a code based on the quasi conservative form of the Euler equations in conjunction with a bow shock fitting algorithm and a Runge-Kutta time stepping scheme. Imbedded shocks are captured. Flows about more complicated geometries containing very strong shocks are simulated using a code based on a symmetric TVD discretization and explicit and implicit time integration. ESA

N92-21753# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
IDENTIFICATION OF AERODYNAMIC COEFFICIENTS USING COMPUTATIONAL NEURAL NETWORKS
DENNIS J. LINSE and ROBERT F. STENGEL 9 Jan. 1992 13 p Presented at the Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992 Previously announced in IAA as A92-23783
(Contract DAAL03-89-K-0092)
(AD-A244711; ARO-25264.13-MA) Avail: NTIS HC/MF A03 CSCL 01/1

Precise, smooth aerodynamic models are required for implementing adaptive, nonlinear control strategies. Accurate

representations of aerodynamic coefficients can be generated for the complete flight envelope by combining computational neural network models with an Estimation-Before-Modeling paradigm for on-line training information. A novel method of incorporating first-partial-derivative information is employed to estimate the weights in individual feedforward neural networks for each aerodynamic coefficient. The method is demonstrated by generating a model of the normal force coefficient of a twin-jet transport aircraft from simulated flight data. Promising results were obtained. GRA

N92-21784# Helsinki Univ. of Technology, Espoo (Finland). Lab. of Aerodynamics.
TWO-DIMENSIONAL TRANSONIC FLOW CALCULATION BY INTERACTION OF EULER AND BOUNDARY LAYER EQUATIONS
Z. ZIQIANG and T. SIIKONEN 26 Oct. 1990 44 p
(PB92-136449; SER-B-90-B27; ISBN-951-22-0389-8) Avail: NTIS HC/MF A03 CSCL 01/1

A viscous/inviscid interaction calculation, based on the Euler and inverse boundary layer equations, is described for computing transonic flows over airfoils. The Euler method is modified to include a prescribed surface transpiration flux distribution obtained from the inverse boundary layer method, which allows calculation of flows with separation. Solutions are presented for airfoils with relatively strong shocks and with separation. The results show good agreement with experimental data. GRA

03

AIR TRANSPORTATION AND SAFETY

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

A92-29507
GREATER RNAV UTILIZATION COULD EXPAND SYSTEM CAPACITY
WILLIAM L. POLHEMUS (Polhemus Associates, Inc., Ann Arbor, MI) ICAO Journal (ISSN 0018-8778), vol. 47, Feb. 1992, p. 16, 17.
Copyright

The aggressive use of RNAV avionics can offset a shortage of U.S. landing surfaces in virtue of the ability of the Loran and GPS receivers (and associated digital processors) involved to implement a near-Category-I-quality instrument-approach procedure at virtually every runway, thereby allowing, at comparatively low cost, intensive recourse to currently underutilized runways and heliports. This would increase the approaches to Washington, D.C. by 10 runways, and furnish at least two landing directions at every instrument runway. RNAV procedures also allow more efficient departure/arrival route implementation. O.C.

A92-29508
FIRE-FIGHTING FOAMS MUST MEET NEWLY-DEVELOPED ICAO STANDARD
BERNARD BROWN (Civil Aviation Authority, London, England) ICAO Journal (ISSN 0018-8778), vol. 47, Feb. 1992, p. 18-20.
Copyright

A new performance test has been devised by the ICAO to measure the effectiveness of various candidate fire-suppression foams; the optimal foam must combine a rapid fire knockdown capability with adequate post-fire security and high burn-back resistance. Attention is presently given to the foam's pH value, viscosity, and tendency to sedimentation. The test fire covers either 2.8 or 4.5 sq m. O.C.

A92-29732
THE SELECTION OF BIRD IMPACT LOAD TYPES
JING YIN and DEPING GAO (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 230-237. Research supported by National Aeronautical Scientific Fund. refs

The finite element method is presently used to compute the nonlinear transient response of turbojet compressor blades or turbofan fan blades to bird strikes, simulating a real blade by means of a rectangular cantilever plate; the results thus obtained can serve as a basis for the selection of bird impact load types. Both point loads and distributed loads are calculated for elastic and plastic states. While in the elastic state the loading location must be accurately selected, in the plastic state there arises a clear difference in blade response between point and distributed loads. O.C.

A92-32238
SELF-COMPENSATING CARRIER AIRCRAFT RECOVERY SYSTEM
ROLF BRODERSEN and GREGORY SAUER (Martin Marietta Corp., Orlando, FL) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 210-216. Previously cited in issue 22, p. 3489, Accession no. A90-48864. refs
Copyright

N92-20156# National Research Council of Canada, Ottawa (Ontario). Inst. for Mechanical Engineering.
FREEZING PRECIPITATION ON LIFTING SURFACES
M. M. OLESKIW Sep. 1991 39 p
(NRC-32124; IME-CRE-TR-003; CTN-92-60430) Avail: NTIS HC/MF A03

On March 10, 1989 an Air Ontario Fokker F-28 crashed during an attempted take-off from the airport at Dryden, Ontario in wet snow conditions. Witnesses reported that snow on the wings appeared to turn to ice during the take-off roll. As part of an investigation into the crash, the National Research Council of Canada Low Temperature Laboratory has undertaken an investigation of the quantity and form of the precipitation adhering the wings during the take-off attempt. Since precipitation measurements during the period of the stopover were unavailable, an empirical formula, utilizing the visibility recorded by the weather observer and by a transmissometer, was used to provide an estimate of 1.38 mm of snowfall. A thermodynamic analysis of the influence of take-off roll upon the precipitation layer on the wings indicated that no significant change caused by the movement of the aircraft occurred during this interval. However, the wing tank fuel temperature during the final stopover was calculated to be below 0 C. Therefore, heat removed from the lower portion of the wet snow layer may have caused freezing of the liquid portion of the snow. As a result when the upper snow layer was blown away during the take-off roll, it likely left behind a very rough ice layer on the wing. This rough layer may have had a very serious effect on the aircraft's aerodynamic performance. CISTI

N92-20303 Toledo Univ., OH.
NUMERICAL SIMULATION OF AN AIRCRAFT ANTI-ICING SYSTEM INCORPORATING A RIVULET MODEL FOR THE RUNBACK WATER Ph.D. Thesis
KAMEL MAHMOUD AL-KHALIL 1991 212 p
Avail: Univ. Microfilms Order No. DA9200761

A numerical simulation of the anti-icing of aircraft surfaces is presented. A basic runback model was developed for the prediction of the surface water temperature as well as for the solid wall temperature distribution using a one-dimensional heat transfer approach for each domain. A variety of test cases were considered in order to validate the various numerical components of the process as well as to show the procedure. The basic model was then improved using a basic theory regarding the breakup of a uniformly thin liquid film into individual streams or rivulets separated by dry spaces. The concept was used to accurately predict the wetness factor distribution over the surface and to more accurately describe the physics of the runback water. A two-dimensional heat transfer approach is used to calculate the temperature distributions

in the runback water and the solid wall. The model allows a multilayer representation of the solid wall with the possibility of heating the surface by means of electrical heating elements embedded within the layers, or by means of convective heating of the surface from the inside using compressor bleed air. Parametric studies were performed to study the effects of some of the problem variables on the results. Dissert. Abstr.

N92-20318# National Oceanic and Atmospheric Administration, Silver Spring, MD. Air Resources Lab.
VORTEX CHARACTERISTICS OF C5A/B, C141B AND C130E AIRCRAFT APPLICABLE TO ATC TERMINAL FLIGHT OPERATIONS TOWER FLY-BY-DATA
L. J. GARODZ and K. L. CLAWSON Aug. 1991 261 p
(PB92-114586; NOAA-TM-ERL-ARL-190) Avail: NTIS HC/MF A12 CSCL 01C

Newly acquired military transport aircraft vortex wake data was examined for application to existing Air Traffic Control (ATC) terminal area flight operations. The data was examined for application to simultaneously parallel runway operations. The full scale vortex flight test data were obtained by the NOAA Air Resources Lab Field Research Div. using the tower fly-by technique. The aircraft studied were U.S. Air Force large jet transports from the Military Airlift Command, namely, the Lockheed C5A/B Galaxy, the C14B Starlifter, and C130E Hercules. The data were collected and analyzed for military purposes. However, the type of data that was collected permitted further analysis, including vortex persistence and transported at low altitudes. A secondary purpose was to attempt to determine a correlation parameter(s), other than ambient wind velocity, for vortex persistence (age). The plan was to correlate vortex persistence with atmospheric conditions existing during the time of flight tests were conducted. This was, of course, dependent on appropriate supporting flight test data. Author

N92-20794# Cranfield Inst. of Tech., Bedford (England). Centre for Transport Studies.
AN EVALUATION OF IN-CABIN SAFETY FEATURES IN PASSENGER AIRCRAFT M.S. Thesis
D. J. NICOL Aug. 1990 209 p
(ETN-92-90656) Copyright Avail: NTIS HC/MF A10

Aircraft passenger safety considerations are evaluated. The advantages of providing smokehoods for passengers and an onboard tender-fed water mist spray system are considered. Cabin configuration, with special reference to seat pitch and aisle width in and around emergency exits, is considered. Safety features which might improve the egress capability of passengers after a survival accident are evaluated within an economic framework. A mathematical model, to be used to determine the effect of cost and weight of various proposed safety features, is developed. ESA

N92-21503*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COCKPIT WEATHER INFORMATION NEEDS Abstract Only
CHARLES H. SCANLON *In* Wichita State Univ., Techfest 18 Proceedings 2 p Jan. 1992
Avail: NTIS HC/MF A03 CSCL 01/3

The primary objective is to develop an advanced pilot weather interface for the flight deck and to measure its utilization and effectiveness in pilot reroute decision processes, weather situation awareness, and weather monitoring. Identical graphical weather displays for the dispatcher, air traffic control (ATC), and pilot crew should also enhance the dialogue capabilities for reroute decisions. By utilizing a broadcast data link for surface observations, forecasts, radar summaries, lightning strikes, and weather alerts, onboard weather computing facilities construct graphical displays, historical weather displays, color textual displays, and other tools to assist the pilot crew. Since the weather data is continually being received and stored by the airborne system, the pilot crew has instantaneous access to the latest information. This information is color coded to distinguish degrees of category for surface observations, ceiling and visibilities, and ground radar summaries. Automatic weather monitoring and pilot crew alerting is accomplished by the airborne computing facilities. When a new weather information is received, the displays are instantaneously changed to reflect the new information. Also, when a new surface or special observation for the intended destination is received, the pilot crew is informed so that information can be studied at the pilot's discretion. The pilot crew is also immediately alerted when a severe weather notice, AIRMET or SIGMET, is received. The cockpit weather display shares a multicolor eight inch cathode ray tube and overlaid touch panel with a pilot crew data link interface. Touch sensitive buttons and areas are used for pilot selection of graphical and data link displays. Time critical ATC messages are presented in a small window that overlays other displays so that immediate pilot alerting and action can be taken. Predeparture and reroute clearances are displayed on the graphical weather system so pilot review of weather along the route can be accomplished prior to pilot acceptance of the clearance. An ongoing multiphase test series is planned for testing and modifying the graphical weather system. Preliminary data shows that the nine test subjects considered the graphical presentation to be much better than their current weather information source for situation awareness, flight safety, and reroute decision making. Author

N92-21513# Kansas Univ., Lawrence.
PRELIMINARY DESIGN AND LAY-OUT OF AN INFANT RESTRAINT SYSTEM Abstract Only
ANTJE ELLROTT *In* Wichita State Univ., Techfest 18 Proceedings 1 p Jan. 1992
Avail: NTIS HC/MF A03 CSCL 01/2

Due to improper restraint systems, infants have died or suffered from serious injuries during airplane crashes. A crashworthy infant restraint system which will not inflict a monetary strain on the adults traveling with the infants needs to be developed. By developing a safe and economical restraint system, most children between the ages of 0-2 years will be able to survive airplane crashes. The study shows the preliminary layout of such a system and its possible installation in a plane. Author

N92-21679# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
EFFECTS OF ADVERSE WEATHER ON AERODYNAMICS
Dec. 1991 287 p In ENGLISH and FRENCH Meeting held in Toulouse, France, 29 Apr. - 1 May 1991
(AGARD-CP-496; ISBN-92-835-0644-8) Copyright Avail: NTIS HC/MF A13; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

This meeting was organized to provide a timely review of the progress being made in advancing the state of the art in predicting, simulating, and measuring the effects of icing, anti-icing fluids, and various forms of precipitation on the aerodynamic characteristics of flight vehicles. Topics included results from both theoretical and experimental programs and material related to procedures and regulations for certification and operation. International participation for the meeting included authors from eight nations and representatives from most of the 16 NATO nations.

N92-21680# Renaudie (J. F.), Versailles (France).
FLIGHT IN ADVERSE ENVIRONMENTAL CONDITIONS
J. F. RENAUDIE *In* AGARD, Effects of Adverse Weather on Aerodynamics 21 p Dec. 1991
Copyright Avail: NTIS HC/MF A13; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Brief accounts are given of a number of papers presented at the Flight Mechanics Panel (FMP) Symposium held in Gol, Norway May 8 to 11, 1989. Atmospheric measurements and modeling, the effect of disturbances on design and operations, visibility, aircraft icing, and electromagnetic disturbances are discussed. Author

N92-21681# Douglas Aircraft Co., Inc., Long Beach, CA.
THE EFFECT OF WING ICE CONTAMINATION ON ESSENTIAL FLIGHT CHARACTERISTICS

R. E. BRUMBY *In* AGARD, Effects of Adverse Weather on Aerodynamics 4 p Dec. 1991
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Contamination of critical aerodynamic surfaces by ice, frost, and/or snow has been identified as the probable cause of a significant number of aircraft accidents. In most cases, the ice contamination has not been large ice accretions on the leading edges or thick layers of adhering snow on top of the wings. Rather, dangerous reductions in stall margins and handling qualities can occur because of ice related roughness equivalent to that of medium-grit sandpaper. Described here are the typical effects of such roughness on lift, drag, and pitching moment, and the corresponding effects on longitudinal and lateral control characteristics during rotation and liftoff. Of great importance is that the visual, aural, and tactical clues signaling a developing critical situation occur within a very few seconds, and usually do not correspond to any for which the flight crew has been trained or has previously experienced. Author

N92-21682# Ecole Royale Militaire, Brussels (Belgium).
LOW TEMPERATURE ENVIRONMENT OPERATIONS OF TURBOENGINES (DESIGN AND USER'S PROBLEMS)
R. JACQUES *In* AGARD, Effects of Adverse Weather on Aerodynamics 12 p Dec. 1991
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The author summarizes and links together a number of papers that were presented at the Propulsion and Energetics (PEP) symposium on low temperature environment operation of turbojet engines that was held October 8 to 12, 1990. Topics covered include operational experience of ice ingestion in the turboprop engine in the 2,000 hp class, icing on helicopter turbo engines, icing test facilities, ice relevant cloud physical parameters, and low temperature and fuel problems. Author

N92-21683# Centre d'Essais en Vol, Istres (France). Ingenieur Navigant d'Essais.
REGULATIONS AND THEIR CHANGES FOR CERTIFICATION OF CIVIL AIRCRAFT IN ICING CONDITIONS [EVOLUTION REGLEMENTAIRE EN MATIERE DE CERTIFICATION DES AVIONS CIVILS EN CONDITIONS GIVRANTES]
GILBERT CATTANEO *In* AGARD, Effects of Adverse Weather on Aerodynamics 9 p Dec. 1991 In FRENCH
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Experience acquired in the process of certifying standards and service use of civil aircraft has shown that a change of regulations is necessary. The regulatory changes in maintaining a safety level during flight in icing conditions that are comparable to flight in conditions where no icing is possible are discussed. Author

N92-21684*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ICING SIMULATION: A SURVEY OF COMPUTER MODELS AND EXPERIMENTAL FACILITIES
M. G. POTAPCZUK and J. J. REINMANN *In* AGARD, Effects of Adverse Weather on Aerodynamics 27 p Dec. 1991 Previously announced as N91-23087
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A survey of the current methods for simulation of the response of an aircraft or aircraft subsystem to an icing encounter is presented. The topics discussed include a computer code modeling of aircraft icing and performance degradation, an evaluation of experimental facility simulation capabilities, and ice protection system evaluation tests in simulated icing conditions. Current research focused on upgrading simulation fidelity of both experimental and computational methods is discussed. The need for the increased understanding of the physical processes governing ice accretion, ice shedding, and iced aerodynamics is examined. Author

N92-21686*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SIMULATION OF ICED WING AERODYNAMICS
M. G. POTAPCZUK, M. B. BRAGG, O. J. KWON, and L. N. SANKAR (Georgia Inst. of Tech., Atlanta.) *In* AGARD, Effects of Adverse Weather on Aerodynamics 15 p Dec. 1991 Previously announced as N91-23086
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The sectional and total aerodynamic load characteristics of moderate aspect ratio wings with and without simulated glaze leading edge ice were studied both computationally, using a three dimensional, compressible Navier-Stokes solver, and experimentally. The wing has an untwisted, untapered planform shape with NACA 0012 airfoil section. The wing has an unswept and swept configuration with aspect ratios of 4.06 and 5.0. Comparisons of computed surface pressures and sectional loads with experimental data for identical configurations are given. The abrupt decrease in stall angle of attack for the wing, as a result of the leading edge ice formation, was demonstrated numerically and experimentally. Author

N92-21687# Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
EFFECTS OF FROST ON WING AERODYNAMICS AND TAKE-OFF PERFORMANCE
R. J. KIND and M. A. LAWRYSYN *In* AGARD, Effects of Adverse Weather on Aerodynamics 11 p Dec. 1991
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Computations were done to predict the effects of various extents of frost coverage on the airfoil, wing, and takeoff performance of two hypothetical aircraft, a small light aircraft and a large transport aircraft. Airfoil performance was computed using rough wall boundary layer calculations coupled to an inviscid vortex panel method which includes a capacity for modeling stalled flow conditions. The roughness parameters determined for one of the frost samples were used for this purpose. A lifting line analysis was used to determine wing performance from the airfoil results. The results indicate that frost having an effective height of only 0.4 mm in the leading edge region of a wing can cause serious performance degradation even for a very large aircraft. On the other hand, frost coverage beginning well down stream of the suction peak, for example at about one/quarter chord, was predicted to have little effect. Author

N92-21688*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MODEL ROTOR ICING TESTS IN THE NASA. LEWIS ICING RESEARCH TUNNEL
ROBERT J. FLEMMING, RANDALL K. BRITTON (Sverdrup Technology, Inc., Brook Park, OH.), and THOMAS H. BOND *In* AGARD, Effects of Adverse Weather on Aerodynamics 25 p Dec. 1991 Previously announced as N91-23184
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Tests of a lightly instrumented two bladed teetering rotor and a heavily instrumented subscale articulated main rotor were conducted in the NASA Lewis Icing Research Tunnel (IRT). The first was an OH-58 tail rotor which had a diameter of 1.575 m and a blade chord of 0.133 m, and was mounted on a NASA designed test rig. The second, a four bladed articulated rotor, had a diameter of 1.83 m with 0.124 m chord blades specifically fabricated for the experiment. This rotor was mounted on a Sikorsky Aircraft Powered Force Model, which enclosed a rotor balance and other measurement systems. The models were exposed to variations in temperature, liquid water content, and medium droplet diameter, and were operated over ranges of advance ratio, shaft angle, tip Mach number (rotor speed), and weight coefficient to determine the effect of these parameters on ice accretion. In addition to strain gage and balance data, the test was documented

with still, video, and high speed photography, ice profile tracing, and ice molds. The sensitivity is presented of the model rotors to the test parameter and a comparison of the results to theoretical predictions. Author

N92-21689# Royal Aerospace Establishment, Farnborough (England).
A REVIEW OF ICING RESEARCH AT THE ROYAL AEROSPACE ESTABLISHMENT
R. W. GENT *In* AGARD, Effects of Adverse Weather on Aerodynamics 15 p Dec. 1991
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A brief review of the computer models developed by the Royal Aerospace Establishment (RAE) for the analysis of natural rotor icing and rotor protection against icing is provided. Experimental results are then presented for the increase in profile drag due to rime, glaze, and beak type icing. These data, combined with other published data, were used to obtain correlations for iced profile performance which were included in a computer model of helicopter performance. This enables the prediction of the increase in rotor power required by a helicopter with unprotected rotors during flight in icing conditions. Comparisons between model prediction and both rig and flight test data are given. K.S.

N92-21690# National Research Council of Canada, Ottawa (Ontario). Applied Aerodynamics Lab.
WIND TUNNEL INVESTIGATION OF A WING-PROPELLER MODEL PERFORMANCE DEGRADATION DUE TO DISTRIBUTED UPPER-SURFACE ROUGHNESS AND LEADING EDGE SHAPE MODIFICATION
R. H. WICKENS and V. D. NGUYEN *In* AGARD, Effects of Adverse Weather on Aerodynamics 19 p Dec. 1991
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A wind tunnel investigation has assessed the effects of distributed upper surface roughness, and leading edge ice formation on a powered wing propeller model. In the unpowered state, it was found that roughness reduces the lift slope, and maximum lift by 30 to 50 percent, depending upon particle size and Reynolds number. The leading edge region is especially sensitive to these disturbances, however, removal of the toughness over a small portion of the nose restored the wing to close to its original performance. The application of power to the wing, with an increase of slipstream dynamic pressure increases the lift slope and maximum lift; however, removal of the roughness over a small portion of the nose restored the wing to close to its original performance. The application of power to the wing, with an increase of slipstream dynamic pressure increases the lift slope and maximum lift; however, this benefit is lost if the wing is roughened. Subtraction of the propeller reactions indicated that the slipstream interaction accounted for half the lift increase, and also resulted in reduced drag for the clean surface. This drag reduction was removed when the wing was roughened, indicating that the degradation of wing performance due to roughening is relatively greater when a slipstream is presented, compared to the unpowered wing. Leading edge ice accretion causes similar large losses in lift and increases of form drag although a comparison of the two types of contamination showed that leading edge ice produces a smaller reduction of lift slope prior to flow separation. In both types of contamination, Reynolds number is important, and emphasizes the necessity of testing under near full-scale conditions. K.S.

N92-21691*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE ADVERSE AERODYNAMIC IMPACT OF VERY SMALL LEADING-EDGE ICE (ROUGHNESS) BUILDUPS ON WINGS AND TAILS
FRANK T. LYNCH, WALTER O. VALAREZO (Douglas Aircraft Co., Inc., Long Beach, CA.), and ROBERT J. MCGHEE *In* AGARD, Effects of Adverse Weather on Aerodynamics 8 p Dec. 1991
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Systematic experimental studies were performed to establish the aerodynamic impact of very small leading-edge simulated ice (roughness) formations on lifting surfaces. The geometries studied include single element configurations (airfoil and 3-D tail) as well as multi-element high-lift airfoil geometries. Emphasis in these studies was placed on obtaining results at high Reynolds numbers to insure the applicability of the findings to full-scale situations. It was found that the well-known Brumby correlation for the adverse lift impact of discrete roughness elements at the leading edge is not appropriate for cases representative of initial ice build up (i.e., distributed roughness). It was also found that allowing initial ice formations of a size required for removal by presently proposed deicing systems could lead to maximum lift losses of approximately 40 percent for single-element airfoils. Losses in angle-of-attack margin to stall are equally substantial - as high as 6 degrees. Percentage losses for multi-element airfoils are not as severe as for single-element configurations, but degradations of the angle-of-attack-to-stall margin are the same for both. K.S.

N92-21692# Fokker B.V., Schipol-Oost (Netherlands). Aerodynamics and Aeroelasticity Dept.
THE EFFECT OF HOAR-FROSTED WINGS ON THE FOKKER 50 TAKE-OFF CHARACTERISTICS
J. VANHENGST and J. N. BOER *In* AGARD, Effects of Adverse Weather an Aerodynamics 9 p Dec. 1991
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Reviewed here is how contamination resulting from ice, snow, or frost accumulated during ground icing degrades the Fokker 50 aircraft aerodynamics and leads to reduced flight safety during takeoff. From simulation tests it was concluded that wing contamination due to ground frost seriously deteriorates the aircraft behavior in takeoff, leading to reduced flight safety. A large increase in takeoff distance is experienced. No improvement was found from cleaning the wing leading edge only or by increasing rotation speed. The results clearly demonstrate the importance of Advisory Circular AC 20-117 emphasizing the 'clean aircraft concept' under adverse weather conditions before takeoff. Author

N92-21693# Dornier Luftfahrt G.m.b.H., Friedrichshafen (Germany, F.R.).
PREPARATION OF THE ICE CERTIFICATION OF THE DORNIER 328 REGIONAL AIRLINER BY NUMERICAL SIMULATION AND BY GROUND TEST
D. WELTE, W. WOHLRATH, R. SEUBERT, W. DIBARTOLOMEO, and R. D. TOOGOOD (Pratt and Whitney Aircraft of Canada Ltd., Longueuil, Quebec) *In* AGARD, Effects of Adverse Weather on Aerodynamics 14 p Dec. 1991
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The Dornier 328, a new regional airliner, is to be qualified to FAR25/JAR25 requirements for operation into known icing conditions. All lifting surfaces are pneumatically deiced. Impingement limits were determined using a validated computational fluid dynamic (CFD) code. Wind tunnel tests with a model of the whole aircraft and the isolated empennage equipped with artificial ice shapes showed a degradation of handling characteristics due to ice accretion. Extensive two and three dimensional CFD calculations evaluated ice accretion at the deflection elevator horn. Icing tunnel tests were performed with a model of the horizontal tail with icing similitude fulfilled. The Dornier Do328 powerplant air induction system has successfully completed a program of icing tests in support of aircraft certification for operation into known icing conditions. Potential flight icing conditions were extensively analyzed using a CFD potential flow code and 3-D particle tracking routine to identify critical flight icing conditions. The tunnel test program verified the analytically predicted critical ice accretion surfaces of the air induction system, the adequacy of the ice protection provisions and demonstrated compliance with the applicable (JAR25) regulatory material. Author

N92-21694*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SUMMARY OF NASA RESEARCH ON EFFECTS OF HEAVY RAIN ON AIRFOILS
DANA J. DUNHAM, R. EARL DUNHAM, JR., and GAUDY M. BEZOS *In* AGARD, Effects of Adverse Weather on Aerodynamics 14 p Dec. 1991
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Results from a broad NASA research program are presented. The intention of the program was to obtain fundamental aerodynamic information regarding the effect of heavy rain on airplane performance. The take-off and landing characteristics are of particular concern, and the aim of the program is to understand the physical phenomena associated with any aerodynamic performance penalty that may occur during a rain encounter. This overview includes results of recent attempts to measure high-intensity, short-duration rainfall, a discussion of some of the earlier analytical investigations of rain effects on airfoils, a review of some promising experimental methods for evaluating rain effects, and some important scaling considerations for extrapolating model data. D.R.D.

N92-21695# Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain). Experimental Aerodynamics Lab.
THE MEASUREMENT OF WATER FILM THICKNESS ON AIRFOILS IN HEAVY RAIN CONDITIONS USING CONDUCTANCE SENSORS
A. FEO, F. ROGLES, and M. URDIALES *In* AGARD, Effects of Adverse Weather on Aerodynamics 14 p Dec. 1991
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Calibration results of liquid film thickness using electric conductance sensors are presented. Two sensor types are analyzed. First, a double electrode sensor whose calibrations compensate liquid conductivity and secondly, a triple electrode sensor that, when properly calibrated, also compensates capacitive effects. For this second type, the electrolytic effects can also be corrected without excessive errors. Tests conducted on a large-scale airfoil under simulated heavy rain conditions, at NASA Langley Research Center are described, and the film thickness that develop, measured. Author

N92-21696# National Research Council of Canada, Ottawa (Ontario). Inst. for Aerospace Research.
EXPERIMENTAL INVESTIGATION OF HEAVY RAINFALL EFFECT ON A 2-D HIGH LIFT AIRFOIL
F. C. TANG *In* AGARD, Effects of Adverse Weather on Aerodynamics 10 p Dec. 1991
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The effects of simulated heavy rainfall on a 2D high lift airfoil were studied in a wind tunnel program. The experiment was carried out in the 2D test section of the 1.5 m x 1.5 m blowdown wind tunnel of the High Speed Aerodynamics Laboratory. The model used in the investigation was a modified NACA 65(sub 2)215 multi-element airfoil with a basic chord of 254 mm. The Mach number was fixed at M = 0.2, typical of the landing speed of transport type aircraft. The chord Reynolds number range was 1.7 to 8.8 x 10(exp 6). Measurements included lift, drag, and pitching moment of the airfoil obtained by side wall balances and the flow rate from a water spray manifold. The effects of the simulated rainfall to the airfoil performances are very significant. The loss in maximum lift coefficient ranged from 6 percent to a high of 16 percent. The drag levels at constant lift are up to 43 percent higher under wet conditions. A smaller performance degradation was noted when the model was stripped of the smooth epoxy paint with which it was originally finished. D.R.D.

N92-21697# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium). Aeronautics/Aerospace Dept.
AERODYNAMIC EFFECTS OF DE/ANTI-ICING FLUIDS AND DESCRIPTION OF A FACILITY AND TEST TECHNIQUE FOR THEIR ASSESSMENT
MARIO CARBONARO *In* AGARD, Effects of Adverse Weather on Aerodynamics 20 p Dec. 1991
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Research carried out at the von Karman Institute, from 1984 to the present, on the subject of flow-off of aircraft de-icing and anti-icing fluids is presented. Additionally, a test methodology for the acceptance of anti- and de-icing fluids is described. D.R.D.

N92-21698# Boeing Commercial Airplane Co., Seattle, WA. Aerodynamics Div.
WIND TUNNEL INVESTIGATION OF THE AERODYNAMIC EFFECTS OF AIRCRAFT GROUND DEICING/ANTI-ICING FLUIDS AND CRITERIA FOR AERODYNAMIC ACCEPTANCE
THOMAS A. ZIERTEN and EUGENE G. HILL *In* AGARD, Effects of Adverse Weather on Aerodynamics 8 p Dec. 1991
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A follow-on wind tunnel investigation of the aerodynamic effects of aircraft ground deicing/anti-icing fluids was performed to supplement earlier reported flight and wind tunnel tests and support the development of aerodynamic acceptance criteria for aircraft ground deicing/anti-icing fluids. The test was conducted at the NASA Lewis Research Center Icing Research Tunnel using both a 2D model and a 3D half model of the 737-200ADV airplane. The fluids that were tested included the following: three Type I Newtonian fluids, which use ethylene, diethylene, and propylene glycol as the freezing point depressant; four Type II non-Newtonian fluids, which are currently in production; eight developmental fluids; and a Mil Spec fluid to be used as a reference fluid in the aerodynamic acceptance test. The Type I and current Type II fluids were tested neat and diluted to determine basic aerodynamic effects. Dilution of the Type II fluids did not significantly alter the aerodynamic effects of the fluids. Diluting the Type I fluids did result in a significant reduction in the adverse aerodynamic effects of these fluids, especially at temperatures of -10 C and colder. Boundary layer displacement thickness, delta*, measurements made with the fluids on the 2D model show excellent correlation with lift loss due to the fluids at maximum lift and at operating angles of attack and with the boundary layer displacement thickness measured on a flat plate in the small von Karman Institute wind tunnel. This correlation validated the future use of flat plate boundary layer displacement thickness measurement as the criterion for the aerodynamic acceptability of a fluid. The limiting boundary layer displacement thickness, which identifies a fluid as being aerodynamically acceptable, is correlated with a loss in maximum lift that results in an allowed specific reduction in aerodynamic performance margins. D.R.D.

N92-21746 Civil Aviation Authority, London (England).
UK AIRMISSES INVOLVING COMMERCIAL AIR TRANSPORT: SEPTEMBER - DECEMBER 1990
Jul. 1991 44 p
(ISSN-0951-6301; ETN-92-91050) Copyright Avail: Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, England

United Kingdom (UK) airmisses are reported. The origin of an airmiss, the purpose and investigation of airmiss reports, the categories of airmisses, the involvement of commercial air transport traffic, and airmisses related to flying hours are discussed. Airmiss reports for Sep. to Dec. 1990 are given. Statistics in commercial transport airmisses are presented. ESA

N92-21833# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT U.S. CIVIL AND FOREIGN AVIATION ISSUE NUMBER 5 OF 1989 ACCIDENTS

18 Dec. 1990 407 p
(PB90-916905; NTSB/AAB-90/05) Avail: NTIS HC/MF A18; paper copy available on Standing Order, deposit account required (minimum deposit $100 U.S., Canada, and Mexico; all others $200) CSCL 01/3

Given here are selected aircraft reports in brief format for U.S. civil and foreign aviation operations in Calendar Year 1989. The approximately 200 general aviation and air carrier accidents included here represent a random selection. The facts, conditions, circumstances, and probable causes for each accident are given. Author

N92-21873# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: UNSTABILIZED APPROACH AND LOSS OF CONTROL NPA, INC. DBA UNITED EXPRESS FLIGHT 2415, BRITISH AEROSPACE BA-3101, N41OUE, TRI-CITIES AIRPORT, PASCO, WASHINGTON, DECEMBER 26, 1989
4 Nov. 1991 68 p
(PB91-910406; NTSB/AAR-91/06) Avail: NTIS HC/MF A04; paper copy available on Standing Order, deposit account required (minimum deposit $100 U.S., Canada, and Mexico; all others $200) CSCL 01/3

On December 26, 1989, United Express, Flight 2415 (Sundance 415), a British Aerospace BA-3101 Jetstream, N41OUE, crashed approximately 400 feet short of runway 21R at Tri-Cities Airport, Pasco, Washington. The airplane crashed while executing an instrument landing approach to the runway. The airplane was destroyed and the two pilots and all four passengers received fatal injuries. Author

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A92-29360
LOS RATE ESTIMATION IN INERTIAL NAVIGATION USING LANDMARKS
YAAKOV BAR-SHALOM (Connecticut, University, Storrs) and CHUN YANG (American GNC Corp., Chatsworth, CA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2981-2985. refs
(Contract N00014-87-K-0057)
Copyright

The problem of estimating the LOS (line of sight) rate of the aimpoint of a guided vehicle from certain angle-only measurements is considered. The onboard IMU (inertial measuring unit) provides primary estimates of the vehicle's absolute position and velocity. However, the IMU-based estimates are not sufficient to guarantee the desired guidance accuracy. A problem is considered in which there are a small number of discrete measurements of the aimpoint LOS angle, and continuous measurements of the LOS angle of some nearby landmarks (track points) are available according to a certain schedule along the trajectory. An algorithm that uses these angle measurements to improve the aimpoint LOS rate estimate is developed. The estimation error of the proposed method is evaluated and illustrated via numerical examples. I.E.

A92-29506
ADVANCED ASDE PROVIDES NEW EYES AND EARS FOR CONTROLLERS
DAVID M. NUSSBAUM (Norden Systems, Inc., Norwalk, CT) ICAO Journal (ISSN 0018-8778), vol. 47, Feb. 1992, p. 11, 12.
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The Advanced Airport Surface Detection Equipment (ASDE) radar system that is to be installed in 29 U.S. airports in the spring of 1992 encompasses the ASDE-3 high-resolution ground-mapping radar for expediting the flow of taxiway and runway traffic. The ASDE-3 radar's capability for tailoring of each ATC display will assist in the avoidance of ground incidents and accidents under adverse conditions; full reliance on the ATC controller for maintaining of the required minimum separation between aircraft will be maintained. A 'windowing' feature of the screen display will allow controllers to view a closeup of an area of special interest. O.C.

A92-29760#
AUTOMATIC DEPENDENT SURVEILLANCE (ADS) PACIFIC ENGINEERING TRIALS (PET)
PETER MASSOGLIA and ROBERT TILL (FAA, Washington, DC) IN: AIAA International Communication Satellite Systems Conference and Exhibit, 14th, Washington, DC, Mar. 22-26, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 73-77. refs
(AIAA PAPER 92-1812)

The paper discusses the ADS engineering trials conducted by the Federal Aviation Administration over the Pacific region in cooperation with the governments of Japan and Australia and participating airlines with the aim of gaining early experience with ADS and satellite data links. The avionics used in the initial testing are designed to a subset of international standards and are expected to evolve as the program matures. One phase of the program is to demonstrate whether satellite position reports can replace oceanic HF radio voice progress reports. The data link experience gained with controllers is to be used for implementation and future enhancements to the Oceanic Program. Data collected during these tests are to be used to certify the satellite link for transmission of Aeronautical Mobile Satellite Safety Services. P.D.

A92-29856#
LOW EARTH ORBIT SATELLITE CONCEPTS FOR AIR TRAFFIC CONTROL APPLICATIONS
B. E. WHITE, R. G. BLAND, C.-H. CHEN, and R. A. POMPONI (Mitre Corp., Bedford, MA) IN: AIAA International Communication Satellite Systems Conference and Exhibit, 14th, Washington, DC, Mar. 22-26, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 885-895. Research supported by Mitre Corp. refs
(AIAA PAPER 92-1927) Copyright

A low earth orbit (LEO) satellite constellation was examined for possible air traffic control communications applications, particularly, automatic dependent surveillance. After performing various system tradeoffs, a satellite system design was selected and system performance was assessed. Each satellite can handle thousands of aircraft; a per satellite frequency reuse factor of 7/4 is possible. The system is satellite power limited due to current technology limitations; however, at most, a few MHz of L-band spectrum is required. Author

A92-29889*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CHARACTERISTICS OF A FUTURE AERONAUTICAL SATELLITE COMMUNICATIONS SYSTEM
PHILIP Y. SOHN (NASA, Lewis Research Center, Cleveland, OH), ALAN STERN (General Electric Co., Princeton, NJ), and FRED SCHMIDT (Ball Corp., Bloomfield, CO) IN: AIAA International Communication Satellite Systems Conference and Exhibit, 14th, Washington, DC, Mar. 22-26, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1183-1199. Previously announced in STAR as N91-23102. refs
(AIAA PAPER 92-2058) Copyright

A possible operational system scenario for providing satellite communications services to the future aviation community was analyzed. The system concept relies on a Ka-band (20/30 GHz) satellite that utilizes multibeam antenna (MBA) technology. The aircraft terminal uses an extremely small aperture antenna as a

result of using this higher spectrum at Ka-band. The satellite functions as a relay between the aircraft and the ground stations. The ground stations function as interfaces to the existing terrestrial networks such as the Public Service Telephone Network (PSTN). Various system tradeoffs are first examined to ensure optimized system parameters. High level performance specifications and design approaches are generated for the space, ground, and aeronautical elements in the system. Both technical and economical issues affecting the feasibility of the studied concept are addressed with the 1995 timeframe in mind. Author

A92-30023* National Aeronautics and Space Administration, Washington, DC.
GPS INTERFEROMETRIC ATTITUDE AND HEADING DETERMINATION - INITIAL FLIGHT TEST RESULTS
FRANK VAN GRAAS and MICHAEL BRAASCH (Ohio University, Athens) Navigation (ISSN 0028-1522), vol. 38, Winter 1991-1992, p. 297-316. Research supported by FAA. refs
(Contract NGR-36-009-017)
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Attitude and heading determination using GPS interferometry is a well-understood concept. However, efforts have been concentrated mainly in the development of robust algorithms and applications for low-dynamic, rigid platforms (e.g., shipboard). This paper presents results of what is believed to be the first real-time flight test of a GPS attitude and heading determination system. Signals from four antennas are processed by a 24-channel GPS receiver. Data from the receiver are sent to a microcomputer for storage and further computations. Attitude and heading data are sent to a second computer for display on a software-generated artificial horizon. Demonstration of this technique proves its candidacy for augmentation of aircraft state estimation for flight control and navigation, as well as for numerous other applications. Author

A92-30651
A CONSISTENCY TEST OF AIRBORNE GPS USING MULTIPLE MONITOR STATIONS
M. E. CANNON, K. P. SCHWARZ, M. WEI (Calgary, University, Canada), and D. DELIKARAOGLOU (Canada Centre for Surveying, Ottawa) Bulletin Geodesique (ISSN 0007-4632), vol. 66, no. 1, March 1992, p. 2-11. Research supported by Canada Centre for Remote Sensing and Canada Centre for Surveying. refs
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In October 1990, several airborne GPS tests were conducted in the Ottawa region by the Canada Centre for Surveying (CCS) and the Canada Centre for Remote Sensing (CCRS). Ashtech XII receivers were located at up to three monitor stations with baseline lengths to the aircraft ranging from 1-200 km. Comparisons were made between the aircraft position and velocity determined from each of the monitor stations to assess the consistency of differential GPS when different reference stations are used. Results show that the degree of consistency is dependent upon the distance to the monitor stations. Author

A92-31063
MULTISENSOR DATA FUSION AND DECISION SUPPORT FOR AIRBORNE TARGET IDENTIFICATION
V. V. S. SARMA (Indian Institute of Science, Bangalore, India) and SAVITHRI RAJU (Electronics and Radar Development Establishment, Bangalore, India) IEEE Transactions on Systems, Man, and Cybernetics (ISSN 0018-9472), vol. 21, Sept.-Oct. 1991, p. 1224-1230. refs
Copyright

A knowledge-based approach and a reasoning system for multisensor data fusion is presented. The scenario taken for the example is an air-land battlefield situation. A data fusion system obtains data from a variety of sensors. A Dempster-Shafer approach to representing and combining data is found appropriate for combining uncertain information from these disparate sensor sources at different levels of abstraction. Evidential reasoning allows confidences to be assigned to sets of propositions rather than to just N mutually exclusive propositions. The software is developed in the Lisp language and tested. The results illustrate the advantages of using multiple sensors in terms of increase in detection probability, increased spatial and temporal coverage, and increased reliability. I.E.

A92-31951
SELECTION OF THE TIME PARAMETERS OF THE PROBING PULSE DURING THE NONSTATIONARY IRRADIATION OF FLIGHT VEHICLES [VYBOR VREMENNYKH PARAMETROV ZONDIRUIUSHCHEGO IMPUL'SA PRI NESTATSIONARNOM OBLUCHENII LETATEL'NYKH APPARATOV]
E. G. LEBED'KO and A. K. SARKISIAN (Leningradskii Institut Tochnoi Mekhaniki i Optiki, Leningrad, Russia) Priborostroenie (ISSN 0021-3454), vol. 34, no. 6, 1991, p. 73-78. In Russian. refs
Copyright

The effect of changes in the time parameters of the probing pulse on the detection capacity of a lidar under conditions of nonstationary illumination of the observed objects is examined. With the irradiation of flight vehicles used as an example, recommendations are given concerning the efficient selection of the time parameters of the probing pulse. V.L.

A92-31955
CHARACTERISTICS OF THE ENERGY ANALYSIS OF OPTICAL RADAR IN THE CASE OF NONSTATIONARY IRRADIATION OF FLYING OBJECTS [OSOBENNOSTI ENERGETICHESKOGO RASCHETA OPTICHESKIKH LOKATOROV PRI NESTATSIONARNOM OBLUCHENII VOZDUSHNYKH OB'EKTOV]
E. G. LEBED'KO and A. K. SARKISIAN (Sankt-Peterburskii Institut Tochnoi Mekhaniki i Optiki, St.Petersburg, Russia) Priborostroenie (ISSN 0021-3454), vol. 34, no. 7, 1991, p. 73-76. In Russian. refs
Copyright

The energy characteristics of optical radar are analyzed in the case of nonstationary irradiation of aircraft, and the need for introducing corrections into the existing computational formulas is demonstrated. A table of values of a coefficient for determining the required power of the probing pulse with allowance for irradiation nonstationarity is presented. V.L.

N92-20356 Rice Univ., Houston, TX.
A CONNECTIONIST APPROACH TO AUTONOMOUS ROBOTIC NAVIGATION Ph.D. Thesis
PETER LAWRENCE WEILAND 1991 278 p
Avail: Univ. Microfilms Order No. DA9136080

Robotic navigation for mobile robot development was examined. A navigation system is presented which is based on biological and behavioral principles which functions in a stimulus-response manner. Using connectionist architectures, a relationship between stimulus and response is required through the learning of conceptual information pertaining to navigation. In this research, the mammalian visual system provides a guide for the processing of environmental stimulus. Simulated laser range data are processed in retinal patch size elements by a cellular neural network. This network is designed to detect obstacle existence for each patch segment based on an invariant feature of range discontinuity. Obstacle information is then mapped in binary format, indicating the traversable state of the patch, to the system's visual cortex. Response to this mapping is derived from a hierarchical structure of back error propagation neural networks in which each network has learned a particular navigational behavior - obstacle avoidance, wander, and goal seeking. Output from these networks indicate an appropriate motor response for the environmental stimulus. A simulation was developed to evaluate the performance of this system by having a robot traverse an environment. The connectionist approach was verified through system display of human-like navigational behavior for the simulation's environment. Advantages of the neural network approach were also demonstrated by its processing speed and adaptability. Procedures are discussed for actual system

implementation in which cycle times of under one second are completely feasible. Dissert. Abstr.

N92-20818# Gesellschaft fuer Mathematik und Datenverarbeitung, Saint Augustin (Germany, F.R.).
TOWARDS COHERENT HYPERMEDIA NAVIGATION BY PRAGMATIC DIALOGUE MODELING
A. STEIN, U. THIEL, and A. TISSEN 1991 21 p
(PB92-114735; GMD-580) Copyright Avail: NTIS HC/MF A03 CSCL 17/7

The successful use of hypermedia systems is often impeded by user disorientation or cognitive overhead caused by the non-linear arrangement of hypertext nodes. Addressed here is the related problem of how a user can be supported in his construction of coherence during the navigation through a hyperdocument. Instead of leaving this task to the hypertext author or designer alone, it proposes to share the responsibility among author, user, and system. As a consequence, it claims that hypermedia systems should apply a progmatic model of navigation to achieve intelligent dialog control. It chooses a case-based architecture. The case-based dialog manager (CADI) disposes of several dialogue plans and can adapt the current plan to the dialogue situation. The user determines the concrete navigation course by selecting a thematical perspective. A prototype (accessing a conference information base) shows the feasibility of assembling the contents of nodes with respect to a user perspective. The nodes are automatically filled with information from the underlying knowledge base. Author

N92-20834# Department of the Navy, Washington, DC.
A METHOD OF PASSIVE RANGE DETERMINATION USING ONLY TWO BEARING MEASUREMENTS Patent Application
ANTHONY F. BESSACINI, inventor (to Navy) 2 Oct. 1991 12 p
(AD-D015182; US-PATENT-APPL-SN-769685) Avail: NTIS HC/MF A03 CSCL 17/7

A method of determining range from a moving vessel to an approaching object using only two bearing measurements is provided. At a first point in time, a first bearing measurement to the approaching object is obtained using the vessel's conventional bearing sensor. The vessel and approaching object are then postulated to be on an intercept course based on the vessel's first velocity vector and first bearing measurement. At a second point in time, the vessel commences a maneuver to a known second velocity vector different from the first velocity vector. Then, at a third point in time, a second bearing measurement to the approaching object is obtained using the vessel's bearing sensor. At the same third point in time, a virtual bearing to the approaching object is provided as if the vessel and the approaching object were on the postulated intercept course. A time difference is computed between the second and third points in time and standard trigonometric methods are applied to determine the range to the approaching object. The determined range is accurate when the approaching object is on an actual intercept course.
Author (GRA)

N92-20902# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Hamburg (Germany, F.R.). Abt. Luft- und Raumfahrtpsychologie.
FLYING AN AIRCRAFT AS A PROBLEM-SOLVING PROCESS: ABOUT THE INSTRUMENT-FAILURE-SIMULATOR (IFS) AS A TEST FOR PILOT-CANDIDATES Ph.D. Thesis - Hamburg Univ.
GERHARD FAHNENBRUCK Jun. 1991 117 p In GERMAN; ENGLISH summary
(DLR-FB-91-23; ISSN-0939-2963; ETN-92-90738) Avail: NTIS HC/MF A06; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 38.50 DM

The IFS was developed on the basis of a theoretical model, showing how pilots fly. The simulator was equipped with instruments which systemically break down. The subjects had to fly and follow a relatively simple track several times, while scanning the instruments for failure. The performance was rated on the basis of the distance between the actual flight path and the given track, and on the ability to detect instrument failures. The results show that the IFS and the model can be used to predict professional success. The model can be used successfully to develop a test for airlines simulators. ESA

N92-21201# Oak Ridge National Lab., TN.
TERRAIN FOLLOWING OF ARBITRARY SURFACES USING A HIGH INTENSITY LED PROXIMITY SENSOR
J. E. BAKER Jan. 1992 26 p
(Contract DE-AC05-84OR-21400)
(DE92-007161; ORNL/TM-11991; CESAR-92/01) Avail: NTIS HC/MF A03

Many robotic operations, e.g., mapping, scanning, feature following, etc., require accurate surface following of arbitrary targets. This paper presents a versatile surface following and mapping system designed to promote hardware, software and application independence, modular development, and upward expandability. These goals are met by a full, a priori specification of the hardware and software interfaces; a modular system architecture; and a hierarchical surface-data analysis method, permitting application specific tuning at each conceptual level of topological abstraction. This surface following system was fully designed independently of any specific robotic host, then successfully integrated with and demonstrated on a completely a priori unknown, real-time robotic system. DOE

N92-21263# Coast Guard Academy, New London, CT. Center for Advanced Studies.
MEASUREMENT OF LORAN-C ENVELOPE TO CYCLE DIFFERENCE IN THE FAR FIELD Final Report
B. B. PETERSON, T. N. THOMSON, and J. RIFFE Sep. 1991 13 p
(PB92-128909; USCGA-TR-2-91) Avail: NTIS HC/MF A03 CSCL 17/7

With continent expansion and increased use of LORAN over extensive land paths by both aviation and terrestrial users, there has been renewed interest in the prediction and measurement of Envelope to Cycle Difference (ECD) in the far field. A number of relevant issues in the measurement of ECD are discussed. These include modelling of the far field pulse, analysis and calibration of the receiver front end, the algorithm used for calculation of ECD and the statistics of the measurements as a function of the signal to noise ratio and the noise model. Via network analysis, the magnitude and the phase of the frequency response of the receiver is measured and used to create a computer model of the front end. Calibration of the front end is accomplished by supplying an ideal LORAN pulse of varying ECD as the input of the model, measuring the output, and applying a conversion curve in the algorithm. Issues such as receiver bandwidth, order, and the waveform samples used for ECD calculation are discussed. The statistics of the measurement process are examined in detail. Examples of bias due to cross rate interference and procedures for calculating the bias are presented. Author

N92-21279# Coast Guard Academy, New London, CT. Center for Advanced Studies.
PROBABILITY OF CYCLE JUMPS IN OMEGA RECEIVERS AND OTHER PHASE LOCKED LOOP APPLICATIONS
B. B. PETERSON and W. H. JONES Nov. 1991 15 p
(PB92-128891; USCGA-TR-6-91) Avail: NTIS HC/MF A03 CSCL 17/7

A study of cycle jumps in phase locked loops with a particular emphasis on Omega receivers is presented. Theoretical predictions using numerical integration of the probability density functions of the phase estimates for both Gaussian and more accurate noise models are presented. These theoretical results are validated through computer and hardware simulations using both Gaussian and atmospheric noise. Hard limited and linear receivers are considered along with various methods of phase estimate averaging. In addition, the combined effect of noise and errors in the velocity or phase estimates are presented. The results relating the probability of cycle jumps to signal to noise ratio (SNR) show

very pronounced thresholding in Gaussian Noise, i.e., very small changes in the SNR can mean the difference between acceptable and unacceptable probability of cycle jumps. This was found not to be true for atmospheric noise due to the significant number of outliers even for large SNR's. The data supports a conclusion that the lower limit on acceptable SNR for receiver operation is due to the probability of receiver cycle errors and not merely fix in accuracy due to noise in lines of position. Author

N92-21404# Computer Technology Associates, Inc., McKee City, NJ.
EVALUATION OF TRIPLE SIMULTANEOUS PARALLEL ILS APPROACHES SPACED 5000 FEET APART, PHASE 4.B Test Report, Sep. 1990 - Nov. 1991
L. HITCHCOCK, T. FISCHER, L. W. BENSEL, G. YASTROP, R. JONES, R. LUONGO, K. REARDON, and B. STARTZEL-DEHEL Jan. 1992 77 p
(Contract DTFA03-89-C-00023)
(DOT/FAA/CT-91/31) Avail: NTIS HC/MF A05

Plans for increasing air traffic capacity and the feasibility are evaluated of using multiple simultaneous, parallel, Instrument Landing System (ILS) approaches. The objective was to evaluate the ability of experienced controllers to handle approach traffic during Instrument Meteorological Conditions (IMC) to a proposed parallel runway airport configuration, using a real time, interactive, air traffic control (ATC) simulation. This simulation used a current radar system, Airport Surveillance Radar (ASR-9), and a current display system, Automated Radar Terminal System (ARTS) IIIA. Triple simultaneous parallel ILS approaches were simulated with controllers monitoring traffic on the approach localizers. To challenge the system, blunders were introduced, according to predetermined scenarios, by having some of the simulated aircraft deviate from the localizer by either 10, 20, or 30 degs. The results indicated that controllers were able to resolve 99 pct. of the blunders initiated in the simulation. It was determined that triple simultaneous parallel ILS approach operations spaced at 5000 ft are acceptable using the ASR-9 radar and the ARTS IIIA displays. Author

N92-21459*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLIGHT DECK BENEFITS OF INTEGRATED DATA LINK COMMUNICATION
MARVIN C. WALLER Washington NASA. Langley Research Center Apr. 1992 49 p
(NASA-TP-3219; L-16845; NAS 1.60:3219) Avail: NTIS HC/MF A03 CSCL 17/7

A fixed-base, piloted simulation study was conducted to determine the operational benefits that result when air traffic control (ATC) instructions are transmitted to the deck of a transport aircraft over a digital data link. The ATC instructions include altitude, airspeed, heading, radio frequency, and route assignment data. The interface between the flight deck and the data link was integrated with other subsystems of the airplane to facilitate data management. Data from the ATC instructions were distributed to the flight guidance and control system, the navigation system, and an automatically tuned communication radio. The co-pilot initiated the automation-assisted data distribution process. Digital communications and automated data distribution were compared with conventional voice radio communication and manual input of data into other subsystems of the simulated aircraft. Less time was required in the combined communication and data management process when data link ATC communication was integrated with the other subsystems. The test subjects, commercial airline pilots, provided favorable evaluations of both the digital communication and data management processes. Author

N92-21509# Nebraska Univ., Omaha. Inst. of Aviation.
COOPERATIVE PLANNING IN AVIATION CONTEXTS Abstract Only
C. ELAINE MCCOY *In* Wichita State Univ., Techfest 18 Proceedings 1 p Jan. 1992
Avail: NTIS HC/MF A03 CSCL 01/2

Design concepts and principles are developed and evaluated to guide in the building of cooperative problem solving systems, particularly the design of cooperative systems for enroute flight planning. A three stage process was studied of modeling human performance in existing environments, building cognitive artifacts, and studying the performance of people working in collaboration with these artifacts. The most significant design concepts and principles identified thus far are summarized. The first stage of research involves the use of a part task simulation. Those concepts that prove most promising based on this initial evaluation will then be used in a second stage in the NASA Ames Advanced Concepts Simulator. In order to run experiments using a part task simulation, the researchers have designed an environment that can support the development and testing of a variety of design concepts. This prototyping shell, designed to run on a Mac IIfx, provides a general environment for developing application software, but does not prohibit programmers from modifying the environment if necessary. Written in Lightspeed C, the system can control displays on up to four color monitors. Author

N92-21839 Rensselaer Polytechnic Inst., Troy, NY.
AN INVESTIGATION OF THE ENERGY LOSS AND NEAR WAKE FLOW FIELD OF TRAILING EDGE INJECTION Ph.D. Thesis
FEDERICO D. LIBERATORE 1991 189 p
Univ. Microfilms Order No. DA9202191

An investigation was conducted on the energy losses caused by three different gas turbine blade trailing edge geometries which featured forced injection cooling. The wake was three dimensional behind two models (patterned after industrial designs) and two dimensional behind the third trailing edge. Energy losses of the test body were subdivided into losses on the portion of the trailing edge and losses on the trailing edge. The losses at the trailing edges of all three models were found to be typically an order of magnitude greater than the losses on the portion forward of the trailing edge. Significant variation in the performance of the three geometries with changes in secondary stream blowing was found. Dissert. Abstr.

N92-21957# Naval Air Test Center, Patuxent River, MD.
ENHANCED DISPLAYS, FLIGHT CONTROLS, AND GUIDANCE SYSTEMS FOR APPROACH AND LANDING
R. W. HUFF and G. K. KESSLER *In* AGARD, Aircraft Ship Operations 22 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The Navy has had an ongoing objective to provide a safe and reliable approach and landing capability with minimum interference from severe weather and sea state, and no limitation due to low ceiling and visibility. An overview is presented of the present and future Navy displays, flight controls, and guidance systems for approach and landing. The results of simulation studies and flight tests concerning enhancement to aircraft displays and flight controls are discussed. The various tradeoffs and issues that must be considered are also discussed. Tradeoffs in landing system accuracy requirements versus integration of aircraft and shipboard data are explored. Author

N92-21958# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
INTEGRATION OF FLIGHT AND CARRIER LANDING AID SYSTEMS FOR SHIPBOARD OPERATIONS
B. DANG VU, T. LEMOING, and P. COSTES *In* AGARD, Aircraft Ship Operations 15 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The operational availability of a carrier depends to a large extent on the capacity of its equipment and its aviation to operate in a wide domain of meteorological conditions and sea states. Some equipments are under development for the future French nuclear carrier in order to extend its operational limits for aircraft launch and recovery: a deck motion tranquillization system, a deck motion prediction system, and an all-weather aircraft localization

system. The impact on deck landing procedures for future carrier-based fighter aircraft is presented. An improved terminal guidance landing strategy making use of the prediction of the carrier motion is proposed. The actual glide path with fixed slope is replaced by a flight path along which the aircraft airspeed and flight path angle are updated in accordance with the predicted deck motion at touchdown, such that all the landing constraints are respected: minimum hook-to-ramp clearance, maximum touchdown sink rate.... The integration of the landing aid systems with the aircraft flight control system will allow the implementation of an automatic landing mode or advanced manual task-tailored control modes. Preliminary simulation results give a general idea on the improvement of deck landing performances with respect to the accuracy of the prediction of the carrier motion. Author

N92-21959# Societe d'Applications Generales d'Electricite et de Mecanique, Paris (France).
APPROACH AND LANDING ASSISTED BY ONBOARD IMAGE PROCESSING [APPROCHE ET APPONTAGE ASSISTES PAR TRAITEMENT D'IMAGE EMBARQUE SUR AERONEF]
Y. LEGUILLOUX *In* AGARD, Aircraft Ship Operations 10 p Nov. 1991 In FRENCH
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A study is made of automation of visual control by an aircraft pilot during landing. The system that is envisaged, comprising one camera (infrared) and the associated electronics for real time image processing, will provide continuous 3-D representation of the aircraft's position in relation to the ship. To do this, the principal characteristics of the aircraft carrier are first localized in the image, then paired with their equivalents in the 3-D model of an a priori known aircraft carrier. By inverse perspective transformation, the pilot is able to determine the position of the ship relative to the aircraft, and from this information he can derive the position and movement of the aircraft relative to the ship. Thus, the system is able to measure the distance from an ideal landing scenario and from there the appropriate compensating actions can be determined. Furthermore, the absolute movement of the aircraft, given by the inertial system, may be combined with the relative movement to give the absolute movement of the ship. Author

N92-21960# Royal Aerospace Establishment, Bedford (England).
APPROACH AND LANDING GUIDANCE
A. J. SMITH and E. J. GUIVER *In* AGARD, Aircraft Ship Operations 15 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The final approach and landing of any aircraft operating from a ship is always a difficult task, even in benign conditions. Ship motion, adverse winds, and atmospheric attenuation compound the problems. High levels of integrity and reliability are an essential feature of any guidance aid in the ship environment since diversion facilities are often not available. Issues related to cost, maintainability, levels of training, and covertness further constrain the choice of guidance aid. The handling characteristics of the user aircraft and operational procedures also influence the choice of aid. To achieve the objective of regular and safe operations in all weather conditions, some form of guidance must be provided. The options range from painted markings and lighting systems that are used by the pilot to augment naturally occurring visual cues to precision radio or radar systems that are integrated into cockpit displays and flight control systems. In military operations there is a perceived need for passive or covert forms of guidance. The development of electro-optical sensors in recent years has increased the number of options and the availability of the Global Positioning System (GPS) will provide even more potential solutions to the design problems of providing precision guidance. The topics of approach and landing guidance has encouraged a large amount of research and development over the years, with many special-to-type solutions being devised. Except for the helicopter landing case, where relatively little research and development effort has been expended, the system designer is confronted with a large number of potential solutions. The above topics are addressed and conclusions are presented. Author

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A92-28875
COMPUTATIONAL FLUID DYNAMICS AND AIRCRAFT DESIGN
Aerospace Engineering (ISSN 0736-2536), vol. 12, March 1992, p. 24-29.
Copyright

An evaluation is made of the potential contributions of CFD tools to concurrent engineering design efforts associated with civil subsonic (and prospective supersonic) airliners. Attention is presently given to the use of Navier-Stokes codes handling up to 1 million grid points in 2-3 hrs of computation time in airfoil/wing-design applications; in selected areas of a given wing, it is possible to use high-resolution grids to resolve the finest details of flow. To date, turbulence modeling remains a major obstacle to the accomplishment of greater CFD accuracy. Attention is given to the aerodynamic performance of a high-lift flap system on landings and takeoffs. O.C.

A92-29418
DORNIER 328 NOW IN FLIGHT TESTING [DORNIER 328 JETZT IN FLUGERPROBUNG]
Luft- und Raumfahrt (ISSN 0173-6264), vol. 13, Jan.-Feb. 1992, p. 9-11. In German.
Copyright

The present status of the Dornier 328 passenger aircraft is discussed. The results of the first flight test of the aircraft are reviewed. The design of the aircraft and the materials of which its various parts are made are shown. C.D.

A92-29518
A NOTE ON THRUST CONTROL FOR JETLINER DURING APPROACH
TSUNEHARU UEMURA and KANICHIRO KATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 457, 1992, p. 92-102. In Japanese.

A method of thrust control is shown for jetliner during approach. With this method, the pilot can reduce airspeed deviation even or less compared with the operation under auto throttle system. In this way, airspeed can be controlled with adequate thrust change, without extra acceleration or deceleration. The flight record is shown to substantiate this. Author

A92-29557
SIKORSKY S-92 - BOLD BID FOR FUTURE
STANLEY W. KANDEBO Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, March 23, 1992, p. 38, 39, 43, 45, 47.
Copyright

An overview is presented of the S-92 family of helicopters now in preliminary design, an extension of the Black Hawk product line, planned in military and commercial versions that would use many of the same components and systems developed for H-60 series. Consideration is given to overall dimensions, the main and tail rotor systems, powerplant specifications, avionics, and design and performance baseline criteria. Attention is given to commercial and military considerations compared to other rotorcraft including the V-22. R.E.P.

A92-29669
COMPOSITES USAGE ON THE RAH-66 COMANCHE

SAMUEL P. GARBO and KENNETH M. ROSEN (Sikorsky Aircraft, Stratford, CT) Vertiflite (ISSN 0042-4455), vol. 38, Mar.-Apr. 1992, p. 8-13.
Copyright

The state-of-the-art Comanche armed reconnaissance/light attack helicopter could not have met its range, payload, and performance requirements apart from intensive use of advanced composite materials. Composite components encompass the structures of aerodynamic surfaces, doors, airframe stringers, bulkheads, the internal center keelbeam, the main rotor pylon fairing, the 'Fantail' shroud, vertical pylon, and horizontal stabilizer. Additional composite components make up the rotor and drive subsystems. The composite types employed are graphite/epoxy laminates and sandwich panels, kevlar/epoxy sandwich panels, and kevlar-graphite hybrid-reinforced/epoxy sandwich panels. Attention is given to the mixture of composite and metallic components in the Comanche rotor system. O.C.

A92-29670
BELL'S OH-58D PROVES ITS RELIABILITY
JOHN E. GALLAGHER, JR. (Bell Helicopter Textron, Inc., Fort Worth, TX) Vertiflite (ISSN 0042-4455), vol. 38, Mar.-Apr. 1992, p. 15-21.
Copyright

Design features and operational capabilities of the OH-58D 'Kiowa Warrior' scout helicopter/gunship which were instrumental in its successful discharge of responsibilities during Desert Shield/Desert Storm are presently discussed. The most important of these were the folded main rotor blade-predicated air transportability of the Kiowa aboard C-130 cargo aircraft, as well as the incorporation of a mast-mounted sight targeting system for laser-designation of targets being addressed by Marine Corps Cobra and Army Apache helicopter-fired Hellfire missiles. Mission reliability rates for the Kiowa during these operations were in excess of 90 percent. O.C.

A92-29671
THE V-22 OSPREY - PREPARING FOR FLEET OPERATIONS
ALAN W. MOFFATT (Bell Helicopter Textron, Inc., Fort Worth, TX) Vertiflite (ISSN 0042-4455), vol. 38, Mar.-Apr. 1992, p. 26-33.
Copyright

The V-22 development and flight test programs have not only validated the reliability of many components, but also identified those whose reliability needed to be improved. In addition, many components have undergone reliability development growth testing as part of the current Full Scale Development effort; it has been established that a comparative handful of components were major contributors to the failures being experienced. Shipboard evaluations are being conducted aboard the USS Wasp, which belongs to the USN's newest amphibious assault ship class. The V-22 is compatible with a wide range of common support equipment normally encountered in airlift and sealift operations. Accessibility throughout the aircraft via over 150 access panels has been the subject of daily evaluation during flight trials, together with the Failure Reporting, Analysis, and Corrective Action system that is integral to the V-22. O.C.

A92-29672
TIGER DEVELOPMENT STATUS
KLAUS SCHYMANIETZ (Eurocopter Deutschland GmbH, Ottobrunn, Federal Republic of Germany) Vertiflite (ISSN 0042-4455), vol. 38, Mar.-Apr. 1992, p. 37-44.
Copyright

The Tiger combat helicopter development program encompasses an antitank version of the aircraft for both French and German forces and an air-to-air engagement-capable ground-support French version. An evaluation is presently made of the extent to which design performance levels have been achieved. Attention is given to experience to date with the first prototype, the status of the Tiger avionics system simulator-laboratory development effort, and the character of the systematic integration of the complete avionics package. O.C.

A92-29675
COLD-CYCLE PRESSURE-JET HELICOPTERS: VENTURES, DESIGNS, AND DEVELOPMENTS. III - COSTS AND DEVELOPMENTS
E. K. LIBERATORE Vertiflite (ISSN 0042-4455), vol. 38, Mar.-Apr. 1992, p. 60-63. refs
Copyright

An historical and current-capabilities evaluation of cold-cycle pressure jet helicopter main rotor drive systems is presently concluded with attention to implementation costs and the character of prospective developments that may facilitate such implementation. It is projected that the optimum pressure-jet drive design will incorporate a free-piston engine, rotor-driven yaw control, and an integrated propulsion-control system. Such an optimal system is of direct consequence for the long-desired 'personal helicopter'. O.C.

A92-30091
DORNIER 328 - A DAIMLER FOR COMMUTERS
GORDON SWANBOROUGH Air International (ISSN 0306-5634), vol. 42, March 1992, p. 123-128.
Copyright

A review is presented of the commercial requirements and engineering development planning leading to the final configuration of the Dornier 328 commuter aircraft. Attention is given to the basic specifications including the two turboprops of 2,300 shp each, six-bladed propellers, 345 kts max cruise speed, 700 nm range with 30 passengers and flight crew of two, max payload of 7,600 lb, and all dimensions listed and illustrated in a full cutaway drawing. Consideration is given to the cockpit layout, the advanced avionics incorporated and the aluminum alloys, carbon-fiber reinforced plastics, Kevlar, glass-fiber-reinforced plastic, and titanium airframe sections utilized. R.E.P.

A92-30134
AERODYNAMIC WING-NACELLE INTEGRATION [OB AERODINAMICHESKOM SOGLASOVANII KRYLA I MOTOGONDOLY]
S. I. SKOMOROKHOV and L. L. TEPERIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 82-88. In Russian. refs
Copyright

The paper discusses the problem of aerodynamic integration of the wing and the nacelle of a subsonic passenger aircraft. The characteristics of the flow past the wing-pylon-nacelle arrangement are analyzed, and a procedure is proposed for reducing drag interference in this region. The efficiency of the procedure is demonstrated by a comparison with the results of wind-tunnel tests obtained on a series of models including those with deformed pylons and wings. I.S.

A92-30140
SELECTION OF EFFICIENT PRIMARY-STRUCTURE/FORCE CONFIGURATIONS FOR AIRCRAFT LIFTING SURFACES SUBJECTED TO DISPLACEMENT CONSTRAINTS [VYBOR RATSIONAL'NYKH KONSTRUKTIVNO-SILOVYKH SKHEM NESUSHCHIKH POVERKHNOSTEI LA PRI OGRANICHENIIAKH PO PEREMESHCHENIIAM]
A. K. KOVALEVSKII TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 112-118. In Russian. refs
Copyright

A generalized optimality criterion is proposed, in the form of the requirement of a uniform energy-density distribution, for selecting efficient primary-structure/force configurations for aircraft lifting surfaces of maximum rigidity. The proposed method and the computer program based on the method are verified by solving the optimization problem for a ten-bar truss, and the results are shown to agree well with those available in the literature. As an example, the problem of selecting the primary-structure/force configuration for an all-moving aircraft stabilizer is solved. I.S.

A92-30209
GENERATION OF LOADS FOR FINITE-ELEMENT MODELS OF LARGE AIRCRAFT [FORMIROVANIE NAGRUZOK DLIA KONECHNO-ELEMENTNYKH MODELEI LETATEL'NYKH APPARATOV BOL'SHOI RAZMERNOSTI]
IU. V. GUSAK and A. A. LITVINENKO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 98-106. In Russian. refs
Copyright

Based on a unified finite-element description of the geometry of load-calculation models, a method is proposed for the automated generation of balanced loads for a finite-element strength model for an aircraft under static loading. An example of the method's application is presented. L.M.

A92-31325
COLD-CYCLE PRESSURE-JET HELICOPTERS: VENTURES, DESIGNS, AND DEVELOPMENTS. I - VENTURES
E. K. LIBERATORE Vertiflite (ISSN 0042-4455), vol. 37, Nov.-Dec. 1991, p. 82-94.
Copyright

Technical developments of helicopters using the cold-cycle pressure-jet principle are reviewed with particular attention given to the prototype pressure-jet programs and their venture aspects. Technical characteristics of various models are presented and discussed, which include model 141 (VG-1) Heligiro, model 193 Honcho, model 200 Yellow Bird, model 202, model 228 Phoenix, and models 255, 280, 281 and 325. O.G.

A92-31606
PERSPECTIVES IN AEROSPACE DESIGN
Washington, DC, American Institute of Aeronautics and Astronautics, 1991, 1023 p. No individual items are abstracted in this volume.
(ISBN 1-56347-010-1) Copyright

The present publication on aerospace design encompasses pedagogical issues of engine and vehicle design, the use of computerized design, several design case studies, propulsion design issues, design methodologies, and other aerospace-design issues including noise, cost, support, and stability/control. Specific issues addressed include design education relevant to rotorcrafts, an evolutionary configuration-development system for space-vehicle design and simulation, the development of the F-12 automatic flight-control system, a structural design for hypersonic research aircraft, and the use of active controls for fuel conservation in commercial transports. Also addressed are such topics as propeller configuration, the requirements of integrated flight controls, the effects of wind on aircraft-cruise performance, hypersonic-transport performance estimates for an all-body configuration, and the application of slender wings and tail sizing to fuel-efficient aircraft. C.C.S.

A92-31668#
FURTHER DEVELOPMENTS IN THREE-DIMENSIONAL SIMULATION OF ELECTROTHERMAL DEICING SYSTEMS
ALAN D. YASLIK, KENNETH J. DE WITT, THEO G. KEITH, JR. (Toledo, University, OH), and WALTER BORONOW (McDonnell Douglas Corp., Long Beach, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. Research supported by McDonnell Douglas Corp. refs
(AIAA PAPER 92-0528) Copyright

This paper examines three-dimensional transient heat transfer in a multi-layered body which is ice covered. The physical application studied is the process of melting and removal of ice from aircraft components by use of electrothermal heaters. To model the ice phase change, a predictor-corrector technique is used which assumes a phase for each ice gridpoint. This allows the use of the Method of Douglas three-dimensional alternating direction numerical solver to iteratively converge on the correct phase of each ice node for each timestep. Enhancements to the previously developed code which allow for more realistic simulation of actual electrothermal deicer systems are presented. Comparisons between experimental deicer test results and numerical simulations are discussed. Author

A92-31669#
EXPERIMENTAL AND NUMERICAL INVESTIGATION OF ANTI-ICING PHENOMENA ON A NACA 0012 ASSEMBLY
MADDALENA FANELLI, WILLIAM B. WRIGHT, K. C. MASIULANIEC, KENNETH J. DE WITT, THEO G. KEITH, JR. (Toledo, University, OH), RICHARD J. COLE, TOM M. WILSON, KATHLEEN K. BOWEN, and CHARLES A. MARTIN (BFGoodrich De-Icing Systems, Uniontown, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 22 p. refs
(AIAA PAPER 92-0531) Copyright

Results are reported of an experimental study investigating the antiicing and deicing characteristics of a stationary NACA 0012 assembly containing an electrothermal deicer pad. The test conditions included temperatures ranging from -23 to +24 F, velocities from 100 to 200 mph, liquid water content from 0.0 gm/cu cm to 2.4 gm/cu cm, and water droplet diameters from 0 to 30 microns. The tests yielded transient temperature responses for the substrate, heater, and abrasion shield at selected positions around the pad. The tests included four phases: dry air testing, antiicing, and deicing tests with adjacent heater on-off times controlled by the leading edge region heater temperature, and tests where prescribed heater cyclic patterns were used. Comparisons are made between the experimental data and both 1D and 1D numerical electrothermal codes. P.D.

A92-31670*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN EFFICIENT FINITE ELEMENT METHOD FOR AIRCRAFT DE-ICING PROBLEMS
J. R. HUANG, THEO G. KEITH, JR., and KENNETH J. DE WITT (Toledo, University, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 20 p. Research supported by NASA. refs
(AIAA PAPER 92-0532) Copyright

In this paper, a finite element formulation based on an assumed states method is proposed for the solution of heat conduction problems with phase change at a fixed temperature. Attention is directed toward reduction of computer cost through the use of an efficient formulation, solver and algorithm. The procedure is applied to the analysis of an electrothermally deiced aircraft surface. Author

A92-31675#
EVALUATION OF THE AERODYNAMIC EFFECTS OF COMMUTER CLASS (TYPE 1-1/2) ANTI-ICING FLUIDS ON SMALL GENERAL AVIATION AIRPLANES
C. F. MUNAFO and CHARLES O. MASTERS (FAA, Technical Center, Atlantic City, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0643)

The testing of deicing fluids that are less viscous than type-II fluids is reported to determine their effectiveness for applications to small general aviation aircraft with low rotation speeds. The moment of liftoff is analyzed at several angles of attack to acquire aerodynamic performance data, and attention is also given to anecdotal expert data from pilots. Two plots are presented of coefficient of lift vs angle of attack as functions of fluid type to describe the performance of aircraft using fluid and without fluid. The flowoff characteristics and thicknesses of the fluid are analyzed with ground and airborne measurements, and residue from the freezing-point depressants (FPDs) is found on the wings after takeoffs. The FPDs have no significant effect on the aircraft lift characteristics and are not incompatible with aircraft materials. It is also shown that the occurrence of FPD residue varies directly with viscosity in the cases studied. C.C.S.

A92-31691#
AERO-PROPULSIVE EFFECTS ON CONFIGURATION SHAPING
L. H. TOWNEND, E. G. BROADBENT, J. F. CLARKE, R. A. EAST, T. R. F. NONWEILER, G. PAGAN, E. A. PARKER, and J. PIKE

(Advanced Propulsion and Energy Control Systems, Ltd., Liss, England) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 15 p. Research supported by Ministry of Technology of England, USAF, and McDonnell Douglas Corp. refs
(AIAA PAPER 91-5064) Copyright

This paper presents a short account of some design methods which may assist the practical and efficient achievement of hypersonic flight. Design methods are outlined by which the component parts of hypersonic airbreathing vehicles (such as the X-30) can be aerodynamically optimized either in isolation or as integrated combinations of structurally realistic geometry. Other methods are illustrated in application to the analysis of fluid features such as the flow around base areas, and beneath supersonic and hypersonic wings, both with and without external mass and heat addition, for typical vehicles such as airbreathing first (and airbreathing second) stages of a TSTO. Other methods describe passive cooling of leading edges and the installation of intakes on volumetrically efficient forebodies which offer low drag and may also permit simplifications in the handling of intake/forebody boundary layers. Author

A92-31878
APPROXIMATE DETERMINATION OF THE EFFECT OF DEVIATIONS OF WING AND TAIL GEOMETRY FROM DESIGN PARAMETERS ON THE DRAG COEFFICIENT OF SUBSONIC AIRCRAFT [PRIBLIZHENNAIA OTSENKA VLIIANIIA OTKLONENIIA GEOMETRICHESKIKH PARAMETROV KRYLA I OPERENIIA OT TEORETICHESKIKH NA KOEFFITSIENT SOPROTIVLENIIA DOZVUKOVYKH SAMOLETOV]
V. A. BARINOV and G. A. FEDORENKO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 100-104. In Russian. refs
Copyright

The paper presents an approximate method for determining drag-coefficient variations for subsonic aircraft in the case of deviations of the wing and tail geometry (airfoil thickness, chord, and span) from design parameters during manufacturing. A numerical example is given, and a method for representing the manufacturing-related deviations of the wing or tail section coordinates from the predicted ones is proposed. L.M.

A92-31881
INTERFERENCE OF HIGH-MOUNTED PROPFAN NACELLES WITH AN UNSWEPT WING AND WAYS TO ATTENUATE IT [INTERFERENTSIIA VERKHNERASPOLOZHENNYKH GONDOL TVVD S PRIAMYM KRYLOM I SPOSOBY EE OSLABLENIIA]
A. N. VISKOV, D. E. OKLADNIKOV, and S. M. CHERNYSHOVA TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 113-116. In Russian.
Copyright

Calculation and experimental results concerning the propfan nacelle effect on the lifting characteristics of an unswept wing are presented for different positions of the leading and trailing edge flaps. The presence of an unfavorable wing-nacelle interference is shown, which leads to a considerable reduction of the lifting characteristics of the aircraft at high angles of attack. Some ways to attenuate this interference are examined. L.M.

A92-31893
IMPROVING THE EFFICIENCY OF PASSENGER AIRCRAFT DURING THE LANDING APPROACH [POVYSHENIE TOPLIVNOI EFFEKTIVNOSTI PASSAZHIRSKIKH SAMOLETOV PRI ZAKHODE NA POSADKU]
A. G. OBRUBOV and A. A. POGODAEV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 3, 1991, p. 61-70. In Russian.
Copyright

Possible ways of improving the fuel efficiency of passenger aircraft during the landing approach are examined. In particular, it is shown that the fuel consumption can be reduced by optimizing the approach procedure (delaying the deployment of high-lift devices and reducing the number of manual operations during the deployment) and by automating the control of flaps and slats. V.L.

A92-31894
A SECOND-ORDER CONTROL OPTIMIZATION METHOD FOR NONLINEAR DYNAMIC SYSTEMS AND ITS USE FOR CALCULATING OPTIMAL AIRCRAFT TRAJECTORIES [METOD VTOROGO PORIADKA OPTIMIZATSII UPRAVLENIIA NELINEINYKH DINAMICHESKIKH SISTEM I EGO PRIMENENIE DLIA RASCHETA OPTIMAL'NYKH TRAEKTORII SAMOLETA]
O. E. EFIMOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 3, 1991, p. 71-80. In Russian. refs
Copyright

An approach to the numerical optimization of nonlinear dynamic systems is considered which is based on a discrete version of a second-order direct method. The approach makes it possible to obtain a weak local optimum with a high degree of accuracy and to construct a family of extreme solutions within a sufficiently short time. The method is suitable for solving aircraft trajectory optimization problems with a number of constraints with respect to normal acceleration loads and thrust and some trajectory parameters. The problem of achieving specified flight altitude and velocity within minimum time and with minimum consumed fuel is analyzed as an example. V.L.

A92-31896
A PROCEDURE FOR CALCULATING THE STATIC AEROELASTICITY CHARACTERISTICS OF FLIGHT VEHICLES BY THE INFLUENCE COEFFICIENT METHOD USING THREE-DIMENSIONAL FINITE ELEMENT SCHEMES [METODIKA RASCHETA KHARAKTERISTIK STATICHESKOI AEROUPRUGOSTI LETATEL'NYKH APPARATOV METODOM KOEFFITSIENTOV VLIIANIIA S ISPOL'ZOVANIEM PROSTRANSTVENNYKH SKHEM METODA KONECHNYKH ELEMENTOV]
A. A. SERGEEV and V. L. TOKAR' TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 3, 1991, p. 92-105. In Russian. refs
Copyright

A procedure is described for calculating the static aeroelasticity characteristics of flight vehicle in horizontal motion by using influence coefficients and compliance matrices obtained by means of three-dimensional finite element schemes. The computational formulas of the influence coefficient method are obtained with allowance for deformations due to inertial forces, including angular acceleration. The aerodynamic elasticity coefficients of a flight vehicle calculated by the method described here are compared with the values obtained by the assumed displacement method. V.L.

A92-32233
PRELIMINARY SIZING METHODOLOGY FOR HYPERSONIC VEHICLES
ARMAND J. CHAPUT (General Dynamics Corp., Fort Worth, TX) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 172-179. Previously cited in issue 07, p. 947, Accession no. A88-22575. refs
Copyright

A92-32247* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LOW-SPEED FLUTTER CHARACTERISTICS OF SOME SIMPLE LOW-ASPECT-RATIO DELTA-WING MODELS
ROBERT V. DOGGETT, JR. (NASA, Langley Research Center, Hampton, VA) and DAVID L. SOISTMANN (Planning Research Corp., Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 273-279. Previously cited in issue 12, p. 1782, Accession no. A89-30802. refs
Copyright

A92-32250* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DYNAMICS OF AN OPTIMIZED ROTOR BLADE AT OFF-DESIGN FLIGHT CONDITIONS
ADITI CHATTOPADHYAY (Arizona State University, Tempe) and HENRY JONES (NASA, Langley Research Center, Hampton, VA) (Vertical Lift Aircraft Design Conference, San Francisco, CA, Jan. 17-19, 1990, Proceedings) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 294-296. Previously cited in issue 21, p. 3307, Accession no. A90-46946. refs
Copyright

A92-32325
THE FIRST FIFTY YEARS OF COMPOSITE MATERIALS IN AIRCRAFT CONSTRUCTION
D. H. MIDDLETON Aeronautical Journal (ISSN 0001-9240), vol. 96, March 1992, p. 96-104. refs
Copyright
The course of development of aircraft primary structure composite construction methods since 1940 is discussed, giving attention to major milestones in both matrix and reinforcing materials composition and fabrication methodology. Although a composite aft fuselage of flax-reinforced phenolic resin was successfully manufactured for a Spitfire fighter in 1940, it was not until 1977 that an all-composite aircraft, the graphite-reinforced epoxy 'Learfan' business jet, flew. Weight-minimizing advanced composites are of critical importance to swept-forward wing aircraft such as the X-29, and all high performance tilt-rotor and rotary-wing VTOL aircraft. O.C.

N92-20064*# Kansas Univ., Lawrence.
PRELIMINARY DESIGN STUDIES OF AN ADVANCED GENERAL AVIATION AIRCRAFT Summary Report
RON BARRETT, SHANE DEMOSS, AB DIRKZWAGER, DARRYL EVANS, CHARLES GOMER, JERRY KEITER, DARREN KNIPP, GLEN SEIER, STEVE SMITH, and ED WENNINGER May 1991 204 p Original contains color illustrations
(Contract NASW-4435)
(NASA-CR-190024; NAS 1.26:190024) Avail: NTIS HC/MF A10; 5 functional color pages CSCL 01C
The preliminary design results are presented of the advanced aircraft design project. The goal was to take a revolutionary look into the design of a general aviation aircraft. Phase 1 of the project included the preliminary design of two configurations, a pusher, and a tractor. Phase 2 included the selection of only one configuration for further study. The pusher configuration was selected on the basis of performance characteristics, cabin noise, natural laminar flow, and system layouts. The design was then iterated to achieve higher levels of performance. Author

N92-20267*# Auburn Univ., AL. Dept. of Aerospace Engineering.
THE FM-007: AN ADVANCED JET COMMUTER FOR HUB TO SPOKE TRANSPORTATION
PETER SCOTT BLOUKE, GEORGE BRYAN ENGEL, KARI SUZANNE FORDHAM, STEVEN JAMES LAYNE, JOEL DAVID MOORE, FREDERICK MARTIN SHAVER, and DOUGLAS HERSHAL THORNTON, JR. 14 May 1991 70 p
(Contract NASW-4435)
(NASA-CR-189988; NAS 1.26:189988) Avail: NTIS HC/MF A04 CSCL 01C
Due to the increasing need for new commuter aircraft, the FM-007 is proposed, a technologically advanced jet propelled short takeoff and landing (STOL) airplane. The proposed commuter is designed for hub to spoke air travel. In order to reduce drag, natural laminar flow technology is integrated into the design using the natural laminar flow airfoil section for the wing. A three lifting surface configuration provides for more efficient cruise flight. This unique design includes a small forward wing (canard), a rear mounted high aspect ratio main wing, and a small horizontal stabilizer high atop the vertical tail. These three surfaces act together to reduce drag by minimizing the downward force the horizontal stabilizer has to account for due to the nose down pitching moment. Commuter aircraft must also incorporate passenger comfort. This is achieved by providing a spacious pressurized cabin with a large galley and reduced cabin noise due to incorporation of noise reduction gear. A basic oval design is adopted, as opposed to a circular design in order to allow for the seating of five passengers abreast. To get STOL capability, an over the wing blown flap is used using a Rolls Royce Tay series engine. Author

N92-20280*# Purdue Univ., West Lafayette, IN. School of Aeronautics and Astronautics.
DESIGN OF A TURBOFAN POWERED REGIONAL TRANSPORT AIRCRAFT Final Report
1991 12 p
(Contract NASW-4435)
(NASA-CR-190130; NAS 1.26:190130) Avail: NTIS HC/MF A03 CSCL 01C
The majority of the market for small commercial transport aircraft is dominated by high efficiency propeller driven aircraft of non-U.S. manufacture. During the past year, an aircraft was designed with ranges of up to 1500 nautical miles and passenger loads between 50 and 90. Special emphasis was placed upon keeping acquisition cost and direct operating costs at a low level while providing passengers with quality comfort levels. Several designs are presented which place a high premium on design innovation. Author

N92-20417*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FULLY INTEGRATED AERODYNAMIC/DYNAMIC OPTIMIZATION OF HELICOPTER ROTOR BLADES
JOANNE L. WALSH, WILLIAM J. LAMARSH, II (Unisys Corp., Hampton, VA.), and HOWARD M. ADELMAN Feb. 1992 18 p Proposed for presentation at the 33rd AIAA, ASME, ASCE, AHS, and ASC Structures, Structural Dynamics and Materials Conference, Dallas, TX, 13-15 Apr. 1992
(NASA-TM-104226; NAS 1.15:104226) Avail: NTIS HC/MF A03 CSCL 01C
A fully integrated aerodynamic/dynamic optimization procedure is described for helicopter rotor blades. The procedure combines performance and dynamic analyses with a general purpose optimizer. The procedure minimizes a linear combination of power required (in hover, forward flight, and maneuver) and vibratory hub shear. The design variables include pretwist, taper initiation, taper ratio, root chord, blade stiffnesses, tuning masses, and tuning mass locations. Aerodynamic constraints consist of limits on power required in hover, forward flight and maneuvers; airfoil section stall; drag divergence Mach number; minimum tip chord; and trim. Dynamic constraints are on frequencies, minimum autorotational inertia, and maximum blade weight. The procedure is demonstrated for two cases. In the first case, the objective function involves power required (in hover, forward flight and maneuver) and dynamics. The second case involves only hover power and dynamics. The designs from the integrated procedure are compared with designs from a sequential optimization approach in which the blade is first optimized for performance and then for dynamics. In both cases, the integrated approach is superior. Author

N92-20500# Israel Aircraft Industries Ltd., Ben-Gurion Airport. TASHAN Engineering Center
A REVIEW OF AGING AIRCRAFT TECHNOLOGY: AN IAI PERSPECTIVE
ABRAHAM BROT and ARNOLD NATHAN May 1991 15 p
(IAITIC-91-1018; ITN-92-85138) Avail: NTIS HC/MF A03
Considerations in the maintenance of aging aircraft are reviewed and discussed, including the use of a logistics computer program for optimal maintenance scheduling, quantitative ranking of critical locations for maintenance, a comparative evaluation of proof testing and preloading as a means of life extension. The primary cause of increasing costs of repair and replacement of parts has been found to be corrosion damage. This causes maintenance costs eventually to rise to the point where the aircraft has to be retired. Israel Aircraft Industries (IAI) has developed

non-destructive inspection procedures, based on low-frequency eddy-current methods, to detect potential cracking problems, to enable spares to be ordered and stocked in advance. Considerations in critical-location ranking include corrosion susceptibility, stress level, accessibility, geometry and past experience. Tests have indicated that preloading to 1.33-1.5 times the normal operating load can extend service life by a factor of 1.2-4.6. Preloading is recommended before the aircraft enters service and on 1-3 occasions during its service life. This treatment should be paralleled by non-destructive inspection at appropriate intervals. ISA

N92-20664*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
SCORPION: CLOSE AIR SUPPORT (CAS) AIRCRAFT
CHRIS ALLEN, RENDY CHENG, GRANT KOEHLER, SEAN LYON, and CECILIA PAGUIO 25 Nov. 1991 107 p
(Contract NASW-4435)
(NASA-CR-189974; NAS 1.26:189974) Avail: NTIS HC/MF A06 CSCL 01/3

The objective is to outline the results of the preliminary design of the Scorpion, a proposed close air support aircraft. The results obtained include complete preliminary analysis of the aircraft in the areas of aerodynamics, structures, avionics and electronics, stability and control, weight and balance, propulsion systems, and costs. A conventional wing, twin jet, twin-tail aircraft was chosen to maximize the desirable characteristics. The Scorpion will feature low speed maneuverability, high survivability, low cost, and low maintenance. The life cycle cost per aircraft will be 17.5 million dollars. The maximum takeoff weight will be 52,760 pounds. Wing loading will be 90 psf. The thrust to weight will be 0.6 lbs/lb. This aircraft meets the specified mission requirements. Some modifications have been suggested to further optimize the design. Author

N92-20665*# Worcester Polytechnic Inst., MA.
NASA ADVANCED AERONAUTICS DESIGN SOLAR POWERED REMOTELY PILOTED VEHICLE
DAVID S. ELARIO, NEAL H. GUILLMETTE, GREGORY S. LIND, JONATHAN D. WEBSTER, MICHAEL J. FERREIRA, GEORGE C. KONSTANTAKIS, DAVID L. MARSHALL, and CARI L. WINDT 30 Apr. 1991 318 p
(Contract NASW-4435)
(NASA-CR-190007; NAS 1.26:190007) Avail: NTIS HC/MF A14 CSCL 01/3

Environmental problems such as the depletion of the ozone layer and air pollution demand a change in traditional means of propulsion that is sensitive to the ecology. Solar powered propulsion is a favorable alternative that is both ecologically harmless as well as cost effective. Integration of solar energy into designs ranging from futuristic vehicles to heating is beneficial to society. The design and construction of a Multi-Purpose Remotely Piloted Vehicle (MPRPV) seeks to verify the feasibility of utilizing solar propulsion as a primary fuel source. This task has been a year long effort by a group of ten students, divided into five teams, each dealing with different aspects of the design. The aircraft was designed to take-off, climb to the design altitude, fly in a sustained figure-eight flight path, and cruise for approximately one hour. This mission requires flight at Reynolds numbers between 150,000 and 200,000 and demands special considerations in the aerodynamic design in order to achieve flight in this regime. Optimal performance requires a light weight configuration with both structural integrity and maximum power availability. The structure design and choice of solar cells for the propulsion was governed by the weight, efficiency, and cost considerations. The final design is a MPRPV weighting 35 N which cruises 7 m/s at the design altitude of 50 m. The configuration includes a wing composed of balsa and foam NACA 6409 airfoil sections and carbon fiber spars, a tail of similar construction, and a truss structure fuselage. The propulsion system consists of 98 10 percent efficient solar cells donated by Mobil Solar, a NiCad battery for energy storage, and a folding propeller regulated by a lightweight and efficient control system. The airfoils and propeller chosen for the design were research and tested during the design process. Author

N92-20951*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
ALPHA GROUP: THE BEHEMOTH APTERYX. FINAL DESIGN PROPOSAL Advanced Design Program, 1990 - 1991
May 1991 85 p
(Contract NASW-4435)
(NASA-CR-190026; NAS 1.26:190026) Avail: NTIS HC/MF A05 CSCL 01/3

The participation of the University of Notre Dame's Alpha Design Group in the NASA/Universities Space Research Association (USRA) University Advanced Design Program for the 1990 to 1991 academic year is presented. Alpha Design Group presented a design for an aircraft called The Behemoth Apteryx. D.R.D.

N92-21210# Federal Aviation Administration, Washington, DC. Vertical Flight Program Office.
FAA VERTICAL FLIGHT RESEARCH, ENGINEERING, AND DEVELOPMENT BIBLIOGRAPHY, 1962 - 1991
ROBERT D. SMITH and MICHELLE VAUGHN (Systems Control Technology, Inc., Arlington, VA.) Mar. 1992 270 p
(Contract DTFA01-87-C-00014)
(FAA/ARD-30; DOT/FAA/RD-92/1) Avail: NTIS HC/MF A12

A bibliography of FAA vertical flight research and development reports published from 1962 to 1991 is presented. Abstracts for approximately 300 reports are included along with various indexes to help identify specific documents of interest. This bibliography was assembled as an aid to those who are interested in research, engineering, and development of vertical flight issues including heliports, vertiports, helicopters, tiltrotor, and tiltwing vehicles. The intended audience includes people within the Federal Aviation Administration (FAA), in industry, and in state and local governments. In selecting technical reports to be included in the bibliography, two limitations were observed. First, the reports are specifically related, in whole or in part, to vertical flight issues. Second, they are limited to reports in which the research, engineering, and development elements of the FAA were involved as sponsors, participants, or authors. Author

N92-21489*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
THE SNODOG: PRELIMINARY DESIGN OF A CLOSE AIR SUPPORT AIRCRAFT
SCOTT ASHBAUGH, KENT BARTEL, J. R. CAVALLI, JOHN CHAN, JASON CHUNG, LIZA DIMARANAN, MIKE FREESE, RICK LEVITT, and DANI SOBAN 17 May 1991 110 p
(Contract NASW-4435)
(NASA-CR-189990; NAS 1.26:189990) Avail: NTIS HC/MF A06 CSCL 01/3

U.S. military forces are presently searching for the next generation Close Air Support aircraft. The following report presents the SnoDog, a low-cost ($14.8 million) aircraft capable of operating from remote battlefields and unimproved airstrips. The configuration consists of a conventional, low aspect-ratio wing, twin booms, twin canted vertical stabilizers along with a high-mounted joined horizontal tail. A supercritical airfoil for the wing enhances aerodynamic performance, while the SnoDog's instability increases maneuverability over current close air support aircraft. Survivability was incorporated into the design by the use of a titanium tub to protect the cockpit from anti-aircraft artillery, as well as, the twin booms and retracted gear disposition. The booms aid survivability by supplying separated, redundant controls, and the landing gear are slightly exposed when retracted to enable a belly landing in emergencies. Designed to fly at Mach .76, the SnoDog is powered by two low-bypass turbofan engines. Engine accessibility and interchangeable parts make the SnoDog highly maintainable. The SnoDog is adaptable to many different missions, as it is capable of carrying advanced avionics pods, carrying external fuel tanks or refueling in-air, and carrying various types of munitions. This makes the SnoDog a multirole aircraft capable of air-to-air and

air-to-ground combat. This combination of features make the SnoDog unique as a close air support aircraft, capable of meeting the U.S. military's future needs. Author

N92-21510# Wichita State Univ., KS. Dept. of Mechanical Engineering.
A STUDY IN DYNAMIC CONTROL OF A SUPER MANEUVER WITH NEURAL NETWORKS Abstract Only
JAMES E. STECK and KAMRAN ROKHSAZ *In its* Techfest 18 Proceedings 1 p Jan. 1992
Avail: NTIS HC/MF A03 CSCL 01/2

The possibility was studied of the use of artificial neural networks to assist the pilot in performing super maneuvers. A three degree of freedom dynamic model was devised. Two such networks were used to ultimately learn to associate a specific type of stick motion with a predefined maneuver. One network was trained to predict the transient aerodynamic force and moment coefficients of a 70 deg delta wing. The accuracy of the predicted values of these coefficients was demonstrated: (1) by comparison of the results with experimental aerodynamic data; and (2) by comparison of the response of the dynamic model to the predicted values as well as those of experiment. In the next phase, the required aerodynamic control input schedule is determined for a specified maneuver. An arbitrary stick motion time history is associated with this schedule. A second neural network was trained to associate the two parameters over a range of reduced frequencies. The comparison of the input and the output of this network for these parameters shows very promising trends. However, at this point, the errors in the predicted values of the required control inputs appear to result in unacceptable errors in the aircraft motion precision. Author

N92-21540*# Auburn Univ., AL. Dept. of Aerospace Engineering.
THE LANGLEY TURBO-PROP COMMUTER DESIGN: A COMPLETE PROJECT DESCRIPTION
GREG BUTTRAM, KEITH HORTON, TIM KEETER, PAUL MILLHOUSE, KELLI NEWBERRY, and BRIAN OBYRNE 4 Jun. 1991 40 p
(Contract NASW-4435)
(NASA-CR-189987; NAS 1.26:189987) Avail: NTIS HC/MF A03 CSCL 01/3

The primary objective of this project was to propose and prove the possibility of a new, advanced technology commuter aircraft design. Among the specifications were short to medium range capabilities, low seat per mile cost, fuel efficiency, and passenger comfort. Based on market evaluation, we found that the optimum size for new regional aircraft is around 50 passengers; we have designed our aircraft for this capacity. Turboprop engines provide substantial reductions in operating costs due to lower fuel consumption. We have therefore chosen an advanced turboprop engine. Composite materials, while more expensive to purchase and manufacture, result in decreased costs later through weight savings and ease of replacement. Author

N92-21565*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
MANX: CLOSE AIR SUPPORT AIRCRAFT PRELIMINARY DESIGN
ANNIE AMY, DAVID CRONE, HEIDI HENDRICKSON, RANDY WILLIS, and VINCE SILVA 25 Nov. 1991 65 p
(Contract NASW-4435)
(NASA-CR-189992; NAS 1.26:189992) Avail: NTIS HC/MF A04 CSCL 01/3

The Manx is a twin engine, twin tailed, single seat close air support design proposal for the 1991 Team Student Design Competition. It blends advanced technologies into a lightweight, high performance design with the following features: High sensitivity (rugged, easily maintained, with night/adverse weather capability); Highly maneuverable (negative static margin, forward swept wing, canard, and advanced avionics result in enhanced aircraft agility); and Highly versatile (design flexibility allows the Manx to contribute to a truly integrated ground team capable of rapid deployment from forward sites). Author

N92-21566*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
THE GUARDIAN: PRELIMINARY DESIGN OF A CLOSE AIR SUPPORT AIRCRAFT
JONATHAN HAAG, DAVID HUBER, KELLY MCINERNEY, GREG MULLIGAN, DAVID PESSIN, and MICHAEL SEELOS 17 May 1991 126 p
(Contract NASW-4435)
(NASA-CR-189991; NAS 1.26:189991) Avail: NTIS HC/MF A07 CSCL 01/3

One design is presented of a Close Air Support (CAS) aircraft. It is a canard wing, twin engine, twin vertical tail aircraft that has the capability to cruise at 520 knots. The Guardian contains state of the art flight control systems. Specific highlights of the Guardian include: (1) low cost (the acquisition cost per airplane is $13.6 million for a production of 500 airplanes); (2) low maintenance (it was designed to be easily maintainable in unprepared fields); and (3) high versatility (it can perform a wide range of missions). Along with being a CAS aircraft, it is capable of long ferry missions, battlefield interdiction, maritime attack, and combat rescue. The Guardian is capable of a maximum ferry of 3800 nm, can takeoff in a distance of 1700 ft, land in a ground roll distance of 1644 ft. It has a maximum takeoff weight of 48,753 lbs, and is capable of carrying up to 19,500 lbs of ordinance. Author

N92-21567*# California Polytechnic State Univ., San Luis Obispo.
A-2000: CLOSE AIR SUPPORT AIRCRAFT DESIGN TEAM
PAUL CARRANNANTO, DON LIM, EVANGELINE LUCAS, ALAN RISSE, DAVE WEAVER, and STEVE WIKSE 25 Nov. 1991 82 p
(Contract NASW-4435)
(NASA-CR-190022; NAS 1.26:190022) Avail: NTIS HC/MF A05 CSCL 01/3

The US Air Force is currently faced with the problem of providing adequate close air support for ground forces. Air response to troops engaged in combat must be rapid and devastating due to the highly fluid battle lines of the future. The A-2000 is the result of a study to design an aircraft to deliver massive fire power accurately. The low cost A-2000 incorporates: large weapons payload; excellent maneuverability; all weather and terrain following capacity; redundant systems; and high survivability. Author

N92-21587* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SERRATED TRAILING EDGES FOR IMPROVING LIFT AND DRAG CHARACTERISTICS OF LIFTING SURFACES Patent
PAUL M. H. W. VIJGEN, inventor (to NASA), FLOYD G. HOWARD, inventor (to NASA), DENNIS M. BUSHNELL, inventor (to NASA), and BRUCE J. HOLMES, inventor (to NASA) 18 Feb. 1992 14 p Filed 31 Oct. 1989 Supersedes N90-15094 (28 - 7, p 879)
(NASA-CASE-LAR-13870-1-CU; US-PATENT-5,088,665; US-PATENT-APPL-SN-429516; US-PATENT-CLASS-244-200; US-PATENT-CLASS-244-198; US-PATENT-CLASS-244-212; US-PATENT-CLASS-244-215; INT-PATENT-CLASS-B64C-21/10)
Avail: US Patent and Trademark Office CSCL 01/3

An improvement in the lift and drag characteristics of a lifting surface is achieved by attaching a serrated panel to the trailing edge of the lifting surface. The serrations may have a saw-tooth configuration, with a 60 degree included angle between adjacent serrations. The serrations may vary in shape and size over the span-wise length of the lifting surface, and may be positioned at fixed or adjustable deflections relative to the chord of the lifting surface.
Official Gazette of the U.S. Patent and Trademark Office

N92-21856 West Virginia Univ., Morgantown.
HELICOPTER ROTOR BLADE DYNAMICS WITH BILINEAR FORMULATION Ph.D. Thesis

GRZEGORZ KAWIECKI 1991 224 p
Avail: Univ. Microfilms Order No. DA9203852

A time finite element method based on Hamilton's Law of Varying Action (HLVA) is applied to the analysis of the dynamics of nonlinear systems. The helicopter blade is chosen as an example of a dynamical system. The temporal dependence of the equations of motion is discretized using the bilinear formulation of the HLVA. The convergence of this method for initial value and boundary value linear, temporal problems has been proven by others. An attempt is made to apply the bilinear formulation of HLVA to solve a system of nonlinear differential equations modeling a nonconservative dynamical system. Two approaches for the numerical implementation of the bilinear formulation are developed. One obtains the response of a general dynamical system using marching in time. The other is based on the assumption that the solution is identical at the beginning and at the end of one period. The feasibility of the bilinear formulation for solving nonlinear problems is shown on an example of a two degree of freedom, strongly nonlinear dynamical system. It is shown that although the bilinear formulation offers good stability and convergence characteristics it cannot match the speed of standard integration algorithms large nonlinear systems. Dissert. Abstr.

N92-21951# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.

AIRCRAFT SHIP OPERATIONS

Nov. 1991 340 p In ENGLISH and FRENCH Symposium held in Seville, Spain, 20-23 May 1991
(AGARD-CP-509; ISBN-92-835-0641-3) Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The Symposium considered problems of mutual interest connected with fixed and rotary wing aircraft operations from ships, and the application of new technology to enhance such operations. The topics covered included the ship environment in terms of wind, temperature, precipitation, turbulence, and deck motion; guidance, controls, and displays, primarily in the approach and landing phase; flight test and simulation techniques; launch, recovery, and handling systems developments; operational/pilot views; and future developments.

N92-21952# Naval Sea Systems Command, Washington, DC. Hull Form and Hydrodynamic Performance Div.

DECK MOTION CRITERIA FOR CARRIER AIRCRAFT OPERATIONS

J. H. PATTISON and R. R. BUSHWAY (Naval Air Systems Command, Washington, DC.) *In* AGARD, Aircraft Ship Operations 18 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Updated ship motion criteria for conventional fixed wing aircraft launch, recovery, and handling operations are presented. The criteria were required to evaluate the effectiveness of proposed hull modifications for USS MIDWAY (CV41). A balanced approach was used to develop the criteria; including a review of existing criteria, an air department workshop, motion measurements during aircraft operations aboard USS MIDWAY and USS CONSTELLATION, flight simulations of aircraft recovery, and a study of the sensitivity of operability calculations to changes in the criteria. Deck attitude (list and trim) and wind limitations are discussed. Sample results are presented to show how the criteria are used to evaluate the effects of hull improvements in a typical operating area of the ocean. It is shown how the criteria may be used in onboard motion displays to guide the ship operator to best speeds and headings to avoid deck motion effects on operations. Author

N92-21956*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

A NEW METHOD FOR SIMULATING ATMOSPHERIC TURBULENCE FOR ROTORCRAFT APPLICATIONS

J. RIAZ, J. V. R. PRASAD, D. P. SCHRAGE, and G. H. GAONKAR (Florida Atlantic Univ., Boca Raton.) *In* AGARD, Aircraft Ship Operations 6 p Nov. 1991 Previously announced in IAA as A92-14368
(Contract NCA2-512)
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 01/3

Simulation of atmospheric turbulence as seen by a rotating blade element involves treatment of cyclostationary processes. Conventional filtering techniques do not lend themselves well to the generation of such turbulence sample functions as are required in rotorcraft flight dynamics simulation codes. A method to generate sample functions containing second order statistics of mean and covariance is presented. Compared to ensemble averaging involving excessive computer time, the novelty is to exploit cycloergodicity and thereby, replace ensemble averaging by averaging over a single path sample function of long duration. The method is validated by comparing its covariance results with the analytical and ensemble averaged results for a widely used 1-D turbulence approximation. Author

N92-21961# Kaman Aerospace Corp., Bloomfield, CT.

ANALYTICAL MODELING OF SH-2F HELICOPTER SHIPBOARD OPERATION

FU-SHANG WEI, ERICH BAITIS, and WILLIAM MYERS (David Taylor Research Center, Bethesda, MD.) *In* AGARD, Aircraft Ship Operations 11 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

An analysis of the shipboard characteristics of the SH-2F helicopter in response to prescribed deck motion, deck friction, and steady wind conditions was developed. The objective of deriving the SH-2F shipboard dynamic model is to define the safe conditions for launching and recovering the helicopter from the flight deck of Navy frigates and destroyers. Operational conditions of interest include helicopter and ship deck dynamic interactions which would potentially cause dangerous interference between the helicopter and the ship such as sliding or tipping of the helicopter. The wind condition, ship deck motion, helicopter rotor thrust, and friction coefficients between helicopter tires and flight deck surfaces are found to be important parameters which affect the helicopter shipboard operations. Four sets of aerodynamic characteristics are modeled in the analysis: one with the rotor operating at very low thrust; one for the rotor stopped and inoperative; one for rotor folded; and one for the fuselage. The ship motion data, including three linear translation and two angular rotation degrees of freedom (roll and pitch) are described in the time domain. The equations of motion of the shipboard dynamic model are derived using the energy method. These equations are solved in the quasi-steady fashion within one-third of a second refresher rate to the prescribed deck motion time histories and steady wind conditions. Author

N92-21962# Canadair Ltd., Montreal (Quebec). Surveillance Systems Div.

HELICOPTER/SHIP ANALYTIC DYNAMIC INTERFACE

BERNARD FERRIER, HENRY POLVI (National Defence Headquarters, Ottawa, Ontario), and FRANCOIS A. THIBODEAU *In* AGARD, Aircraft Ship Operations 20 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

An analytic approach to helicopter/ship dynamic interface testing is introduced. The development of dynamic interface from ship motion simulation is presented. A demonstration of a deck handling clearance study is performed for an EH101 helicopter and CPF ship model. Preliminary results of the Landing Period Designator Development Project are provided. Author

N92-21963# Naval Air Test Center, Patuxent River, MD. Strike Aircraft Test Directorate.

EVALUATING FIXED WING AIRCRAFT IN THE AIRCRAFT CARRIER ENVIRONMENT

C. P. SENN *In* AGARD, Aircraft Ship Operations 9 p Nov.

1991
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Operating fixed wing aircraft from today's modern aircraft carrier is a demanding task. Evaluation of aircraft/ship compatibility, both during the concept development phase and full scale development (FSD) ground and flight tests presents the evaluation team with unique challenges. The capabilities and characteristics of high performance carrier based tactical aircraft must be quantified for the catapult launch and subsequent flyaway, and the carrier approach and arrested landing tasks. Catapult launching involves determining the minimum safe launch airspeeds while maintaining acceptable flight characteristics in this low altitude, high angle of attack (AOA) regime. Approach and landing requires the slowest possible approach airspeeds while retaining the performance and handling qualities needed for precision glide slope control. Defining the lowest catapult launch and landing airspeeds reduces wind over deck (WOD) requirements, resulting in reduced ship's operating speed and increased operational flexibility. The tight operating confines of the flight and hanger decks, in conjunction with the large number of other aircraft, support equipment, and personnel dictate unique design requirements which must be considered in the earliest design stages of a new airplane. The shore based and shipboard ground and flight tests which are conducted to assess the flying qualities, performance, and structural suitability of an airplane in the aircraft carrier environment are addressed. Author

N92-21964# Agusta Sistemi S.p.A., Varese (Italy). Flight Test Dept.
EH 101 SHIP INTERFACE TRIALS: FLIGHT TEST PROGRAMME AND PRELIMINARY RESULTS
R. LONGOBARDI, G. VISMARA, and B. PAGGI *In* AGARD, Aircraft Ship Operations 7 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The development program of the EH 101 includes, for its naval variant, the investigation of the ship-helicopter interface characteristics to grant a preliminary release for helicopter operations on board Italian and British Navy units. The testing will be done according to the following scheme: (1) EH 101 handling qualities assessment while operating near a ship, during the final approach phase; (2) deck landings and take-offs for a preliminary identification of deck motion limits and wind envelope; (3) assessment of the deck landing technique with the use of landing aids; (4) assessment of the aircraft landing on the deck, rotors folding, refueling, armament loading, taxiing, tie downs, etc.; (5) assessment of helicopter operations in a heavy electromagnetic environment; and (6) assessment of the maintainability characteristics of the EH 101 in limited spaces (engine and gear boxes change). Additionally, the results of the preliminary sea trials carried out with the EH 101 prototypes will be presented. Author

N92-21965# National Aerospace Lab., Amsterdam (Netherlands).
DETERMINATION OF LIMITATIONS FOR HELICOPTER SHIP-BORNE OPERATIONS
R. FANG *In* AGARD, Aircraft Ship Operations 9 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A brief outline of helicopter-ship qualification programs, as performed by the National Aerospace Laboratory NLR (the Netherlands), is given. The outline describes how detailed information about the helicopter's capabilities, the ship's motion characteristics, and the wind-climate above the ship's flight deck is used to set up and to execute a safe and efficient helicopter flight test program. The program leads to a safe and maximum operational availability of the helicopter on board the ship in terms of take-off and landing capabilities as functions of relative wind and sea-state. Author

N92-21966# Aeroplane and Armament Experimental Establishment, Boscombe Down (England). Rotary Wing Performance Section.
UNITED KINGDOM APPROACH TO DERIVING MILITARY SHIP HELICOPTER OPERATING LIMITS
B. A. FINLAY *In* AGARD, Aircraft Ship Operations 14 p Nov. 1991 Sponsored in part by Ministry of Defence
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

In the United Kingdom the Aeroplane and Armament Experimental Establishment (A&AEE) is responsible for conducting trials to determine the limitations appropriate to military Ship Helicopter Operations. The philosophy behind these trials is presented. Additionally, the many considerations which play a part in successful trials are discussed. The tests which are carried out before trials at sea are described together with details of how trials are conducted with a helicopter and a ship to determine the widest possible operating envelopes. It is concluded that the methods used by the A&AEE establish envelopes for any particular combination of aircraft and ship that are both operationally valuable and safe. Author

N92-21967# Aeronautical Research Labs., Melbourne (Australia). Flight Mechanics and Propulsion Div.
A REVIEW OF AUSTRALIAN ACTIVITY ON MODELLING THE HELICOPTER/SHIP DYNAMIC INTERFACE
A. M. ARNEY, J. BLACKWELL, L. P. ERM, and N. E. GILBERT *In* AGARD, Aircraft Ship Operations 13 p Nov. 1991 Sponsored by Royal Australian Navy
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The Aeronautical Research Laboratory (ARL) was tasked by the Royal Australian Navy (RAN) to develop a computer model of the S-70B-2 Seahawk/FFG-7 dynamic interface and to use this to investigate operational problems and limitations. An overview of the status of the task is presented, with particular emphasis on undercarriage dynamics and studies of the airwake in the region of the flight deck. For the undercarriage model, modification resulting from static trials, as well as plans for dynamic trials, are given. For the airwake studies, only preliminary results are available. These relate to full-scale airwake and ship motion trials aboard the FFG-7 class frigate HMAS Darwin, and 'mean flow' airwake studies in the low-speed wind tunnel at ARL using a 1/64th size model of an FFG-7 Author

N92-21968# Naval Air Test Center, Patuxent River, MD. Strike Aircraft Test Directorate.
UNITED STATES NAVY SKI JUMP EXPERIENCE AND FUTURE APPLICATIONS
T. C. LEA, III, C. P. SENN, and J. W. CLARK, JR. (Naval Air Development Center, Warminster, PA.) *In* AGARD, Aircraft Ship Operations 15 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The United States Navy has evaluated the performance benefits of using a ski jump during takeoff. The significant gains available with the use of Vertical and Short Takeoff and Landing (V/STOL) aircraft operating from a ski jump were documented many times in the past; however, the U.S. Navy has expanded the concept to include Conventional Takeoff and Landing (CTOL) aircraft. The results from a recent shipboard test are presented. The test was an evaluation of the AV-8B aboard the Spanish ski jump equipped ship PRINCIPE DE ASTURIAS, and a shore based flight test evaluation of CTOL aircraft operation from a ski jump ramp. The analytical tools developed during the CTOL phase of testing are used to project the benefits which could be realized by combining the steam powered catapult and a 'mini' ski jump ramp compatible with today's aircraft carriers. Author

N92-21969# RDM Technology, Rotterdam (Netherlands).
HELICOPTER HANDLING: EXPERIENCE AND NEW DEVELOPMENTS
W. R. M. REIMERING and T. CRAIG (MacTaggart, Scott and Co.

Ltd., Loanhead, Scotland) *In* AGARD, Aircraft Ship Operations 18 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

In the last 25 years, helicopter handling became a necessity in order to meet the mission requirements for operating helicopters from small ships. A survey of experiences and new developments in the field of helicopter handling is presented. The interface solutions, that are provided, take into consideration restrictions imposed by the airframe and the ship's construction. One set of solutions concentrates heavily on helicopter traversing systems. The other solutions discuss the landing grid and the design and construction of the decklock (sometimes referred to as the harpoon or talon). Author

N92-21970# Dassault-Breguet Aviation, Saint Cloud (France). Direction General Technique.
DYNAMIC PERFORMANCE OF AN AIRCRAFT ON ITS LANDING GEAR: TEST AND EVALUATION ON A DIHEDRAL [COMPORTEMENT DYNAMIQUE D'UN AVION SUR SES ATTERRISSEURS: EXPERIMENTATION ET VALIDATION PAR FRANCHISSEMENT D'UN DIEDRE]
D. FLEYGNAC and E. BOURDAIS *In* AGARD, Aircraft Ship Operations 13 p Nov. 1991 In FRENCH
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The essential role of the dynamic performance of landing gear in this study of instances of contact with the ground and, more particularly, the analysis of catapulting marine aircraft has justified the desire to validate the models used in the design phase of existing aircraft. Described here is the preparation, installation, and use of a dihedral to launch a MIRAGE 2000. These trials permitted a detailed identification of the performance characteristics of landing gear in a particular dynamic phase that is fairly representative of the conditions encountered when catapulting, as well as the aerodynamic effectiveness of control surfaces with ground effect. Author

N92-21971# British Aerospace Public Ltd. Co., Lancashire (England). Advanced Studies Dept.
SOME IMPLICATIONS FOR ADVANCED STOVL OPERATION FROM INVINCIBLE CLASS SHIPS
K. AINSCOW and P. G. KNOTT *In* AGARD, Aircraft Ship Operations 10 p Nov. 1991
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Replacing the Sea Harrier with a high performance Advanced Short Takeoff and Vertical Landing (ASTOVL) design for use on Invincible class ships was studied. Four different ASTOVL propulsion concepts are discussed. The integration of these larger, heavier aircraft with the small ship carrying EH101 helicopters is discussed. It is shown that the constraints of the ship and the size and performance of the aircraft require some changes in operational procedures when compared with Sea Harrier practice. The higher takeoff thrust to weight ratio and more hostile exhaust plumes suggest the use of the aft deck for recovery, a shorter deck run with the sky ramp for launching, and a blast deflector between the two areas. A study of the deck environment generated by the ASTOVL aircraft indicates that a delicate balance among size, mass, performance and exhaust environment will need to be struck in future Sea Harrier replacement studies for small ship operation. Author

N92-21973# Stato Maggiore Marina, Rome (Italy).
LIMITATIONS ON HELICOPTER OPERATIONS IN THE AERONAVAL ENVIRONMENT [LIMITATIONS DES OPERATIONS DES HELICOPTERES DANS LE MILIEU AERONAVAL]
D. FALCINELLI *In* AGARD, Aircraft Ship Operations 6 p Nov. 1991 In FRENCH
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The particular problems faced by pilots during flight activities onboard military ships are discussed. Problems include limited space, motion of the flight deck, wind, and turbulence. Various situations were studied using helicopters, but the results can be generalized to other types of aircraft. Problems of approach and landing are of special interest. Limitations of the environment, systems that help flight operations, markings and visual cues, landing and relocation systems, and approach systems are briefly discussed. Author

N92-21974# Atlantic Research Corp., Landover, MD.
REVOLUTION AT SEA: AIRCRAFT OPTIONS FOR THE YEAR 2030
JAMES C. BIGGERS and PETER A. SILVIA (David Taylor Research Center, Bethesda, MD.) *In* AGARD, Aircraft Ship Operations 12 p Nov. 1991
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Some innovative options for future aircraft and a revolutionary approach to the ships from which they operate are presented. Some options have been explored through the preliminary design stage, some are only at the conceptual design stage, and others are mere speculation. The limitations of the present fleet are noted, along with some possible solutions. All options assume the integration of ships and aircraft in more depth than previously. The objective here is to create in the reader a vision of the future surface and air fleet that is significantly different from today's Navy, and to get the reader involved in bringing this vision to reality. Author

N92-22000# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Munich (Germany, F.R.). Materials and Structures Research Dept.
MATERIALS AND STRUCTURES RESEARCH DEPARTMENT: SCIENTIFIC REPORT (1990)
DOROTHEA KOCH-PETERS, ed. and MARIANNE SALEIN, ed. 1991 151 p In ENGLISH and GERMAN Original contains color illustrations
(ISSN-0174-3910; ETN-92-90727) Avail: NTIS HC/MF A08

The research and development tasks are directed towards two basic requirements of aircraft construction, ultraweight structures and high efficiency propulsion systems, towards the main challenges of hypersonic and reentry flight, high temperatures and temperature gradients, and towards related problems of energy technology. The scope of the research department's work stretches from materials research to design, construction and processing methods, to structural-dynamic and aeroelastic performance, and to testing and qualification of aerospace devices, supplemented by investigations of innovative materials and substances to be produced under zero gravity conditions. In detail the following activities are being pursued: production technology and materials research on production of rapidly solidified metals, fiber-reinforced Al, Mg, and Ti alloys, monolothic and fiber-reinforced high performance ceramics, fiber-reinforced plastics, layers providing protection against heat and corrosion, monocrystalline materials; material and function-adapted design principles, methods of producing and shaping components, lay-up and adhesion methods for laminates, assembly procedures, powder metallurgy, hot isostatic pressing, reaction sintering, slip-casting, infiltration techniques, automated production processes; calculation and investigation of the static, dynamic and aeroelastic performance of components and structures (rotor blades, airframe, spacecraft, buildings); the damage mechanics of fiber compounds, thermomechanics, hybrid constructions, modal coupling, and entire systems. ESA

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A92-28874
AVIONICS SYSTEMS OF THE 21ST CENTURY
Aerospace Engineering (ISSN 0736-2536), vol. 12, March 1992, p. 19-23.
Copyright

Coupled with advancements in software partitioning, fault-tolerant electronics have reached a level of development in avionics-related applications which promise unprecedented availability and integration, as well as reduced installed system weight. In addition, the implementation of 'modularity' concepts to avionics design has allowed application-specific components to be furnished by tailoring various predefined modular elements to perform the required functions. Comparably far-ranging accomplishments are at hand for data transmission, as in the case of the fiber-optic transmission paths-based ARINC 629 two-way data-transmission buses: which bring immunity to intense EMI while yielding weight reductions. Cockpit display and flight-management computer technology benefits are evaluated, relative to conventional systems. O.C.

A92-32060
AIRFLOW EFFECTS ABOUT PMS PROBES ON THE DLR FALCON
J. I. MACPHERSON (National Research Council of Canada, Flight Research Laboratory, Ottawa), H. P. FIMPEL (DLR, Oberpfaffenhofen, Federal Republic of Germany), and D. BAUMGARDNER (NCAR, Boulder, CO) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 107-112. refs
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A plug-in pod to measure flow velocity and angles has been developed for in-flight verification of the flow model predictions at mounting locations of PMS (Particle Measuring System) particle spectrometers. Instrumentation and test procedures are described, and results from four flights with different pod configurations are summarized. Some of the findings are compared with results for a typical wing-tip mounting location. C.D.

A92-32062
MODIFICATIONS TO AND DATA CORRECTION METHODS FOR SOME RADIOMETERS USED ON AIRCRAFT
VINCE GLOVER and DAVID M. MCFARLAND (NCAR, Boulder, CO) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 118-120. refs
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Extremes of temperature, rate of temperature change, and the attitude during aircraft maneuvers produce instrument offsets in radiometers that should be corrected. The RAF has attempted to facilitate these corrections by modifications to the Eppley infrared radiometer and the Barnes surface temperature thermometer. These modifications and some corrections that should be applied to airborne measurements of irradiance are reviewed in this paper. C.D.

A92-32064
THE DESIGN AND OPERATIONAL CHARACTERISTICS OF A HEATED RADOME FOR AIR MOTION MEASUREMENT
EDWARD N. BROWN (NCAR, Boulder, CO) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 134-139. refs
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The engineering design, flight evaluation, and operational performance of a heated radome air motion system for a jet aircraft are described. Data are presented on the results of natural icing encounters. The system measurement uncertainty is addressed. C.D.

A92-32080
USE OF RELATIVE HUMIDITY SENSORS FOR PLANES MEASUREMENT
G. ABADIE, G. COCHER, and C. BERNE (Etablissement d'Etudes et de Recherches Meteorologiques, Magny-les-Hameaux, France) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 247-249.
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The use of hygrometric measurement to determine the speed of French aircraft is described. The devices are summarized and sample hygrometric calculations and sounding results are briefly presented. C.D.

A92-32082
AN AIRBORNE DOPPLER LIDAR FOR METEOROLOGICAL RESEARCH
R. L. SCHWIESOW, V. M. GLOVER, M. P. SPOWART, K. A. WEAVER, and J. S. BOGEN (NCAR, Boulder, CO) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 252-255. refs
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The current and planned capability of the NCAR Airborne Infrared Lidar System (NAILS), which is approaching readiness for field experiments, are discussed. The applications of NAILS to cloud dynamics, boundary-layer dynamics, and transport of atmospheric constituents is addressed, and performance parameters are given. The design of the NAILS platform interface, optics, and data system is examined. C.D.

A92-32089
A NEW AIRCRAFT UNIVERSAL LIGHTWEIGHT DIGITAL DROPSONDE
TERRENCE F. HOCK and HAL L. COLE (NCAR, Boulder, CO) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 291-296. refs
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An overview is presented of the Lightweight Loran Digital Dropwindsonde (L2D2) and the Lightweight Omega Digital Dropsonde (LOD2). The cone chute and sensors for pressure, temperature, and humidity are examined. The past results of using L2D2 are briefly discussed. C.D.

A92-32090
AN AIRBORNE CRYOGENIC FROST-POINT HYGROMETER
PAUL A. SPYERS-DURAN (NCAR, Boulder, CO) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 303-306. refs
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The operational principles, calibration and measurement, measurement limitations, data acquisition, and data processing of an NCAR-developed airborne cryogenic frost-point hygrometer are described. This hygrometer eliminates an existing gap in low-humidity measurements from an airborne platform by providing continuous, fast, and accurate frost-point measurements in the -20 to -80 C temperature range. C.D.

A92-32091
THE DLR LYMAN-ALPHA HYGROMETER
REINHOLD BUSEN (DLR, Institut fuer Physik der Atmosphaere, Oberpfaffenhofen, Federal Republic of Germany), ARDEN L. BUCK (Buck Research, Boulder, CO), and RANDY D. HORN (Digilog Instruments, Boulder, CO) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan.

14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 316-321. refs
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The design and special features of the DLR Lyman-alpha hygrometer called L-5 are described. The calibration process is described and the performance of the instrument is shown by power spectra and time plots. C.D.

A92-32095
VISIBILITY MEASUREMENTS FOR THE AUTOMATED SURFACE OBSERVING SYSTEM (ASOS)
JAMES T. BRADLEY, RICHARD LEWIS (NOAA, National Weather Service, Sterling, VA), and JOHN NILSEN (FAA, Washington, DC) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 344-347.
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The results are presented of qualification testing for visibility sensors to support aviation applications and the sensor needs for the Automated Surface Observing System (ASOS). The forward-scatter sensor pairs are identified which have the potential of meeting the requirements. C.D.

A92-32097
DESIGN AND PRELIMINARY TESTS OF A NEW AIRBORNE THERMOMETER
R. P. LAWSON (NCAR, Boulder, CO) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 366-371. Research supported by NCAR. refs
(Contract NSF ATM-88-19676)
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A new airborne thermometer designed to overcome deficiencies of current thermometers has been developed. Compared to the Rosemount, reverse flow, and K probes, the new thermocouple thermometer demonstrates much improved response. The coherence between the two sensors on the probe was greater than 10 Hz (compared to less than 1 Hz between the other thermometer), making possible accurate measurements of temperature structures in the atmosphere of order 1-10 m. The sensor in the probe appeared to stay dry under most test conditions, but suffered wetting errors when the concentration of (drizzle) drops measured by the PMS 2D-C probe exceeded about 10 to 100/L. C.D.

A92-32140
DIGITAL OZONESONDES - EXAMPLES OF RESULTS FROM THE EMEFS EXPERIMENTS OF 1988 AND 1990
R. E. MICKLE, R. M. HOFF, J. MARKES, and F. A. FROUDE (Atmospheric Environment Service, Egbert, Canada) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. J138-J141. Research supported by NOAA. refs
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The development of AES-modified sondes is described, and representative results from the system are presented. The principles of the EEC sonde and the interface to a commercial upper air sonde are discussed. A tropospheric ozone profile from one of the linear CMOS sondes used during the Eulerian Model Evaluation Field Studies II is shown. P.D.

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.

A92-29116
FULL ENVELOPE MULTIVARIABLE CONTROL OF A GAS TURBINE ENGINE
R. A. PEREZ (Wisconsin, University, Milwaukee) and O. D. I. NWOKAH (Purdue University, West Lafayette, IN) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 735-740. refs
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The problem of improving the performance of a gas turbine engine operating throughout the whole flight envelope in the presence of predominantly destructive dynamical interactions is addressed. The controller aimed for is decentralized, thus making the system tolerant to soft and/or hard failures and allowing the tuning of every loop separately. The control strategy consists of static compensators to minimize the interaction between loops, diagonal lead/lag for performance enhancement, and a diagonal prefilter for loop shaping. A significant performance improvement over previous control schemes is obtained. I.E.

A92-29356
THERMAL CONTROL FOR HYPERSONIC VEHICLE PROPULSION
JAMES M. KRAUSE, GARY L. HARTMANN (Honeywell Systems and Research Center, Minneapolis, MN), and GEORGE D. IANCULESCU (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2961-2966.
(Contract F33657-87-C-2214)
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A description is presented of some of the key features and conclusions of a preliminary thermal control system design for the National Aero-Space Plane (NASP). The cooling of the airframe and propulsion system is achieved by pumping cold fuel through a network of heat exchangers prior to combustion. Simultaneously, the controller must provide the proper total flow for thrust generation, and must optimize the turbomachinery operating point within the turbomachinery operating constraints. For this problem, it is found that efficient use of fuel cooling throughout the vehicle's operating envelope requires modulating the flow splits within the network as the flight condition changes. I.E.

A92-29375
MODEL DEVELOPMENT FOR ACTIVE SURGE CONTROL/ROTATING STALL AVOIDANCE IN AIRCRAFT GAS TURBINE ENGINES
K. M. EVEKER and C. N. NETT (Georgia Institute of Technology, Atlanta) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 3166-3172. Research supported by U.S. Navy, NSF, USAF, et al. refs
Copyright

The focus of this work is on the development of models for use in the design of active surge control/rotating stall avoidance systems in aircraft gas turbine engines. Model development is illustrated for the case of a single-speed, centrifugal compressor, turbojet engine currently housed within the LICCHUS experimental facility at the Georgia Institute of Technology. This engine is equipped with high bandwidth fuel flow, nozzle area, and compressor discharge bleed area servos. The model developed

for this engine is based on engine component steady state performance maps and unsteady quasi one-dimensional flow equations. The latter are rigorously developed. Special attention is paid to the assumptions underlying the model development, particularly those pertaining to the unsteady flow aspects of the model and its dynamic order. I.E.

A92-29376
AN INTEGRATED, FULL-RANGE SURGE CONTROL/ROTATING STALL AVOIDANCE COMPRESSOR CONTROL SYSTEM
O. O. BADMUS, C. N. NETT, and F. J. SCHORK (Georgia Institute of Technology, Atlanta) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 3173-3180. Research supported by U.S. Navy, NSF, and General Electric Co. refs
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An integrated compressor control scheme is presented which is capable of achieving simultaneous surge control and rotating stall avoidance over the full range of compressor operation. The approach adopted is based on a combination of closed-loop feedback and open-loop feedforward control of throttle valve area. The feedback control is based on a compressor mass flow measurement. The feedforward control is based on measurements of inlet and outlet pressure and temperature. Both the feedback and feedforward controller parameters are continuously scheduled as a function of nominal operating conditions. This approach achieves simultaneous surge control and rotating stall avoidance, over the full range of compressor operation. I.E.

A92-29709
CUSAE '91; PROCEEDINGS OF THE 1ST CHINA-USSR SEMINAR ON AERO ENGINES, NANJING, PEOPLE'S REPUBLIC OF CHINA, APR. 15-20, 1991
Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, 340 p. For individual items see A92-29710 to A92-29743.

The present conference discusses a novel approach to swirl control in an S-duct, spacecraft thermonuclear powerplants, the effects of freestream turbulence on cascade performance, heat-induced transient behaviors in axial compressors, a mathematical model of multiphase nonisothermal turbulent jets, and the thermal visualization of heat-transfer characteristics for a single impinging jet. Also discussed are carcinogenic hydrocarbon emissions from gas turbine engines, aviation-kerosene combustion in nonuniform airflow, model truncation errors in rotor system vibrational analyses, rotordynamic problems of small turbojets, and surge control based on fuel pulse cutoff in a dual-spool turbojet. O.C.

A92-29711
ON THE EXPERIMENTAL INVESTIGATION OF AIR-BREATHING ENGINE OF NEW SCHEMES
V. I. BAKULEV and I. V. KRAVCHENKO (Moskovskii Aviatsionnyi Institut, Moscow, Russia) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 15-22.

An evaluation is made of the configurational possibilities suggested by the availability of hydrogen fuel for aircraft propulsion systems exhibiting high specific thrust and low specific fuel consumption. The present investigation gives attention to unique characteristics of the thermodynamic cycle, control requirements, etc, of such powerplant configurations, as they would be scaled for very small applications. O.C.

A92-29717
EFFECTS OF BLEED AND POWER EXTRACTION ON THE OPERATING LINE OF ENGINES
FENG QI, TANG G. CAI, and YE P. LIANG (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 76-82.

In this work a general digital computer program is developed for calculating design and off-design performance for turbofan and turbojet engines. For a fictitious turbojet engine, given the characteristics of its components, the operating points were calculated under various kinds of bleed and power extraction. The numerical results show that with increasing bleed from the low pressure compressor, (1) the operating line of the low pressure compressor moves away from its surge-line, (2) the operating line of the high pressure compressor does not change (although the operating point changed) with increasing bleed from high pressure compressor, and (3) both operating lines of the low and high pressure compressors move away from their surge lines. Power extraction (if large enough) from high pressure spool leads to the shift of both operating lines toward surge lines. Author

A92-29718
INVESTIGATION AND APPLICATION OF COMPRESSOR LOADING TECHNIQUE
YE P. LIANG and LI J. YU (Gas Turbine Establishment, Sichuan, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 83-93. refs

An account is given of the results obtained by surge tests of a twin-shaft engine, using a fuel-step system derived from the engine's main fuel pump. Attention is given to the causes of divergent results between the engine compression system and separate tests of the compressor in isolation. The phenomena of severe overheating and overspeeding during fuel-stepping are discussed in light of both the present and previously reported test results. O.C.

A92-29721
HEAT INDUCED TRANSIENT BEHAVIOURS OF AXIAL COMPRESSORS
G. C. TANG, X. J. LI, and J. HU (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 112-121. refs

The present investigation of heat-induced transient behavior in axial compressors proceeds by defining a fluid-dynamics model and deriving governing equations, taking into account heat-energy effects on the response of the compressor. The numerical results obtained are indicative of general trends, as well of solutions for cases in which the initial operating point lies within the hysteresis region. It is found that there are two critical values of the nondimensional stability parameter: one for rotating stall, and the other for surge. O.C.

A92-29729
EXPERIMENTAL INVESTIGATION ON COMBUSTOR WITH DOUBLE CO-AXIAL SWIRLERS
QING-FAN ZHANG, QING-PING ZHENG, and BIAO ZHOU (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 202-212. refs

A combustor with double coaxial swirlers is an innovative gas turbine scheme. A six-orientation hot-wire probe technique was used to measure cold flow characteristics, and detailed information was obtained for various combinations of inner and outer swirler parameters. Results showed that the flowfield in the combustor was determined by swirl numbers of both swirlers, and counter-rotating between the two swirlers could produce a good flowfield for combustion. Fuel atomization at the trailing edge of venturi tube was also measured by a pulsed laser holographic system to obtain drop size and drop spatial distributions which are useful for combustor designer. Combustion tests showed that, for counter-rotating combustion, results could be significantly

improved by selecting a larger inner swirl number. The corner recirculation zone is beneficial in improving flame stability and fuel-lean limit. Author

A92-29731
SIMULATION OF VIBRATIONAL STATUS OF GAS-TURBINE ENGINE
V. SAMOKHIN and A. IVANOV (Moskovskii Aviatsionnyi Institut, Moscow, Russia) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 222-228. refs

Design-phase methodologies are presented for gas turbine engines. These mathematical models fall into three categories: (1) axisymmetric, considering such components as rotors, engine cases, and engine mounts; (2) anisotropic, involving the differences in rigidity and inertial characteristics of elements in mutually-perpendicular surfaces; and (3) nonaxisymmetric, taking into account those centers of dynamic bending that are not on the engine axis. Attention is given to the application of these three methods to specific engines and with varying degrees of accuracy. O.C.

A92-29733
CYCLIC SYMMETRIC CONTACT STRESS ANALYSIS OF AEROENGINE ROTOR ASSEMBLY
ZEYONG YIN, JINGXU NIE, BAIAN HU, XIANGLIN ZHANG, and BENGHAN DONG (Nanhua Powerplant Research Institute, Zhuzhou, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 238-247. refs

Photoelastic experiments and finite-element analyses have been conducted for several representative aircraft gas turbine assemblies, in order to ascertain the partially cyclic-symmetric characteristics of the displacement and stress field. A rotor assembly structure is then modeled on the basis of 20-node solid elements, 8-node shell elements, and 15-node solid-shell transient elements. Attention is given to the results obtained for a stress-analysis problem solved via this general-purpose finite-element stress-analysis program. O.C.

A92-29736
SOME ROTORDYNAMIC PROBLEMS IN SMALL TURBO-ENGINES
TAIPING HUANG (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 269-278. refs

Due to their exceptionally high rotational speeds, small turbine engines can incur severe rotordynamic problems. Analytical methods for the solution of such problems are presented and compared with both numerical and experimental results. Attention is given to behavior in the vicinity of critical speeds. The illustrative cases considered encompass (1) a turboshaft engine; (2) a combined, centrifugal compressor-plus-two-stage turbine turboshaft engine; (3) an axial compressor; and (4) a centrifugal compressor. O.C.

A92-29737
A STUDY OF SURGE CONTROL USING FUEL PULSE CUTOFF FOR DUAL SPOOL TURBO-JET ENGINE
JIAN-GUO SUN, SI-MING HU (Nanjing Aeronautical Institute, People's Republic of China), and CAI-HONG JIANG (Shenyang Aeroengine Research Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 281-290. refs

In the present dynamic model of a two-spool turbojet with poststall capability, unstalled compressor test data as well as performance estimates are employed. Results are presented for combustor flammability limits in both rich-blowout and lean-dieout conditions. Volume dynamics are characterized by means of conservation equations for fluid energy, mass, and momentum. The engine model incorporates the main control for fuel-flow metering; by these means, it has been possible to induce surge by opening the nozzle and main combustor fuel-step. Surge-operation computer simulations are performed for the case of a fuel pulse cutoff in two-spool turbojets. O.C.

A92-29739
INVESTIGATIONS OF THE LAWS OF SURGE AND ROTATING STALL FORECAST IN AERONAUTICAL ENGINE
ZHEN CHEN and HONGLI YANG (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 297-304. refs

Aircraft gas turbine compressor surge and rotating stall prediction are presently discussed in the framework of two nonlinear models, for the case where the compressor-inlet flowfield is steady. Two prediction methods are developed, respectively based on the engine's inlet-temperature rate change and the relative pressure change rate of the compressor exit. The effects of distortion amplitude must be taken into account. Computer predictions using the present methodologies employ an adaptive-recursion algorithm. O.C.

A92-29740
REAL-TIME SIMULATION AND ADAPTIVE PID CONTROL OF QSK-06A CONTROL FOR GAS TURBINE
SHAOJI ZHANG (Shenyang Aeroengine Research Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 305-314. refs

The QSK-06A full-authority digital engine control (FADEC) system's real-time simulation has been conducted on a test rig in order to validate both its hardware and its software. The results obtained show this simulation scheme, which employed two microcomputers, to be feasible and to yield the FADEC system's static performance and dynamic response in real time. An adaptive/variable-gain PID control renders the FADEC system's performance superior to conventional PID control under varying engine operating conditions. O.C.

A92-29741
ELECTRONIC CONTROL OF A TURBINE POWER UNIT
DAOBO WANG (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 315-323. refs

In order to improve the reliability of a turbine power unit, its electronic controller employs three control loops operating in the 'bibackup' mode. This control methodology satisfies aeronautical application reliability requirements. The primary fuel control adopted a proportional-plus-integration strategy, as well as pulse-width modulation for the control valve. The parameters of the control-system reliability model were derived from experimental data. O.C.

A92-29742
AN INVESTIGATION OF REAL-TIME DIAGNOSTIC TECHNIQUE FOR DEEC SYSTEM
TZE-YUEN CHAO, JIAN-GUO MAO, HUA YAO, and JIN-RONG CHAO (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 324-330. refs

The present consideration of a digital electronic engine-control (DEEC) system's real-time diagnostics for the estimation of engine performance and electronic system status gives attention to the

establishment of a hardware system, the simplification of the engine mathematical model for diagnostics, and the details of the diagnoses. The hardware takes the form of a full-authority, two-channel system with selective redundancy. The 286-microprocessor-based diagnostic system is linked to several interface modules via serial communications interface. O.C.

A92-29743
ON MODELLING OF AERO-GAS TURBINE ENGINE FOR REAL-TIME DIGITAL SIMULATOR
YAN-SHEN GUAN and TZE KUO (Northwestern Polytechnical University, Xian, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 331-340. refs

A multifunctional and nonlinear aerothermal engine model for real-time digital simulation of an aircraft gas turbine control system is presently implemented in a real-time simulator by means of a parallel microcomputer. Transients of a two-spool reheated turbojet are computed via 0.03-0.05 sec/time-step of computation time. Attention is given to the results obtained for both open-loop and closed-loop engine cases at sea-level conditions. O.C.

A92-29944#
POWER BEAMING - ENERGY TRANSMISSION AT 35 GHZ AND HIGHER FREQUENCIES
MARK H. MACHINA, PETER KOERT, and JAMES T. CHA (Arco Power Technologies, Inc., Washington, DC) IN: AIAA International Communication Satellite Systems Conference and Exhibit, 14th, Washington, DC, Mar. 22-26, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1671-1674. refs
(AIAA PAPER 92-2027) Copyright

A program to develop a microwave power beaming system at 35 GHz and higher frequencies is briefly discussed. An illustrative microwave powered aircraft system including a power system and a high-altitude platform is described. The power system consists of a ground station with a high-power RF source and a prime power source, high gain antenna to beam the power, C3 system to control and platform and process the collected data, and rectenna integrated into the aircraft. The platform is an aircraft planned as a composite structure with aspect ratio of about 17:1. Power requirements on the platform vary with mission. Altitude and payload weight are the principle drivers in the platform design, with an estimated 30-100 kW required for high-altitude missions for payloads of 50-100 kg. C.D.

A92-29973
THE EFFECT OF AIR-COMPRESSOR ADJUSTMENT BY MEANS OF AIR-BLEED ON THE RESERVE OF ITS STABLE OPERATION [WPLYW REGULACJI SPREZARKI UPUSTEM POWIETRZA NA ZAPAS STATECZNEJ PRACY]
MAREK ORKISZ (Wyzsza Oficerska Szkola Lotnicza, Deblin, Poland) Rozprawy Inzynierskie (ISSN 0035-9408), vol. 38, no. 3-4, 1990, p. 397-404. In Polish. refs
Copyright

An analysis of the effect of air-compressor adjustment by means of air-bleed on the reserve of its stable operation is presented. The influence of the amount of bled air on the line position of the joint operation of a turbine and compressor in steady-state conditions is evaluated. P.D.

A92-30133
PROBLEMS OF STRENGTH AND AEROELASTICITY OF PRESENT-DAY PROPFANS [PROBLEMY PROCHNOSTI I AEROUPRUGOSTI SOVREMENNYKH VINTOVENTILIATOROV /VV/]
B. B. MARTYNOV and G. M. FOMIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 71-81. In Russian. refs
Copyright

The design characteristics of the propfan-engine (PFE) are formulated and compared with those of traditional propellers, showing their substantial differences with respect to geometry, structural materials, and load levels. Special attention is given to the aeroelasticity problems of PFEs, the various types of the flutter phenomenon specific to PFEs, and to the principles involved in simulating the dynamic PFE processes and in designing dynamically scaled PFE models with the use of composite materials. I.S.

A92-30381
RESTORATION OF AIRCRAFT ENGINE NOZZLE BLOCK BLADES BY VACUUM ARC BRAZING WITH CONTROLLED CURRENT [VOSSTANOVLENIE LOPATOK SOPLOVOGO APPARATA AVIATSIONNYKH DVIGATELEI DUGOVOI PAIKOI V VAKUUME S PROGRAMMNYM REGULIROVANIEM TOKA]
V. M. VOROB'EV Moskovskii Gosudarstvennyi Tekhnicheskii Universitet, Vestnik, Seriia Mashinostroenie (ISSN 0236-3941), Oct.-Dec. 1990, p. 97-101. In Russian. refs
Copyright

The technology of vacuum arc brazing with current controlled according to a specified program is described, and its application to the restoration of engine nozzle block blades is considered. Results of a study of the effects of discharge-current variations on the formation of the joint and the macrostructure of the weld seam are presented. L.M.

A92-31660#
A PARAMETRIC STUDY OF AIRBREATHING PULSED DETONATION ENGINE
S. EIDELMAN, I. LOTTATI, and W. GROSSMANN (Science Applications International Corp., McLean, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(AIAA PAPER 92-0392) Copyright

The airbreathing Pulsed Detonation Engine (PDE) is analyzed by direct simulations of its cycle using CFD. A CFD methodology of composite structure/unstructured grids is described which is used for detailed analysis of tne PDE performance. This performance is analyzed for a unique engine geometry in which the PDE is located in a wing section. Examination of the key processes in the PDE device shows that the largest portion of its thrust is produced during the very short time interval when the detonation wave reflects from the thrust wall, and that detonation cycle frequency up to 200 Hz is feasible. The PDE-type devices can compete with small diameter turbojet engines in performance characteristics while surpassing them in simplicity of design, flexibility of geometrical configuration, and price. Author

A92-31683#
FRENCH RESEARCH AND TECHNOLOGY PROGRAM ON ADVANCED HYPERSONIC PROPULSION
BRUNO DEBOUT (DGA, Service Technique des Programmes Aeronautiques, Paris, France) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 6 p. Research supported by DGA, Ministere de la Recherche et de la Technologie, and CNES.
(AIAA PAPER 91-5003) Copyright

A development history and development status evaluation is presented for French R&D efforts toward airbreathing hypersonic propulsion systems for manned vehicles, including single-stage-to-orbit, integrated-scramjet launch vehicles such as the STAR-H and STS 2000. Attention is given to initial French developmental testing of the Griffon ramjet-powered experimental fighter, the investigation of airframe-propulsion integration, the development of actively cooled structures, and possible structural organization schemes for further work. O.C.

A92-31685#
DESIGN CONSIDERATIONS FOR NOZZLES OF HYPERSONIC AIRBREATHING PROPULSION
W. KOSCHEL and W. RICK (Aachen, Rheinisch-Westfaelische Technische Hochschule, Federal Republic of Germany) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 14 p. Research supported by MTU Motoren- und

Turbinen-Union Muenchen GmbH. refs
(Contract DFG-SFB-253)
(AIAA PAPER 91-5019) Copyright

A numerical study has been made with the goal to compare the performance of SERN-type nozzles and plug nozzles in regard to applications for hypersonic airbreathing propulsion. An explicit Taylor-Galerkin FEM algorithm is used for the solution of 2D/3D-Euler/Navier-Stokes equations applied to the computation of the expansion flow in the nozzles. External flow conditions are taken into account. A detailed analysis in regions with complex flow conditions has been performed utilizing unstructured computational grids with adaptive mesh refinement. The results for the different nozzle investigations are presented and discussed for design and off-design conditions with special emphasis on the transonic flight regime. Author

A92-31689#
A COMPUTATIONAL EXPLORATION OF THE IMPORTANCE OF THREE-DIMENSIONALITY, BOUNDARY LAYER DEVELOPMENT, AND FLOW CHEMISTRY TO THE PREDICTION OF SCRAMJET NOZZLE PERFORMANCE
M. A. PIERCE and W. L. ELY (McDonnell Aircraft Co., Saint Louis, MO) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 10 p. refs
(Contract F33615-86-C-3602)
(AIAA PAPER 91-5059) Copyright

Three-dimensional expansion, boundary layer build-up, and flow chemistry are examined for a variety of scramjet nozzles to identify which of these phenomena are essential to the prediction of nozzle force and moment. It is shown that normal force and pitching moment predictions are strongly affected by 3D expansion and boundary layer displacement effects. Thrust is less sensitive to the external lateral expansion, while being significantly reduced by shear stresses along the nozzle walls. Flow chemistry effects are found to be smaller than other phenomena under consideration. A good approximation to the finite-rate results have been obtained through constant ratio of specific heats solutions at greatly reduced computational expense. Results suggest that the 3D and viscous characteristics of the flow must be taken into account to obtain satisfactory predictions of net nozzle force and moment, while flow chemistry may be modeled using a constant ratio of specific heats formulation. O.G.

A92-31696#
WIDE-RANGE COMBUSTION CHAMBER OF RAMJET
S. I. BARANOVSKII and V. M. LEVIN (Moskovskii Aviatsionnyi Institut, Moscow, Russia) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 3 p. refs
(AIAA PAPER 91-5094) Copyright

The development and testing of a ramjet wide-range combustion chamber is described with attention given to the optimization of the mixture-formation system. Structures called micropylons are introduced into the flow to generate small disturbances that enhance the uniformity of fuel distribution. The ramjet has a short combustion chamber with an optimized shape, and the experimental results indicate that the thermal intensity in the combustion chamber can be maximized by enhancing fuel combustion efficiency and minimizing chamber length. C.C.S.

A92-31700#
ISSUES ASSOCIATED WITH LONG DURATION HIGH ENTHALPY SCRAMJET COMBUSTOR TESTING
(Previously cited in issue 05, p. 678, Accession no. A92-17862)
3rd, Orlando, FL, Dec. 3-5, 1991. 10 p.
Copyright

A92-32296
RUSSIANS WANT U.S. TO JOIN SCRAMJET TESTS
STANLEY W. KANDEBO Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, March 30, 1992, p. 18-20.
Copyright

U.S. collaboration on the Russian test flight of a subscale axisymmetric ramjet/scramjet (RS) is reported with attention given to the RS's potential for supersonic combustion in flight. The RS is described in terms of its potential applications and technological benefits, and the participation by the U.S. government is concluded to be a result of waning Russian funds for aerospace activities. The test apparatus and the RS are described in detail, and further cooperation with the U.S. is expected for the testing of the RS in a large rocket which could reach about Mach 10. C.C.S.

A92-32297
GE, SNECMA CONSIDER VENTURE TO DEVELOP UPRATED PERM PS-90
Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, March 30, 1992, p. 40, 41.
Copyright

The potential development of an uprated version of the Russian design bureau Perm's PS-90A turbofan engine is reported, and three development philosophies are compared. An intermediate solution is emphasized in which the engine's fan and booster would be made more efficient and the power-plant's turbine-inlet temperature would be reduced. The intermediate-solution uprated Perm PS-90 is expected to have a rating of about 17,000-18,000 kgf as opposed to the present 16,000 kgf. C.C.S.

A92-32298
RUSSIANS SAY D-30F6 ENGINE USED IN MIG-31 IS HIGHLY RELIABLE
STANLEY W. KANDEBO Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, March 30, 1992, p. 42, 43.
Copyright

The Russian MiG-31 D-30F6 engine is described in terms of its performance and longevity with attention given to the opinion of engine specialists comparing the engine to those of western military aircraft. The engine is compared in the description to 'an early 1970s engine' with full-authority digital engine control and a flight data-recording system. Russians contend that the engine can be modified to meet western reliability standards, but western experts say that in spite of the durability of some components the D-30F6 cannot meet western longevity requirements. C.C.S.

A92-32299
SATURN/LYULKA DIVERSIFIES BUSINESS TO COPE WITH RUSSIAN ECONOMIC CRISIS
Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, March 30, 1992, p. 44-46.
Copyright

The business strategy of the Russian design bureau Saturn/Lyulka is described including diversification into areas not directly related to the aerospace and participation in civil/commercial aviation projects. The development of turboprop/turboshaft engines is discussed with attention given to a lightweight heat exchanger designed for the engines. The bureau plans to incorporate full-authority digital engine control into naval engines and to develop a supersonic engine for commercial jets. C.C.S.

A92-32300
RUSSIA BIDS TO SALVAGE DEVELOPMENT OF SOYUZ-POWERED VTOL FIGHTER
STANLEY W. KANDEBO Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, March 30, 1992, p. 47, 48.
Copyright

This paper describes the Russian Yakovlev Yak-141 supersonic VTOL fighter aircraft, the development problems related to the aircraft, and the attempted sale of the fighter to the Indian navy. The fighter is powered by the Soyuz R79 engine which incorporates a fixed nonarticulating version of an axisymmetric thrust-vectoring nozzle. Developmental requirements for the R79 are found to be minimal, but the need for ground tests of a fully articulated nozzle is identified. C.C.S.

N92-20179# Rolls-Royce Ltd., Derby (England).
USE OF CFD IN THE DESIGN OF A MODERN MULTISTAGE AERO ENGINE LP TURBINE DESIGN

C. T. J. SCRIVENER, C. F. CONNOLLY, J. C. COX, and G. M. DAILEY 1 Apr. 1991 11 p
(PNR-90862; ETN-92-90851) Copyright Avail: NTIS HC/MF A03

Modern civil aeroengines require turbomachinery components of the highest possible efficiency. Furthermore the blading must be simultaneously designed for minimum cost and weight whilst remaining consistent with the highest possible durability. Satisfying all these requirements culminates in a component offering a competitive advantage to the customer. The role of three dimensional viscous computational fluid dynamics methods in the design of a modern multistage LP turbine is described. These methods have now advanced to the state where they can be used during the design iteration to determine the aerofoil geometry. Technical issues addressed by these methods include separation bubbles, aerofoil stack and lean for optimum performance, flow deviation, incidence sensitivity and the control of secondary flows. ESA

N92-20196*# Toledo Univ., OH. Dept. of Chemical Engineering.
COMPUTER CODE FOR PRELIMINARY SIZING ANALYSIS OF AXIAL-FLOW TURBINES Final Report
ARTHUR J. GLASSMAN Washington NASA. Lewis Research Center Feb. 1992 17 p
(Contract NAG3-1165)
(NASA-CR-4430; E-6150; NAS 1.26:4430) Avail: NTIS HC/MF A03 CSCL 21E

This mean diameter flow analysis uses a stage average velocity diagram as the basis for the computational efficiency. Input design requirements include power or pressure ratio, flow rate, temperature, pressure, and rotative speed. Turbine designs are generated for any specified number of stages and for any of three types of velocity diagrams (symmetrical, zero exit swirl, or impulse) or for any specified stage swirl split. Exit turning vanes can be included in the design. The program output includes inlet and exit annulus dimensions, exit temperature and pressure, total and static efficiencies, flow angles, and last stage absolute and relative Mach numbers. An analysis is presented along with a description of the computer program input and output with sample cases. The analysis and code presented herein are modifications of those described in NASA-TN-D-6702. These modifications improve modeling rigor and extend code applicability. Author

N92-20436# Rolls-Royce Ltd., Colne (England).
SUPERPLASTIC APPLICATIONS IN AERO ENGINES
J. O. FOWLER 12 Nov. 1990 4 p
(PNR-90788; ETN-92-90842) Copyright Avail: NTIS HC/MF A01

Superplastic Forming with Diffusion Bonding (SPF/DB) and/or without diffusion bonding (SPF) are identified as cost and weight effective methods of manufacture for critical rotating parts and static structural components in aeroengines. The basic benefits are well known and include: reduced manufacturing cost; reductions in part weight; short manufacturing lead times; reduced skilled labour content; improved material utilization; elimination of fasteners; stiff structures; design flexibility; complex shapes; high automation potential. In an environment where the price of the product is fixed by the market against a background of intense competitive pressure, manufacturing techniques must be introduced that increases the price/cost ratio and increases the number of engines sold. SPF and SPF/DB contribute in both areas due to reduced manufacturing cost and an improvement in engine performance. ESA

N92-20459# Rolls-Royce Ltd., Derby (England). Airworthiness Services Div.
ETOPS: A DEVELOPING SCENE
D. W. ALLARD 17 Apr. 1991 18 p
(PNR-90844; ETN-92-90794) Copyright Avail: NTIS HC/MF A03

Extended Range Twin Engine Operations (ETOPS) is concerned with the operations of twin-engine commercial transport aircraft that are more than 60 minutes of single engine flying time from a suitable airfield. The history of ETOPS is traced; the current scene is described; and the next stage in the development of ETOPS is investigated. Bias is given towards engine/powerplant reliability in the ETOPS scenario, although, it is recognized that the reliability of the total aircraft system must be considered. ESA

N92-20460# Rolls-Royce Ltd., Bristol (England).
THE 60 YEARS OF BRISTOL ENGINES
G. M. LEWIS 1 Nov. 1990 19 p
(PNR-90845; ETN-92-90795) Copyright Avail: NTIS HC/MF A03

Some of the most significant engineering achievements and historical events that have shaped the Bristol engine factory as it is known today are discussed. A tribute is paid to the late Sir Roy Fedden. Additionally, developments over the last 60 years are outlined. ESA

N92-20523*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PERFORMANCE TESTS OF A CRYOGENIC HYBRID MAGNETIC BEARING FOR TURBOPUMPS
ELISEO DIRUSSO and GERALD V. BROWN 1992 14 p Proposed for presentation at the Third International Symposium on Magnetic Bearings, Alexandria, VA, 29-31 Jul. 1992
(NASA-TM-105627; E-6775; NAS 1.15:105627) Avail: NTIS HC/MF A03 CSCL 21/5

Experiments were performed on a Hybrid Magnetic Bearing designed for cryogenic applications such as turbopumps. This bearing is considerably smaller and lighter than conventional magnetic bearings and is more efficient because it uses a permanent magnet to provide a bias flux. The tests were performed in a test rig that used liquid nitrogen to simulate cryogenic turbopump temperatures. The bearing was tested at room temperature and at liquid nitrogen temperature (-320 F). The maximum speed for the test rig was 14000 rpm. For a magnetic bearing stiffness of 20000 lb/in, the flexible rotor had two critical speeds. A static (nonrotating) bearing stiffness of 85000 lb/in was achieved. Magnetic bearing stiffness, permanent magnet stiffness, actuator gain, and actuator force interaction between two axes were evaluated, and controller/power amplifier characteristics were determined. The tests revealed that it is feasible to use this bearing in the cryogenic environment and to control the rotor dynamics of flexible rotors when passing through bending critical speeds. The tests also revealed that more effort should be placed on enhancing the controller to achieve higher bearing stiffness and on developing displacement sensors that reduce drift caused by temperature and reduce sensor electrical noise. Author

N92-20525*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF A STEADY POTENTIAL SOLVER FOR USE WITH LINEARIZED, UNSTEADY AERODYNAMIC ANALYSES
DANIEL HOYNIAK and JOSEPH M. VERDON (United Technologies Research Center, East Hartford, CT.) 1991 14 p Presented at the Sixth International Symposium on Unsteady Aerodynamics, Aeroacoustics, and Aeroelasticity of Turbomachines and Propellers, Notre Dame, IN, 15-19 Sep. 1991; sponsored by the International Union for Theoretical and Applied Mechanics
(NASA-TM-105288; E-6620; NAS 1.15:105288) Avail: NTIS HC/MF A03 CSCL 21/5

A full potential steady flow solver (SFLOW) developed explicitly for use with an inviscid unsteady aerodynamic analysis (LINFLO) is described. The steady solver uses the nonconservative form of the nonlinear potential flow equations together with an implicit, least squares, finite difference approximation to solve for the steady flow field. The difference equations were developed on a composite mesh which consists of a C grid embedded in a rectilinear (H grid) cascade mesh. The composite mesh is capable of resolving blade to blade and far field phenomena on the H grid, while accurately resolving local phenomena on the C grid. The resulting system of algebraic equations is arranged in matrix form using a

sparse matrix package and solved by Newton's method. Steady and unsteady results are presented for two cascade configurations: a high speed compressor and a turbine with high exit Mach number. Author

N92-20573# Rolls-Royce Ltd., Leavesden (England).
APPLICATION OF A WATER DROPLET TRAJECTORY PREDICTION CODE TO THE DESIGN OF INLET PARTICLE SEPARATOR ANTI-ICING SYSTEMS
D. L. MANN and S. C. TAN (Cranfield Inst. of Tech., Bedford, England) 1 Nov. 1990 11 p Sponsored in part by Ministry of Defence
(PNR-90839; ETN-92-90792) Copyright Avail: NTIS HC/MF A03

A dust particle trajectory code is considered. Recent work on the code is described. This includes an ice accretion prediction model suitable for use as a design aid for a wide variety of gas turbine engine inlets, but particularly for particle separator geometries. The calculation of the local heat transfer coefficient is seen to be critical to the success of the ice accretion prediction. The incorporation of a suitable model is described and it is shown that a series of validation tests, carried out on a full scale rig satisfactorily verified the code. A second series of validation experiments, carried out in an icing facility, further shows the prediction model to be appropriate. ESA

N92-20650*# Sverdrup Technology, Inc., Brook Park, OH.
ROTARY ENGINE PERFORMANCE LIMITS PREDICTED BY A ZERO-DIMENSIONAL MODEL
TIMOTHY A. BARTRAND and EDWARD A. WILLIS Mar. 1992 19 p Presented at the International Congress and Exposition, Detroit, MI, 24-28 Feb. 1992; sponsored in part by Society of Automotive Engineers
(Contract NAS3-25945)
(NASA-CR-189129; E-6880; NAS 1.26:189129) Avail: NTIS HC/MF A03 CSCL 21/5

A parametric study was performed to determine the performance limits of a rotary combustion engine. This study shows how well increasing the combustion rate, insulating, and turbocharging increase brake power and decrease fuel consumption. Several generalizations can be made from the findings. First, it was shown that the fastest combustion rate is not necessarily the best combustion rate. Second, several engine insulation schemes were employed for a turbocharged engine. Performance improved only for a highly insulated engine. Finally, the variability of turbocompounding and the influence of exhaust port shape were calculated. Rotary engines performance was predicted by an improved zero-dimensional computer model based on a model developed at the Massachusetts Institute of Technology in the 1980's. Independent variables in the study include turbocharging, manifold pressures, wall thermal properties, leakage area, and exhaust port geometry. Additions to the computer programs since its results were last published include turbocharging, manifold modeling, and improved friction power loss calculation. The baseline engine for this study is a single rotor 650 cc direct-injection stratified-charge engine with aluminum housings and a stainless steel rotor. Engine maps are provided for the baseline and turbocharged versions of the engine. Author

N92-21519*# General Applied Science Labs., Inc., Ronkonkoma, NY.
PIONEERING SCRAMJET DEVELOPMENTS BY ANTONIO FERRI
JOHN I. ERDOS and LOUIS M. NUCCI *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 10 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

The concept is summarized of a diffusive burning supersonic combustion ramjet engine (scramjet) envisioned by Antonio Ferri and some of the salient technologies are highlighted as developed by General Applied Science Labs, PIBAL, and NYU, under his direction. Author

N92-21520*# Wright Research Development Center, Wright-Patterson AFB, OH.
ADVANCED RAMJET CONCEPTS PROGRAM
J. L. LEINGANG *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 9 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

Uniquely advantageous features, on both the performance and weight sides of the ledger, can be achieved through synergistic design integration of airbreathing and rocket technologies in the development of advanced orbital space transport propulsion systems of the combined cycle type. In the context of well understood advanced airbreathing and liquid rocket propulsion principles and practices, this precept of synergism is advanced mainly through six rather specific examples. These range from the detailed component level to the overall vehicle system level as follows: using jet compression; achieving a high area ratio rocket nozzle; ameliorating gas generator cycle rocket system deficiencies; using the in-duct special rocket thrust chamber assembly as the principal scramjet fuel injection operation; using the unstowed, covered fan as a duct closure for effecting high area ratio rocket mode operation; and creating a unique airbreathing rocket system via the onboard, cryogenic hydrogen induced air liquefaction process. Author

N92-21521*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE NASA HYPERSONIC RESEARCH ENGINE PROGRAM
KENNEDY F. RUBERT and HENRY J. LOPEZ (Allied-Signal Aerospace Co., Torrance, CA.) *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 9 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

An overview is provided of the NASA Hypersonic Research Engine Program. The engine concept is described which was evolved, and the accomplishments of the program are summarized. The program was undertaken as an in-depth program of hypersonic airbreathing propulsion research to provide essential inputs to future prototype engine development and decision making. An airbreathing liquid hydrogen fueled research oriented scramjet was to be developed to certain performance goals. The work was many faceted, required aerodynamic design evaluation, structures development, and development of flight systems such as the fuel and control system, but the main objective was the study of the internal aerothermodynamics of the propulsion system. Author

N92-21522*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HYPERSONIC AIRBREATHING PROPULSION/AIRFRAME INTEGRATION
JOHN P. WEIDNER *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Turorial Session 6 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

Recent interest in airbreathing hypersonic flight has centered around the need to develop advanced space launch systems which can reduce the cost of inserting payloads in orbit and make space more accessible. An effect of the thermal environment is to require the vehicle to operate at high altitudes, in very thin air, to maintain aircraft structural load limits. The high altitudes at which the hypersonic vehicle must operate give rise to the concept of an airframe integrated propulsion system to provide a much larger inlet and nozzle to process the required volume of air at low density, atmospheric conditions. In the integrated system, the forward portion of the vehicle compresses the air flow and serves as the external portion of the inlet; the aftbody completes the expansion process for the nozzle. In addition, the engine, which is contained between the body and the forebody shock wave, lends itself to a modular integration of a number of separate engines. In this manner, a relatively small engine can be defined to allow engine development in existing ground facilities. Author

N92-21523*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AIRBREATHING COMBINED CYCLE ENGINE SYSTEMS
JOHN ROHDE *In its* Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 9 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

The Air Force and NASA share a common interest in developing advanced propulsion systems for commercial and military aerospace vehicles which require efficient acceleration and cruise operation in the Mach 4 to 6 flight regime. The principle engine of interest is the turboramjet; however, other combined cycles such as the turboscramjet, air turborocket, supercharged ejector ramjet, ejector ramjet, and air liquefaction based propulsion are also of interest. Over the past months careful planning and program implementation have resulted in a number of development efforts that will lead to a broad technology base for those combined cycle propulsion systems. Individual development programs are underway in thermal management, controls materials, endothermic hydrocarbon fuels, air intake systems, nozzle exhaust systems, gas turbines and ramjet ramburners. Author

N92-21527*# Marquardt Corp., Van Nuys, CA.
SUPERCHARGED EJECTOR RAMJET
JERRY ROSEVEAR *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Turorial Session 8 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

The Supercharged Ejector Ramjet (SERJ) engine is a highly flexible and promising composite propulsion system offering significant payoffs in high performance vehicle systems. Its basic subsystems such as fan, ejector, and ramjet have been experimentally demonstrated. These components have also been integrated into engine demonstrators and tested in Marquardt Cell 2 facilities. It is recommended that Marquardt's past SERJ related test data and studies be reviewed and updated by incorporating state-of-the art technologies. Author

N92-21529*# Allied-Signal Aerospace Co., Torrance, CA.
H2-FUELED HIGH-BYPASS TURBOFAN
J. C. RIPLE *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 11 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

The study developed preliminary design concepts for the exploitation of the properties of LH2 in a turbofan engine intended for air transport use, and showed the benefits which accrue in reduction of aircraf direct operating cost. Design concepts for the engine fuel delivery and control system, including the engine high pressure fuel pump, were developed, and general concept feasibility was shown. For both the engine and the fuel delivery and control system, recommendations were made for the advanced development which is necessary to bring the technology to a state of readiness for design application. The study was of necessity abbreviated in nature: more intensive study of both the engine and fuel delivery and control system is recommended. K.S.

N92-21531*# Marquardt Corp., Van Nuys, CA.
H2 FUELED FLIGHTWEIGHT RAMJET CONSTRUCTION AND TEST
ALBERT MALEK *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 11 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

The ACES Program began the investigation of regeneratively cooled ramjet engines for propelling aircraft at Mach 6 to 8 flight regimes while collecting and processing air for later use as oxidizer in rocket propulsion into an orbit flight mode. The Marquardt Company had as its prime task the design and demonstration of a ramjet capable of steady state operating using hydrogen as the regenerative coolant and with fuel flow limited to a theta = 1. Marquardt progressed from shell type combustors to advanced tubular combustion chambers in direct connect test rigs. The first tests were made with water cooled center bodies and plug nozzles using a pebble bed air heater to simulate flight air temperature. Later tests were made on completely H2 cooled flight weight V/G assemblies direct connected to a SUE burner heater. Design studies were also conducted on integrated systems for take-off capability using offset turbojets connected to 2-D or axisymmetric inlets. An 18 inch hypersonic ramjet evaluation scale model was designed based on the hot test results using a fully V/G inlet and exit nozzle. This thruster would provide 25000 lbs. of thrust with an estimated weight of 250 lbs. A V/G inlet would also incorporate an inlet seal for possible take-off thrust by rocket operation. Hypersonic ramjet construction features and chamber thrust development are discussed. K.S.

N92-21532*# Wright Research Development Center, Wright-Patterson AFB, OH.
SCRAMJET ANALYSIS, TESTING
J. L. LEINGANG and F. D. STULL *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 8 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

A survey of supersonic combustion ramjet (scramjet) engine development in the US covers development of this unique engine cycle from its inception in the early 1960's through the various programs currently being pursued and, in some instances, describing the future direction of the programs. These include developmental efforts supported by the US Navy, NASA, and US Air Force. Results of inlet, combustor, and nozzle component tests, free-jet engine tests, analytical techniques developed to analyze and predict component and engine performance, and flight-weight hardware development are presented. These results show that efficient scramjet propulsion is attainable in a variety of flight configurations with a variety of fuels. Since the scramjet is the most efficient engine cycle for hypersonic flight within the atmosphere, it should be given serious consideration in future propulsion schemes. Author

N92-21533*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
SYSTEM CONTROLS CHALLENGES OF HYPERSONIC COMBINED-CYCLE ENGINE POWERED VEHICLES
RUSSELL H. MORRISON and GEORGE D. IANCULESCU *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 8 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

Hypersonic aircraft with air-breathing engines have been described as the most complex and challenging air/space vehicle designs ever attempted. This is particularly true for aircraft designed to accelerate to orbital velocities. The propulsion system for the National Aerospace Plane will be an active factor in maintaining the aircraft on course. Typically addressed are the difficulties with the aerodynamic vehicle design and development, materials limitations and propulsion performance. The propulsion control system requires equal materials limitations and propulsion performance. The propulsion control system requires equal concern. Far more important than merely a subset of propulsion performance, the propulsion control system resides at the crossroads of trajectory optimization, engine static performance, and vehicle-engine configuration optimization. To date, solutions at these crossroads are multidisciplinary and generally lag behind the broader performance issues. Just how daunting these demands will be is suggested. A somewhat simplified treatment of the behavioral characteristics of hypersonic aircraft and the issues associated with their air-breathing propulsion control system design are presented. K.S.

N92-21534*# National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH.
NASP X-30 PROPULSION TECHNOLOGY STATUS
WILLIAM E. POWELL *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 8 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

The performance goals of the NASP program require an aero-propulsion system with a high effective specific impulse. In order to achieve these goals, the high potential performance of air-breathing engines must be achieved over a very wide Mach number operating range. This, in turn, demands high component performance and involves many important technical issues which must be resolved. Scramjet Propulsion Technology is divided into five major areas: (1) inlets, (2) combustors, (3) nozzles, (4) component integration, and (5) test facilities. A status report covering the five areas is presented. D.R.D.

N92-21535*# National Aeronautics and Space Administration, Washington, DC.
NASA'S HYPERSONIC PROPULSION PROGRAM: HISTORY AND DIRECTION
STEVE WANDER *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 15 p 1992
Avail: NTIS HC/MF A12 CSCL 21/5

Research into hypersonic propulsion; i.e., supersonic combustion, was seriously initiated at the Langley Research Center in the 1960's with the Hypersonic Research Engine (HRE) project. This project was designed to demonstrate supersonic combustion within the context of an engine module consisting of an inlet, combustor, and nozzle. In addition, the HRE utilized both subsonic and supersonic combustion (dual-mode) to demonstrate smooth operation over a Mach 4 to 7 speed range. The propulsion program thus concentrated on fundamental supersonic combustion studies and free jet propulsion tests for the three dimensional fixed geometry engine design to demonstrate inlet and combustor integration and installed performance potential. The developmental history of the program is presented. Additionally, the HRE program's effect on the current state of hypersonic propulsion is discussed. D.R.D.

N92-21740# Rolls-Royce Ltd., Derby (England). Combustion Dept.
EMISSIONS FROM AIRCRAFT: STANDARDS AND POTENTIAL FOR IMPROVEMENT
D. M. SNAPE and M. T. METCALFE 1 Aug. 1990 11 p Presented at the International Symposium on Freight Transport and Environment, Schereningen, Fed. Republic of Germany, 3-5 Jul. 1990
(PNR-90768; ETN-92-90760) Copyright Avail: NTIS HC/MF A03

Types of exhaust emissions produced by aircraft gas turbine engines are considered and an attempt to put these into context in both global and local airport terms with particular emphasis on freight transport is made. The basic operation of the gas turbine combustor and the need to maintain a high standard of airworthiness is discussed and the various techniques which are used to bring about emissions reductions are described. This leads into consideration of the likely trends in emission from aircraft sources as air traffic growth occurs and discussion of the need for future technological development to bring out emissions reductions. The various levels and types of technology which are associated with differing emission reductions are considered. ESA

N92-21848# Rolls-Royce Ltd., Derby (England).
COMPRESSING THE COMPRESSOR
R. J. HILL, D. J. NICHOLAS, and H. TUBBS 1 Nov. 1990 22 p Presented at the Dr. D. M. Smith Memorial Lecture IMechE, 10 Apr. 1990
(PNR-90824; ETN-92-90786) Copyright Avail: NTIS HC/MF A03

The development of the axial flow compressor from its conception to how it is today is outlined giving special attention to aerodynamic developments, materials used and mechanical design. The use of computers to model the aerodynamics and mechanical behavior is discussed and future trends are considered. ESA

N92-21850# Rolls-Royce Ltd., Derby (England).
THE EVOLUTION OF THE BYPASS ENGINE
G. M. LEWIS 15 Nov. 1990 11 p
(PNR-90832; ETN-92-90788) Copyright Avail: NTIS HC/MF A03

The evolution of the bypass engine starting from Whittle's ducted fan patented in 1936 is described and illustrated. Throughout the evolution of the bypass engine, the basic principles and most of the relevant design configurations have been those which were established by the pioneers of jet propulsion. Progress in the civil field was contingent upon the advances in aerodynamic design to produce high efficiency single stage fans, high duty and hence short HP compressors, high temperature turbines and low drag nacelles and installations. These advances progressively reduced the mechanical design problems of concentric rotors, shafts and bearings, and enabled basically simple engines to be designed with acceptable mass. The development of fighter engines, although not directed specifically towards increased bypass ratio, contributed to the resources to evolve the advanced technologies required. Throughout the history of aviation the contribution of fighter engine development of the advance of civil engines has been evident and this will continue in the generation of advanced core technology. In the future the continuing divergence of design configuration between the civil and military engine will necessitate substantial research and development funding for the particular features of the new generation of civil engines. The future of world fuel prices and availability, and the economics of air transport systems will determine the level of investment and the pace of future progress towards the engine concepts that were identified about 40 years ago. ESA

08

AIRCRAFT STABILITY AND CONTROL

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

A92-29061
WASHOUT FILTERS IN THE BIFURCATION CONTROL OF HIGH ALPHA FLIGHT DYNAMICS
HSIEN-CHIARN LEE and EYAD H. ABED (Maryland, University, College Park) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 206-211. Research supported by TRW Foundation. refs
(Contract NSF ECS-86-57561; NSF CDR-88-03012; AF-AFOSR-90-0015)
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Washout filters are used in the design of stabilizing controllers for systems undergoing bifurcations. The advantages of using washout filters are demonstrated in the control of a high-angle-of-attack nonlinear aircraft model. By complementing the technique of Abed and Lee (1990) with washout filters for the control of F-8 high alpha dynamics, a fixed controller can be used through a range of flight conditions, without affecting the set of open-loop equilibria. The stability of the equilibrium of interest is significantly enhanced. I.E.

A92-29093* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INTEGRATED FLIGHT/PROPULSION CONTROL DESIGN FOR A STOVL AIRCRAFT USING H-INFINITY CONTROL DESIGN TECHNIQUES
SANJAY GARG and PETER J. OUZTS (NASA, Lewis Research Center, Cleveland, OH) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 568-576. Previously announced in STAR as N91-21140.

refs
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Results are presented from an application of H(infinity) control design methodology to a centralized integrated flight/propulsion control (IFPC) system design for a supersonic short take-off and vertical landing (STOVL) fighter aircraft in transition flight. The emphasis is on formulating the H(infinity) control design problem such that the resulting controller provides robustness to modeling uncertainties and model parameter variations with flight condition. Experience gained from a preliminary H(infinity)=based IFPC design study performed earlier is used as the base to formulate the robust H(infinity) control design problem and improve the previous design. Detailed evaluation results are presented for a reduced-order controller obtained from the improved H(infinity) control design showing that the control design meets the specified nominal performance objectives as well as provides stability robustness for variations in plant system dynamics with chnages in aircraft trim speed within the transition flight envelope. Author

A92-29094
MEETING VSTOL AIRCRAFT PERFORMANCE REQUIREMENTS USING SCHEDULED H(INFINITY) CONTROLLERS
R. A. HYDE and K. GLOVER (Cambridge, University, England) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 577-582. Research supported by SERC. refs
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Meeting required handling qualities for VSTOL aircraft using H(infinity) robust control design techniques is discussed. The key characteristic of VSTOL aircraft is widely varying dynamics across the flight envelope. The controller must not only have good robust stability to these changing dynamics, but also exhibit good robust performance so that handling qualities are met at all operating conditions. An approach for meeting these design aims is presented. The method consists of performing linear H(infinity)-optimal designs at a set of operating points, and then scheduling the controllers using linear interpolation of the gains. An exact observer representation of the controller is used to interpolate the gains. I.E.

A92-29102
ON THE ADAPTIVE CONTROL OF MISSILE AUTOPILOTS
P. BENDOTTI (Aerospatiale, Chatillon, France) and M. M'SAAD (Grenoble, Ecole Nationale Superieure d'Ingenieurs Electriciens, Saint-Martin-d'Heres, France) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 643-648. refs
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An adaptive control application involving a skid-to-turn missile is addressed. The yaw channel is adaptively controlled using control algorithms derived with the shift operator and delta operator, respectively. The latter is mainly motivated by its underlying numerical robustness which has been emphasized in Middleton and Goodwin (1987). In each case, the time domain performances and the stability margins are shown to demonstrate the adaptive control performances vis-a-vis that of the fixed parameter control. I.E.

A92-29115
DESIGN AND MODELING ISSUES FOR INTEGRATED AIRFRAME/PROPULSION CONTROL OF HYPERSONIC FLIGHT VEHICLES
DUANE MCRUER (Systems Technology, Inc., Hawthorne, CA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 729-734.
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An examination is made of the impact of vehicle and engine control factors on aircraft performance by examining some illustrative performance by examining some illustrative performance limit boundaries for a point mass vehicle, i.e., a vehicle without attitude dynamics. Some of the important aircraft, aircraft and engine modes, and dynamic characteristics which define the effective vehicle dynamics to be controlled are summarized. This constitutes an outline of possible major vehicle and engine dynamic control issues for hypersonic vehicles. One of these dynamic interactions is used to illustrate that flight options within the conventional performance boundaries can be quite limited. I.E.

A92-29117* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INTEGRATED FLIGHT/PROPULSION CONTROL SPECIFICATIONS FOR SYSTEMS WITH TWO-WAY COUPLING
STEPHEN M. ROCK (Stanford University, CA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 741-746. refs
(Contract NAG3-1177)
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A general technique for generating specifications for integrated flight propulsion control is extended to include systems with significant two-way coupling between the flight and propulsion systems. These specification define how the subsystems must perform within an integrated control system in order to assure that performance goals (specifically stability) are met when the subsystems are combined to form a closed-loop integrated system. Such specifications are useful for a large class of integrated control problems that are best approached in a partitioned or decentralized manner. An example demonstrating the application of these techniques to a simple helicopter problem is provided. I.E.

A92-29118* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
IMPAC - AN INTEGRATED METHODOLOGY FOR PROPULSION AND AIRFRAME CONTROL
SANJAY GARG, PETER J. OUZTS, CARL F. LORENZO, and DUANE L. MATTERN (NASA, Lewis Research Center, Cleveland, OH) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 747-754. Previously announced in STAR as N91-20122. refs
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The NASA Lewis Research Center approach to developing integrated flight propulsion control (IFPC) technologies is an in-house research program referred to as IMPAC-Integrated Methodology for Propulsion and Airframe Control. The goals of IMPAC are to develop a viable alternative to the existing integrated control design methodologies that will allow for improved system performance and simplicity of control law synthesis and implementation, and to demonstrate the applicability of the methodology to a supersonic STOVL fighter aircraft. An overview of IMPAC is presented, including a detailed discussion of the various important design and evaluation steps in the methodology. I.E.

A92-29119* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DECENTRALIZED HIERARCHICAL PARTITIONING OF CENTRALIZED INTEGRATED CONTROLLERS
PHILLIP SCHMIDT (Akron, University, OH) and SANJAY GARG (NASA, Lewis Research Center, Cleveland, OH) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 755-760. refs
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A framework for a decentralized hierarchical controller partitioning structure is developed. This structure allows for the design of separate airframe and propulsion controllers which, when assembled, will meet the overall design criterion for the integrated airframe/propulsion system. An algorithm based on parameter optimization of the state-space representation for the subsystem controllers is described. The algorithm is currently being applied to an integrated flight propulsion control design example. I.E.

A92-29120* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A FRAMEWORK FOR THE ANALYSIS OF AIRFRAME/ENGINE INTERACTIONS AND INTEGRATED FLIGHT/PROPULSION CONTROL
DAVID K. SCHMIDT and JOHN D. SCHIERMAN (Arizona State University, Tempe) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 761-766. refs
(Contract NAG3-998)
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Potential sources of airframe/engine interactions are explored for aircraft subject to the study of integrated flight/propulsion control. A quasi-linear framework for the analysis of these dynamical interactions between the airframe and engine systems is presented. This analysis can be used to quantify, in a meaningful way, the magnitude of the interactions between the airframe and engine systems, determine if these interactions are significant to warrant further consideration in the control law synthesis, and if so, what are the critical frequency ranges where problems may occur due to these interactions. Justification for the use of this method, along with the assumptions, conditions, and restrictions that apply are discussed. I.E.

A92-29124
FUZZY CONTROLLER DESIGN AND STABILITY ANALYSIS FOR AN AIRCRAFT MODEL
STEPHEN CHIU and SUJEET CHAND (Rockwell International Science Center, Thousand Oaks, CA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 821-826. refs
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A fuzzy roll controller design for Rockwell International's Advanced Technology Wing (ATW) aircraft model is described. The controller modulates six control surfaces on the ATW to achieve the desired roll rate while maintaining wing loads within safe bounds. The use of fuzzy control rules enabled highly flexible control behavior that operated the system closed to the constraint limits, thereby achieving excellent roll performance. A method is presented for stability analysis for fuzzy control systems based on partitioning the state space and applying a Liapunov stability criterion to the individual partitions. A subset of the control rules is analyzed using this method and shown to provide asymptotically stable control. I.E.

A92-29127
ROBUST CONTROL LAW DEVELOPMENT FOR A HYPERSONIC CRUISE AIRCRAFT
MARK R. ANDERSON, ABBAS EMAMI-NAEINI, and JAMES H. VINCENT (Systems Control Technology, Inc., Palo Alto, CA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 839-845. Research sponsored by USAF. refs
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A model-following design technique developed under a previous U.S. Air Force study has been cast into an H(infinity) synthesis framework. The design approach has the potential for direct design of control laws which feature both robust stability and performance. Two vehicles are being considered in the MAVRIC program: a fighter aircraft with enhanced maneuverability and a hypervelocity flight vehicle. Control law development for the hypersonic vehicle is discussed. I.E.

A92-29128
CONTROLLER DESIGN FOR THE F-14 PITCH AXIS CONTROL PROBLEM USING THE QUANTITATIVE FEEDBACK THEORY APPROACH
JIANN-SHIOU YANG (Minnesota, University, Duluth) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 846, 847. refs
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The controller design of the F-14 pitch axis control problem is examined. The system block diagram is modified by using two, instead of the original four, controllers. The quantitative feedback theory (QFT) is then used to design the robust controllers. Simulations show that the angle-of-attack and pitch rate step responses of the designed system under the linearized plant parameter variations satisfy the design specifications. I.E.

A92-29171
HOVER CONTROL OF A PVTOL USING NONLINEAR REGULATOR THEORY
J. ROLTGEN (McDonnell Douglas Missile Systems Co., Saint Louis, MO) and C. I. BYRNES (Washington University, Saint Louis, MO) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 2. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 1126-1130. Research supported by USAF and NSF. refs
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An approach to the problem of hover control is derived based on the nonlinear regulator theory. This general theory allows for more general tracking maneuvers in hover control, which is nominally a set-point control problem. However, hover control is treated as a special case. Although the theory used is an asymptotic and local one, simulations show excellent transient behavior for surprisingly large horizontal displacements. I.E.

A92-29188
ROBUST ADAPTIVE NONLINEAR CONTROL OF HIGH PERFORMANCE AIRCRAFT
SWAMINATHAN GOPALSWAMY and J. K. HEDRICK (California, University, Berkeley) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 2. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 1279-1284. refs
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A robust adaptive control law for multivariable nonlinear systems affine in the input was presented in the work of Gopalswamy and Hedrick (1990). All constant parameters that could be linearly parameterized in the input-output dynamic equation were adaptively estimated, and uncertainties in all the other terms were accounted for by appropriate choice of sliding gains. This adaptive control law is implemented in the control of the pitch axis dynamics of an AFTI-16, a high performance aircraft. The lift, drag, and moment coefficients corresponding to the control surfaces, the elevator, and the flaperons, are adaptively estimated. I.E.

A92-29330* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SYNTHESIS OF ROBUST NONLINEAR AUTOPILOTS USING DIFFERENTIAL GAME THEORY
P. K. A. MENON (NASA, Ames Research Center, Moffett Field, CA; Georgia Institute of Technology, Atlanta) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2483-2487. refs
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A synthesis technique for handling unmodeled disturbances in nonlinear control law synthesis was advanced using differential game theory. Two types of modeling inaccuracies can be included in the formulation. The first is a bias-type error, while the second is the scale-factor-type error in the control variables. The disturbances were assumed to satisfy an integral inequality constraint. Additionally, it was assumed that they act in such a way as to maximize a quadratic performance index. Expressions for optimal control and worst-case disturbance were then obtained using optimal control theory. I.E.

A92-29331
TILTROTOR CONTROL LAW DESIGN FOR ROTOR LOADS ALLEVIATION USING MODERN CONTROL TECHNIQUES

DAVID G. MILLER, TERRY M. BLACK (Boeing Defense and Space Group, Helicopters Div., Philadelphia, PA), and MUKUND JOGLEKAR (Bell Helicopter Textron, Inc., Fort Worth, TX) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2488-2493. refs
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A weighted least-squares eigenstructure assignment technique and a balanced singular value Linear Quadratic Gaussian with Loop Transfer Recovery (LQC/LTR) technique were used to develop rotor load alleviation control laws for the V-22 Osprey aircraft. These techniques were applied to alleviate rotor yoke chord loads as part of a comprehensive structural load limiting control law design effort. Analysis and design of the rotor load alleviation control laws using linear and nonlinear aircraft math models and piloted simulation are discussed. I.E.

A92-29332* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SYSTEM IDENTIFICATION REQUIREMENTS FOR HIGH-BANDWIDTH ROTORCRAFT FLIGHT CONTROL SYSTEM DESIGN
MARK B. TISCHLER (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2494-2502. refs
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The application of system identification methods to high-bandwidth rotorcraft flight control system design is examined. Flight test and modeling requirements are illustrated using flight test data from a BO-105 hingeless rotor helicopter. The proposed approach involves the identification of nonparametric (transfer function and state space) model identification. Results for the BO-105 show the need for including coupled body/rotor flapping and lead-lag dynamics in the identification model structure to allow the accurate prediction of control ssytem bandwidth limitations. I.E.

A92-29361
TRAJECTORY SHAPING BY THE U-PARAMETER DESIGN METHOD
PETER DORATO (New Mexico, University, Albuquerque), YANG WEI, and CHUN-LIN SHEN (Nanjing Aeronautical Institute, People's Republic of China) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2986-2991. Research supported by NNSFC. refs
(Contract NSF INT-88-21843)
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The application of the U-parameter design method to a problem of trajectory shaping is considered. Three linearized models are assumed for an unpowered vehicle with modeling errors introduced by variations in flight path angle. Corresponding to the three linearized models, three controllers, which are used in different flight phases, are designed by means of U-parameter theory. The three controllers guarantee that the motion of the vehicle during its approach to target point is robustly stable and is optimal at the nominal flight path in the sense that the step error response of the resultant feedback control system is minimal in the mean square sense. Digital simulation results show that U-parameter design method can be successfully used for the problem. I.E.

A92-29516
APPLICATION OF THE DELTA-OPERATOR IN MIMO DISCRETE-TIME ADAPTIVE FLIGHT CONTROL SYSTEMS
YOSHIMASA OCHI, KIMIO KANAI, and YASUO KISHIMOTO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 457, 1992, p. 78-84. In Japanese. refs

A transfer function of an aircraft for some input and output has the relative degree of two or more. In such a case, it is known that unstable zeros, which are called limiting zeros, can appear when the system is discretized at a fast sampling rate. In an MIMO case, the inverted system can be unstable if the transfer functions have unstable limiting zeros. This fact makes it difficult or impossible to apply the MRACS to the design of the flight controller. In order to overcome this problem, application of the delta-operator is considered, and the numerical simulations show the usefulness of this approach. Author

A92-30131
THE ANALYSIS AND APPROXIMATE REPRESENTATION OF THE OPTIMAL CONTROL LAW FOR A MANEUVERABLE AIRCRAFT [ANALIZ I PRIBLIZHENNOE PREDSTAVLENIE OPTIMAL'NOGO ZAKONA UPRAVLENIIA MANEVRENNYM SAMOLETOM]
O. V. BALABANOV and V. T. PASHINTSEV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 49-61. In Russian. refs
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The paper considers a problem of a time-optimal lift, roll, and thrust control for an aircraft velocity turned to a given course angle. The optimal control structure is analyzed. Near-optimal control laws are obtained as functions of time, phase coordinates, and a number of constants. Examples are provided for calculations of near-optimal trajectories, and they are compared with exact solutions. I.S.

A92-30132
ESTIMATING THE PROBABILITY OF A SAFE FLIGHT FOR AN AIRCRAFT FLYING UNDER THE EFFECT OF DISTURBANCES [OTSENKA VEROIATNOSTI BEZOPASNOGO POLETA LETATEL'NYKH APPARATOV PRI DEISTVII VOZMUSHCHENII]
V. P. KUZ'MIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 62-70. In Russian. refs
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The paper considers an approximate numerical method for determining the probability that the phase coordinates describing the motion of an aircraft to leave the bounds of a specified region during a given time period. The effect of random disturbances on the aircraft is investigated with special attention given to the case where the probability of the phase coordinates leaving the specified region is small, permitting the application of asymptotic probabilistic estimates. A problem is solved in which the specified angles of attack are exceeded due to random gusts. I.S.

A92-30149
DYNAMICS OF HELICOPTER TIP-OVER DURING TAXIING [DINAMIKA OPROKIDYVANIIA VERTOLETA PRI RULENII]
A. M. VOLODKO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 73-83. In Russian. refs
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The problem of the nonstationary controlled curvilinear motion of a helicopter on the ground is investigated analytically in connection with the known cases of helicopter tip-over while making sharp turns during taxiing. The conditions leading to tip-over during turning on the ground are determined from the results of the calculations, and methods of preventing the tip-over are discussed. V.L.

A92-30150
ESTIMATION OF THE OPTIMAL LOAD CHARACTERISTICS OF AIRCRAFT CONTROL LEVERS [OTSENKA OPTIMAL'NYKH KHARAKTERISTIK ZAGRUZKI RYCHAGOV UPRAVLENIIA SAMOLETOM]
L. E. ZAICHIK and V. V. RODCHENKO TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 84-93. In Russian. refs
Copyright

Based on a generalization of the known characteristics of the pilot as the operator in the man-machine system, a criterion (Z-criterion) is proposed for the estimation of the optimal load characteristics of the aircraft control levers. This criterion is then used to extend the A-criterion, proposed in an earlier study (Zaichik et al., 1986) to different load characteristics of the control levers.

The A-criterion makes it possible to estimate the optimal values of the static controllability characteristics as a function of the dynamic aircraft characteristics. V.L.

A92-30190
CHARACTERISTICS OF THE PHUGOID MOTION OF NONMANEUVERABLE AIRCRAFT [OSOBENNOSTI FUGOIDNOGO DVIZHENIIA NEMANEVRENNOGO SAMOLETA]
V. A. GRIGOR'EV and V. K. SVIATODUKH TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 5, 1990, p. 59-68. In Russian. refs
Copyright

The possibility of simplifying equations of longitudinal nonperturbed motion for the analysis of the phugoid (long-period) motion of nonmaneuverable aircraft is examined. It is shown that, even in the case of separable roots of the characteristic equations, the use of assumptions 'eliminating' the dynamics of the short-period component may lead to significant errors in phugoid motion determinations. A new interpretation of phugoid motion is proposed which emphasizes the forces and moments associated with changes in the flight velocity and/or height. The efficiency of the approach proposed here is demonstrated by an example in which the short-period and phugoid motions are separated in the frequency domain. V.L.

A92-30191
ANALYSIS OF THE STABILITY OF THE LATERAL MOTION OF AIRCRAFT [ANALIZ USTOICHIVOSTI BOKOVOGO DVIZHENIIA SAMOLETA]
A. V. VLADIMIROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 5, 1990, p. 69-82. In Russian. refs
Copyright

A method is proposed for the approximate estimation of the roots of the characteristic (fourth-order) equation of the lateral motion of aircraft. It is shown that, in addition to high accuracy, the method provides a high degree of clarity and simplicity in the analysis of the effect of the aerodynamic parameters determining the lateral motion of aircraft on the roots of the equation. V.L.

A92-30192
DETERMINATION OF THE MEAN DURATION OF NORMAL ACCELERATION LOADS AT THE CENTER OF MASS OF AIRCRAFT DURING A FLIGHT IN A TURBULENT ATMOSPHERE [OPREDELENIE SREDNEI PRODOLZHITEL'NOSTI NORMAL'NYKH PEREGRUZOK V TSENTRE MASS SAMOLETA PRI POLETE V TURBULENTNOI ATMOSFERE]
A. V. ALAKOZ and M. A. ERUSALIMSKII TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 5, 1990, p. 83-91. In Russian. refs
Copyright

Based on the hypothesis of the local normality of atmospheric turbulence, an expression is obtained for determining the mean time of normal acceleration loads at the center of mass of aircraft in the presence of wind gusts. Calculations based on these expressions are compared with direct measurements based on on-board recorder data, and the agreement is shown to be better than that for the standard atmospheric turbulence model. V.L.

A92-30549
SAFETY TEST ON THE ROLLING ANGLES OF A WINGED VEHICLE IN HYPERSONIC SPEED
A. YOSHINAGA, TOKUSHI TATE, SHIGEYA WATANABE, and K. WATANABE (Institute of Space and Astronautical Science, Sagamihara, Japan) IN: Fluid Dynamics Conference, 22nd, Osaka, Japan, Nov. 15, 1990, Proceedings. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, p. 184-187. In Japanese. refs

The space plane model for wind tunnel test is presented. The rolling angles of a winged vehicle in hypersonic speed are analyzed. Test results are examined. Y.P.Q.

A92-30995
COMMENTS ON 'FUZZY LOGIC FOR CONTROL OF ROLL AND MOMENT FOR A FLEXIBLE WING AIRCRAFT'
ADAM L. SCHWARTZ (California, University, Berkeley) IEEE Control Systems Magazine (ISSN 0272-1708), vol. 12, Feb. 1992, p. 61, 62; Author's Reply, p. 62, 63. refs
Copyright

In a paper by Chiu et al. (1991) the use of fuzzy logic in certain control problems is explored as an alternative to conventional control methodologies. An attempt is made to demonstrate the usefulness of the fuzzy design by example. There are two notable features about the article that deserve a closer look. It is shown that it is a simple matter to design a linear controller that appears to outperform the fuzzy logic controller presented in the paper, and that the claims made about the capabilities of fuzzy logic are vague and unsubstantiated. I.E.

A92-31021
AIRCRAFT CONTROL AND SIMULATION
BRIAN L. STEVENS (Georgia Institute of Technology, Atlanta) and FRANK L. LEWIS (Texas, University, Arlington) New York, Wiley-Interscience, 1992, 637 p. refs
(ISBN 0-471-61397-5) Copyright

The book focuses on the theoretical and practical aspects of aircraft control and simulation. In particular, attention is given to equations of motion, building of an aircraft model, basic analytical and computational tools, and aircraft dynamics and classical design techniques. The discussion also covers modern design techniques, robustness and multivariable frequency-domain techniques, and digital control. The discussion is illustrated by a large number of realistic design examples, including many examples relating to the F-16 aircraft. V.L.

A92-31692*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ENERGY-HEADING TRANSIENTS IN ATMOSPHERIC FLIGHT GUIDANCE FOR AIRBREATHING HYPERSONIC VEHICLES
EUGENE M. CLIFF (Virginia Polytechnic Institute and State University, Blacksburg) and KLAUS-H. WELL (Stuttgart, Universitaet, Federal Republic of Germany) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 7 p. refs
(Contract NAG1-1244)
(AIAA PAPER 91-5065) Copyright

A time-range-fuel optimization problem is formulated for an airbreathing, hypersonic vehicle. Singular perturbation theory is used to decompose the problem into simpler subproblems. Analysis of the cruise-dash problem shows the importance of a Mach-limit. Energy-heading transients are studied and a family of trajectories, fairing asymptotically to a cruise condition, are generated.
Author

A92-31865
LIFTING SURFACE DESIGN USING THE PRINCIPLE OF PASSIVE CONTROL OF ELASTIC CHARACTERISTICS [PROEKTIROVANIE NESUSHCHEI POVERKHNOSTI S PRIMENENIEM PRINTSIPA 'PASSIVNOGO' UPRAVLENIIA UPRUGIMI KHARAKTERISTIKAMI]
E. K. LIPIN and V. E. TENIAEVA TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 103-106. In Russian.
Copyright

Results of an analysis of efficient design schemes of forward horizontal control surfaces are reported. In particular, attention is given to two design approaches, a maximum stiffness design and a flexible design scheme. The elastic deformations of the structure are controlled by varying the number and orientation of the plies of the composite material. V.L.

A92-31876
HORIZONTAL FLIGHT OF AN AIRCRAFT WITH PERIODIC THRUST REVERSAL [GORIZONTAL'NYI POLET SAMOLETA S PERIODICHESKIM PEREKLIUCHENIEM TIAGI]

L. P. FEDOROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 2, 1991, p. 82-94. In Russian. refs
Copyright

Horizontal flight of an aircraft with periodic thrust reversal is considered in the framework of the solution of 2D linear flight-mechanics problems. The paper gives a clear geometrical interpretation of the conditions under which periodic engine startup and shutdown permit an increase in the horizontal flight time or range as compared with the conventional continuous thrust variations. The proposed approach makes it possible to evaluate the possibility of increasing the horizontal flight time and range by using the throttle characteristics and to indirectly determine their maximum values and the optimal velocity of this flight. L.M.

A92-32242
EFFECT OF WIND SHEAR ON AIRSPEED DURING AIRPLANE LANDING APPROACH
ROLAND J. WHITE (Boeing Co., Seattle, WA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 237-242. Previously cited in issue 20, p. 3156, Accession no. A90-45160. refs
Copyright

A92-32248
INTEGRATED AEROELASTIC CONTROL OPTIMIZATION OF LAMINATED COMPOSITE LIFTING SURFACES
THEODORE N. DRACOPOULOS and HAYRANI OZ (Ohio State University, Columbus) (Dynamics and control of large structures; Proceedings of the Seventh VPI&SU Symposium, Blacksburg, VA, May 8-10, 1989, p. 361-378) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 280-288. Research supported by Ohio State University. Previously cited in issue 08, p. 1158, Accession no. A91-23743. refs
Copyright

N92-20148 Virginia Polytechnic Inst. and State Univ., Blacksburg.
A MULTI-LOOP GUIDANCE SCHEME USING SINGULAR PERTURBATION AND LINEAR QUADRATIC REGULATOR TECHNIQUES SIMULTANEOUSLY Ph.D. Thesis
PHILIP MERTON BUSHONG 1991 162 p
Avail: Univ. Microfilms Order No. DA9200413

A design method for a multiloop mixed discrete continuous trajectory following pitch control algorithm for a generic aerospace vehicle is presented. This design methodology is facilitated by a time scale separation observed in the dynamical system. Two variations of this algorithm are considered, with features and drawbacks of both evaluated. The algorithm is then tested by simulations with two vehicles flying arbitrary trajectories. Results are presented for a thrust vector controlled high performance missile without atmospheric effects, and for a single stage to orbit hypersonic vehicle with both elevator and thrust vector control. It is shown that the control algorithm results in a pitch loop feedback controller that is robust and very stable, and is at least near optimal for the class trajectories considered. No claims of optimality are made for the outer loop, but it is shown in the simulations that the outer loop tracker can do a reasonable job of following the prescribed nominal trajectory. Dissert. Abstr.

N92-20195*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CONTROL INTEGRATION CONCEPT FOR HYPERSONIC CRUISE-TURN MANEUVERS
DAVID L. RANEY and FREDERICK J. LALLMAN Feb. 1992 63 p
(NASA-TP-3136; L-16928; NAS 1.60:3136) Avail: NTIS HC/MF A04 CSCL 01C

Piloting difficulties associated with conducting aircraft maneuvers in hypersonic flight are caused in part by the nonintuitive nature of the aircraft response and the stringent constraints anticipated on allowable angle of attack and dynamic pressure variations. An approach is documented that provides precise, coordinated maneuver control during excursions from a hypersonic cruise flight path and the necessary flight condition constraints. The approach is to achieve specified guidance commands by resolving altitude and cross range errors into a load factor and bank angle command by using a coordinate transformation that acts as an interface between outer and inner loop flight controls. This interface, referred to as a 'resolver', applies constraints on angle of attack and dynamic pressure perturbations while prioritizing altitude regulation over cross range. An unpiloted test simulation, in which the resolver was used to drive inner loop flight controls, produced time histories of responses to guidance commands and atmospheric disturbances at Mach numbers of 6, 10, 15, and 20. Angle of attack and throttle perturbation constraints, combined with high speed flight effects and the desire to maintain constant dynamic pressure, significantly impact the maneuver envelope for a hypersonic vehicle. Author

N92-20376*# Boeing Co., Seattle, WA.
APPLICATION OF ANALYSIS TECHNIQUES FOR LOW FREQUENCY INTERIOR NOISE AND VIBRATION OF COMMERCIAL AIRCRAFT
A. E. LANDMANN, H. F. TILLEMA, and G. R. MACGREGOR Jan. 1992 91 p
(Contract NAS1-18027)
(NASA-CR-189555; NAS 1.26:189555; D6-55817) Avail: NTIS HC/MF A05 CSCL 01C

Finite element analysis (FEA), statistical energy analysis (SEA), and a power flow method (computer program PAIN) were used to assess low frequency interior noise associated with advanced propeller installations. FEA and SEA models were used to predict cabin noise and vibration and evaluate suppression concepts for structure-borne noise associated with the shaft rotational frequency and harmonics (less than 100 Hz). SEA and PAIN models were used to predict cabin noise and vibration and evaluate suppression concepts for airborne noise associated with engine radiated propeller tones. Both aft-mounted and wing-mounted propeller configurations were evaluated. Ground vibration test data from a 727 airplane modified to accept a propeller engine were used to compare with predictions for the aft-mounted propeller. Similar data from the 767 airplane was used for the wing-mounted comparisons. Author

N92-20475# National Aerospace Lab., Amsterdam (Netherlands). Aeroelasticity Div.
INVESTIGATION OF A SEMI-EMPIRICAL METHOD TO PREDICT LIMIT CYCLE OSCILLATIONS OF MODERN FIGHTER AIRCRAFT
J. J. MEIJER and R. J. ZWAAN 23 Mar. 1990 29 p Presented at the AGARD Specialists Meeting on Aircraft Dynamic Loads Due to Flow Separation, Sorrento, Italy, 1-6 Apr. 1990
(NLR-TP-90087-U; ETN-92-90965; AD-B158646L) Avail: NTIS HC/MF A03

Requirements of modern fighter aircraft to operate with high maneuverability in the transonic speed regime may lead under certain conditions to Limit Cycle Oscillations (LCO), produced by a structural/aerodynamic interaction. Conditions of transonic LCO are moderate angle of attack and Mach numbers ranging from 0.9 to 1.1. An analysis of steady wind tunnel data, obtained for a fighter type aircraft in a typical configuration indicated that shock induced separation plays a dominant role. A semi empirical prediction method which makes use of these steady data is presented and some results are shown. Possibilities to extend the method to the use of unsteady wind tunnel data are discussed. ESA

N92-20586*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DESIGN AND EVALUATION OF A ROBUST DYNAMIC NEUROCONTROLLER FOR A MULTIVARIABLE AIRCRAFT CONTROL PROBLEM
T. TROUDET (Sverdrup Technology, Inc., Brook Park, OH.), S. GARG, and W. MERRILL 1992 9 p Proposed for presentation at the International Joint Conference on Neural Networks, Baltimore, MD, 7 Jun. 1992

(NASA-TM-105579; E-6905; NAS 1.15:105579) Avail: NTIS HC/MF A02 CSCL 01/3

The design of a dynamic neurocontroller with good robustness properties is presented for a multivariable aircraft control problem. The internal dynamics of the neurocontroller are synthesized by a state estimator feedback loop. The neurocontrol is generated by a multilayer feedforward neural network which is trained through backpropagation to minimize an objective function that is a weighted sum of tracking errors, and control input commands and rates. The neurocontroller exhibits good robustness through stability margins in phase and vehicle output gains. By maintaining performance and stability in the presence of sensor failures in the error loops, the structure of the neurocontroller is also consistent with the classical approach of flight control design. Author

N92-20849# Israel Aircraft Industries Ltd., Ben-Gurion Airport. Dept. of Dynamics and Flight Control.

SOME INTERESTING PHENOMENA FROM LAVI TEST FLIGHTS RELATING TO AIRCRAFT STABILITY AND CONTROL

MOSHE ATTAR Mar. 1991 12 p

(IAITIC-91-1017; ITN-92-85137) Avail: NTIS HC/MF A03

The subject of this paper deals with two interesting phenomena encountered during the flight tests of the Lavi prototypes and the Avionics Systems Technology Demonstrator (T.D.) aircraft. These phenomena are related to: (1) The low damping and pitch oscillations near Mach 0.95; and (2) The pitch-up during slow down turn across Mach 1. In addition, some examples of reproducing flight test results from a six-degrees of freedom simulator and with the 'FFT-GPM' (Fast Fourier Transforms for Gain and Phase Margins) tool are given. Author (ISA)

N92-21253*# Boeing Commercial Airplane Co., Seattle, WA. New Airplane Div.

HIGH-SPEED CIVIL TRANSPORT FLIGHT- AND PROPULSION-CONTROL TECHNOLOGICAL ISSUES Final Report

J. K. RAY, C. M. CARLIN, and A. A. LAMBREGTS Mar. 1992 161 p Prepared for PRC Kentron, Inc., Edwards, CA and NASA-Hugh L. Dryden Flight Research Facility, Edwards, CA

(Contract NAS2-12722; ATD-91-BCA-7201)

(NASA-CR-186015; H-1794; NAS 1.26:186015) Avail: NTIS HC/MF A08 CSCL 01/3

Technology advances required in the flight and propulsion control system disciplines to develop a high speed civil transport (HSCT) are identified. The mission and requirements of the transport and major flight and propulsion control technology issues are discussed. Each issue is ranked and, for each issue, a plan for technology readiness is given. Certain features are unique and dominate control system design. These features include the high temperature environment, large flexible aircraft, control-configured empennage, minimizing control margins, and high availability and excellent maintainability. The failure to resolve most high-priority issues can prevent the transport from achieving its goals. The flow-time for hardware may require stimulus, since market forces may be insufficient to ensure timely production. Flight and propulsion control technology will contribute to takeoff gross weight reduction. Similar technology advances are necessary also to ensure flight safety for the transport. The certification basis of the HSCT must be negotiated between airplane manufacturers and government regulators. Efficient, quality design of the transport will require an integrated set of design tools that support the entire engineering design team. Author

N92-21357*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

THRUST VECTORING FOR LATERAL-DIRECTIONAL STABILITY

LEE R. PERON and THOMAS CARPENTER (California Polytechnic State Univ., San Luis Obispo.) Mar. 1992 74 p

(Contract NCC2-586)

(NASA-CR-186016; H-1645; NAS 1.26:186016) Avail: NTIS HC/MF A04 CSCL 01/3

The advantages and disadvantages of using thrust vectoring for lateral-directional control and the effects of reducing the tail size of a single-engine aircraft were investigated. The aerodynamic characteristics of the F-16 aircraft were generated by using the Aerodynamic Preliminary Analysis System II panel code. The resulting lateral-directional linear perturbation analysis of a modified F-16 aircraft with various tail sizes and yaw vectoring was performed at several speeds and altitudes to determine the stability and control trends for the aircraft compared to these trends for a baseline aircraft. A study of the paddle-type turning vane thrust vectoring control system as used on the National Aeronautics and Space Administration F/A-18 High Alpha Research Vehicle is also presented. Author

N92-21360# Naval Postgraduate School, Monterey, CA.

BASELINE VIBRATION MEASUREMENTS OF REMOTELY PILOTED HELICOPTERS FOR HIGHER HARMONIC CONTROL RESEARCH M.S. Thesis

KEVIN M. RANSFORD Dec. 1991 70 p

(AD-A244669) Avail: NTIS HC/MF A04 CSCL 01/3

The Dept. of Aeronautics and Astronautics at the Naval Postgraduate School (NPS) is conducting a research program in methods of high harmonic control (HHC) for reduction of helicopter vibrations. The program at NPS uses remotely piloted helicopters (RPH) to study HHC effects on vibration and blade load reduction. The scope of this thesis was to measure the baseline vibration profile of the RPH test vehicles prior to the installation of a HHC system. This goal was met by the development of a data instrumentation and recording system and by conducting a ground and flight test program for the RPH test vehicles. From the results of these tests it was concluded that: (1) the data instrumentation and recording system was of sufficient sensitivity to detect vibrations experienced within the RPH airframe; and (2) the RPH exhibited a vibration profile similar to that of a full scale helicopter. It is recommended that a HHC system be designed, fabricated, and installed on the RPH so that the effects of HHC on helicopter performance may be evaluated. GRA

N92-21410*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A METHODOLOGY FOR COMPUTING UNCERTAINTY BOUNDS OF MULTIVARIABLE SYSTEMS BASED ON SECTOR STABILITY THEORY CONCEPTS

MARTIN R. WASZAK Apr. 1992 42 p

(NASA-TP-3166; L-16846; NAS 1.60:3166) Avail: NTIS HC/MF A03 CSCL 01/3

The application of a sector-based stability theory approach to the formulation of useful uncertainty descriptions for linear, time-invariant, multivariable systems is explored. A review of basic sector properties and sector-based approach are presented first. The sector-based approach is then applied to several general forms of parameter uncertainty to investigate its advantages and limitations. The results indicate that the sector uncertainty bound can be used effectively to evaluate the impact of parameter uncertainties on the frequency response of the design model. Inherent conservatism is a potential limitation of the sector-based approach, especially for highly dependent uncertain parameters. In addition, the representation of the system dynamics can affect the amount of conservatism reflected in the sector bound. Careful application of the model can help to reduce this conservatism, however, and the solution approach has some degrees of freedom that may be further exploited to reduce the conservatism. H.A.

N92-21440*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

MODELING METHODS FOR HIGH-FIDELITY ROTORCRAFT FLIGHT MECHANICS SIMULATION

M. HOSSEIN MANSUR, MARK B. TISCHLER, MENAHEM CHAIMOVICH, AVIV ROSEN, and OMRI RAND (Israel Inst. of Tech., Haifa.) Jan. 1992 17 p Presented at the Sixteenth European Rotorcraft Forum, Glasgow, Scotland, 18-20 Sep. 1990

(NASA-TM-103842; A-91080; NAS 1.15:103842;

USAAVSCOM-TR-91-A-005) Avail: NTIS HC/MF A03 CSCL 01/3

The cooperative effort being carried out under the agreements of the United States-Israel Memorandum of Understanding is discussed. Two different models of the AH-64 Apache Helicopter, which may differ in their approach to modeling the main rotor, are presented. The first model, the Blade Element Model for the Apache (BEMAP), was developed at Ames Research Center, and is the only model of the Apache to employ a direct blade element approach to calculating the coupled flap-lag motion of the blades and the rotor force and moment. The second model was developed at the Technion-Israel Institute of Technology and uses an harmonic approach to analyze the rotor. The approach allows two different levels of approximation, ranging from the 'first harmonic' (similar to a tip-path-plane model) to 'complete high harmonics' (comparable to a blade element approach). The development of the two models is outlined and the two are compared using available flight test data. Author

N92-21752# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

COMPUTER-AIDED DESIGN OF FLIGHT CONTROL SYSTEMS

ROBERT F. STENGEL and SUBRATA SIRCAR 1991 8 p Presented at the AIAA Guidance, Navigation, and Control Conference, New Orleans, LA, 12-14 Aug. 1991 Previously announced in IAA as A91-49645

(Contract DAAL03-89-K-0092)

(AD-A244657; ARO-25264.7-MA) Avail: NTIS HC/MF A02 CSCL 12/5

A comprehensive computer program for designing and evaluating multidisciplinary aircraft flight control systems is described. The FlightCAD program contains a variety of modeling, synthesis, analysis, and simulation alternatives. The program will be used to produce a control design for the 1991 AIAA Controls Design Challenge (to be completed in 1992). FlightCAD ultimately will implement a number of control design techniques; here it uses direct digital synthesis to produce a robust, proportional-integral-filter controller with scheduled linear-quadratic-Gaussian gains and command generator tracking of pilot inputs. The FlightCAD design approach is reviewed, and a status report is presented. GRA

09

RESEARCH AND SUPPORT FACILITIES (AIR)

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

A92-29505

NEW SPECIFICATIONS PROPOSED FOR TAXIING GUIDANCE SIGNS

NORM BERRY (Transport Canada, Aviation Group, Ottawa) ICAO Journal (ISSN 0018-8778), vol. 47, Feb. 1992, p. 8-10.

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The ICAO's Visual Aids Panel Working Group for Surface Movement Guidance and Control has made several recommendations for eliminating obstacles faced by pilots during taxi operations. It is suggested that signs be divided into those presenting mandatory instructions and those which simply furnish information; white and red are to be used for the former, and yellow and black for the latter. A further distinction is made between signs furnishing location information and those for directional instructions. Trials of these recommendations were conducted at Calgary International Airport in Canada. O.C.

A92-29674

ENGINEERING DEVELOPMENT SIMULATION - TEST VEHICLE OF THE FUTURE

MICHAEL J. FERRANTI (Sikorsky Aircraft, Stratford, CT) Vertiflite (ISSN 0042-4455), vol. 38, Mar.-Apr. 1992, p. 53-59. refs

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The use of an engineering development full mission flight simulator (EDFMFS) allows design engineers to explore the aerodynamic and operational suitability of prospective vehicle designs, allowing problems to be identified and resolved with substantially lower costs than those associated with developmental flight testing. Flight characteristics, flight control laws, and cockpit design can be evaluated in the comfort and safety of an EDFMDS. Attention is presently given to the EDFMFS simulation of tactical situations for a multirole helicopter, envisioning various prospective threats from different weapons systems. O.C.

A92-29712

EXPERIMENTAL STUDY OF A TWO-DIMENSIONAL RANDOM FREQUENCY GENERATOR

JIAJU MA and CHENGYI PENG (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 23-29. refs

Test results are presented for a 2D random-frequency generator's shock-oscillation, vortex-scale, air-humidity effect, and exit boundary-condition characteristics. Attention is given to design considerations for distortion-shaping screens applicable to random-frequency generators. Under test conditions, the size of the separation bubble for the case of constant pressure exit is 30 percent greater than for sonic exit boundary conditions. O.C.

A92-30409

AN ELECTROMAGNETIC SUSPENSION SYSTEM FOR AERODYNAMIC STUDIES [SISTEMA ELEKTROMAGNITNOI PODVESKI DLIA AERODINAMICHESKIKH ISSLEDOVANII]

A. V. KUZIN (Moskovskii Aviatsionnyi Institut, Moscow, Russia) Pribory i Tekhnika Eksperimenta (ISSN 0032-8162), Aug. 1990, p. 227-230. In Russian. refs

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The paper describes the magnetic suspension and balance system for wind tunnel studies which was installed at the Moscow Aviation Institute in 1989 and is designed for laboratory investigations and the development of magnetic suspension techniques. The system, applicable to the suspension of models weighing up to 1 kg, has six degrees of freedom and its size is 300 x 400 mm. It has seven electromagnets with conventional copper windings, and is equipped with an optical model positioning sensing system and an analog control system. L.M.

A92-31174

FORCE MEASUREMENT ON ROTATING, ABLATING MODELS USING AN AIR BEARING BALANCE

C. W. HALDEMAN and A. D. WEINBERG (MIT, Lexington, MA) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 1039-1045. Research supported by USAF. Previously cited in issue 16, p. 2492, Accession no. A90-38452. refs

A92-31686#

TESTING CAPABILITIES AT AEDC FOR DEVELOPMENT OF HYPERSONIC VEHICLES

R. K. MATTHEWS, F. L. CROSSWY (Calspan Corp., Arnold AFB, TN), and F. J. SACKLEH (USAF, Arnold Engineering Development Center, Arnold AFB, TN) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 15 p. refs

(AIAA PAPER 91-5027)

The development of hypersonic vehicles will require a large volume of high-quality data which will be primarily used to validate codes. In the development of hypersonic vehicles (e.g., Space Shuttle) the Arnold Engineering Development Center (AEDC) played a major role in producing the required data. In recent years capability improvements have been made with particular emphasis on flow-field diagnostics which are needed to validate codes. This paper provides a brief survey of test capabilities, facility

deficiencies/developments, and flow-field diagnostic techniques. Author

A92-32056
RELATIVE ACCURACY OF WIND TUNNEL CALIBRATION SPEEDS
THOMAS J. LOCKHART (Meteorological Standards Institute, Fox Island, WA) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 73-76.
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A round-robin experiment involving the transfer standard method and a helicoid propeller has been used to demonstrate that carefully calibrated wind tunnels deliver wind at speeds known to an accuracy of about one percent. This level of accuracy is sufficient for all meteorological applications. The helicoid propeller method defines the precision measurement of the wind tunnel speed by using the standard error of the Y estimate or the rms error of the linear regression of speed differences vs. speed as determined by the propeller. The goal should be 0.025 m/s or less. C.D.

N92-20448# National Inst. of Standards and Technology, Gaithersburg, MD.
PROTOTYPING THE IRDS: AN AIRPORT APPLICATION
A. P. SANI Oct. 1991 119 p Sponsored in part by Erindale Coll., Mississauga, Ontario
(PB92-112580; NISTIR-4688) Avail: NTIS HC/MF A06 CSCL 14B

The management of geographic information resources (GIRS) continues to be plagued by problems of monitoring, locating, and controlling the array of geographic information in complex organizations. Software tools to support these functions are fundamental to any effort to maintain the integrity of geographic information as it changes. In addition, such tools are desirable when formalizing, then managing the integration of geographic information resources within an organization. One of the major approaches to the problem in the area of data base systems has been the development of the information resource dictionary (IRD) which contains meta-data. An Information Resource Dictionary System (IRDS) is a data base of meta-data along with software and procedures for the creation and maintenance of the IRD. In 1989, the American National Standards Institute (ANSI) X3.138-1988 IRDS (ANSI-IRDS) was adopted as Federal Information Processing Standard 156 by the U.S. Government. ANSI-IRDS is intended to support the definition, management, and control of meta-data. The first known attempt to actually apply ANSI-IRDS in the geographic information management domain is presented. Author

N92-20455# Applied Research Associates, Inc., Lakewood, CO.
RAREFACTION WAVE ELIMINATOR DESIGN STUDY Final Report, 18 Sep. 1987 - 15 Jul. 1989
ROBERT L. GUICE, JAMES R. BUTZ, and JAMES GOTTLIEB (Toronto Univ., Ontario) Dec. 1991 354 p
(Contract DAAA15-87-C-0086; DA PROJ. 1L1-62120-AH-25)
(AD-A244401; ARA-5462; BRL-CR-678) Avail: NTIS HC/MF A16 CSCL 14/2

Active and passive Rarefaction Wave Eliminators (RWE) were investigated for use on a small shock tube. An active RWE with rotation louvers for a modest size BRL shock tube was designed, with the open area versus time setting based on requirements from free-jet theory and the Random-Choice Method. This design yielded a device which met the operational requirements of completely closing within the 30 ms time duration of the positive phase of the simulated blast wave, and thereafter opened for the negative phase. The RWE was installed and tested at three blast wave overpressures. The results with the RWE are compared to those for both an open channel end and an extended channel on the shock tube, in order to evaluate the RWE performance. The experimental results showed that the preprogrammed theoretical area closing function was fairly accurate, especially at the lower overpressure levels. The predicted area setting is not accurate for the first few milliseconds after the shock arrives at the RWE, when the shock-induced outflow is inherently unsteady prior to the establishment of a quasi-steady jet outflow. Extrapolation of the small scale RWE design was made to the Large Blast and Thermal Simulator concept as well as the determination of preliminary costs. GRA

N92-20898# Calspan Corp., Arnold AFS, TN.
INITIAL CALIBRATION OF THE HEAT-H2 ARC-HEATED WIND TUNNEL Final Report, period ending Sep. 1990
L. M. DAVIS and D. B. CARVER Jan. 1992 77 p Prepared for AEDC, Arnold Air Force Station, TN
(AD-A245072; AEDC-TR-91-16) Avail: NTIS HC/MF A05 CSCL 14/2

An arc-heated wind tunnel added to the test facility inventory can provide a large free-jet (up to 42 in. diameter at the nozzle exit) hypersonic flow. The tunnel, designated HEAT-H2, is capable of true temperature, true pressure simulations at speeds up to 15,000 ft/sec and altitudes up to 165,000 ft. Flow Mach numbers from 4 to 8 can be achieved with the existing nozzles. Included herein is a description of the test facility, along with initial calibration results obtained from one nozzle/throat combination. The calibration was performed using a 1.5 in. diameter throat and a 24 in. exit diameter, 8 deg half-angle conical nozzle. Arc heater chamber conditions ranged from 32 to 66 atm pressure, with total enthalpy from 1,560 to 2,160 Btu/lbm. Measurements within the free jet included distributions of pitot pressure, total enthalpy, and flow angle. Surface pressure distributions on a blunt cone were also obtained. GRA

N92-21162*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Transportation Research.
RUNWAY EXIT DESIGNS FOR CAPACITY IMPROVEMENT DEMONSTRATIONS. PHASE 2: COMPUTER MODEL DEVELOPMENT
A. A. TRANI, A. G. HOBEIKA, B. J. KIM, V. NUNNA, and C. ZHONG 15 Jan. 1992 149 p Sponsored in part by FAA
(Contract NAS1-18471)
(NASA-CR-190166; NAS 1.26:190166; CTR-R-1-92-PHASE-2; DOT/FAA/RD-92/6-PHASE-2) Avail: NTIS HC/MF A07 CSCL 14/2

The development is described of a computer simulation/optimization model to: (1) estimate the optimal locations of existing and proposed runway turnoffs; and (2) estimate the geometric design requirements associated with newly developed high speed turnoffs. The model described, named REDIM 2.0, represents a stand alone application to be used by airport planners, designers, and researchers alike to estimate optimal turnoff locations. The main procedures are described in detail which are implemented in the software package and possible applications are illustrated when using 6 major runway scenarios. The main output of the computer program is the estimation of the weighted average runway occupancy time for a user defined aircraft population. Also, the location and geometric characteristics of each turnoff are provided to the user. Author

N92-21511# Wichita State Univ., KS. Dept. of Aerospace Engineering.
THE FLIGHT SIMULATION FACILITY AT THE WICHITA STATE UNIVERSITY Abstract Only
STEPHEN G. MCCAULEY *In its* Techfest 18 Proceedings 1 p Jan. 1992
Avail: NTIS HC/MF A03 CSCL 01/2

A flight simulation is currently being developed at the National Institute for Aviation Research in order to study a pilot's workload during terminal area operations. The simulator is a fixed base Learjet cockpit that has been outfitted with a 19 inch monitor for the outside scene visual displays and a 14 inch monitor used to display an instrument panel. A 32 button switch panel is also used to allow for the pilot interactions. The simulation is being performed by a network of computers. Current research on the simulator is the development of a highly interactive autopilot. This can perform as an autopilot or as a head-up display (HUD) showing the pilot what inputs to make. Various other HUD's have been

developed and are being studied in order to determine whether the autopilot actually helps improve the pilot's performance. Future desired improvements and research include the addition of a wide screen visual display, force feedback controls, and an artificially intelligent co-pilot that could be voice activated. Author

N92-21720# Aerospace Medical Research Labs., Brooks AFB, TX.
ANALYSIS OF MEASURED ENVIRONMENTAL NOISE LEVELS: AN ASSESSMENT OF THE EFFECTS OF AIRBASE OPERATIONAL MODEL VARIABLES ON PREDICTED NOISE EXPOSURE LEVELS Final Report, Jul. 1979 - Mar. 1980; Jun. 1989 - Dec. 1990
WAYNE R. LUNDBERG Jun. 1991 268 p
(Contract AF PROJ. 7231)
(AD-A244805; AL-TR-1991-0097) Avail: NTIS HC/MF A12 CSCL 14/2

This report presents an exhaustive study of measured noise data collected during a three week period at McChord AFB. The NOISECHECK methodology for comparing noise predictions to measured noise data was used in an effort to quantify the complicating factors relevant to airbase environmental noise prediction. These factors are dominated by parameters of the aircraft operations model. The operational model parameters are segregated and their effects on noise level predictions discussed, using the Probability of Consistency as a measure of their overall impact. It was found that noise generation was very sensitive to relatively small changes in power setting. The operational model of aircraft altitude and track location produced the most significant effects on predicted noise levels. The level of detail analysis attained allowed further assessment of the problems of noise generation and propagation modeling. The detailed NOISECHECK Sound Exposure Level analysis was automated using a database management system, which greatly reduced the effort required to conduct the repeated analyses required for this study. The retrieval and comparison of NOISEMAP noise level predictions were also automated. An accurate approach to estimating the operational parameters needed to model variable aircraft operations was developed and partially validated. GRA

N92-21777# National Inst. of Standards and Technology, Gaithersburg, MD. Office of Standards Code and Information.
CRITERIA FOR THE OPERATION OF FEDERALLY-OWNED SECONDARY CALIBRATION LABORATORIES (IONIZING RADIATION) Final Report
E. H. EISENHOWER Aug. 1991 66 p
(PB92-112481; NIST/SP-812) Avail: NTIS HC/MF A04 CSCL 14/2

Given here are standards of performance for laboratories that calibrate instrumentation used to measure ionizing radiation. Such standards are useful for the development of a secondary level of calibration laboratories that can provide a high-quality link between the National Institute of Standards and Technology and those who make routine measurements at the field level. The standards may also be used as criteria on which a decision is based regarding accreditation of a particular laboratory. They were developed by representatives of federally-owned laboratories that perform calibrations of the type addressed by the document. General criteria that must be satisfied by all laboratories seeking accreditation are noted, as well as requirements relating to management and staff, physical aspects of the laboratory, calibration facilities and equipment, operational procedures, accuracy and quality assurance, and records and reports. Criteria are established for calibration of survey instruments, irradiation of personnel dosimeters, calibration of sources, calibration of instruments for diagnostic levels, and calibration of reference-class instruments. The types of radiation covered include gamma rays, x rays, beta particles, neutrons, and alpha particles. The proficiency tests administered by NIST to secondary laboratories as a prerequisite for their accreditation are described. Author

N92-21870# National Inst. of Standards and Technology, Gaithersburg, MD. Public Affairs Div.
RESEARCH, SERVICES, AND FACILITIES (NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY)
M. A. BELLO, G. PORTER, and S. A. SHAFFER Aug. 1991 92 p
(PB92-109172; NIST/SP-817) Avail: NTIS HC/MF A05; also available SOD HC $4.75 as 003-003-03098-8 CSCL 14/2

Described here is the full spectrum of National Institute of Standards and Technology (NIST) programs and facilities available for industry participation and use. Each item includes the name and telephone number of an NIST program manager or researcher to contact for more information. Specific topics covered include gaining the competitive edge, serving the customer, technology services, the Electronics and Electrical Engineering Laboratory, the Manufacturing Engineering Laboratory, the Chemical Science and Technology Laboratory, the Physics Laboratory, the Materials Science and Engineering Laboratory, the Building and Fire Research Laboratory, the Computer Systems Laboratory, the Computing and Applied Mathematics Laboratory, a facilities index, and a subject index. Author

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ASTRONAUTICS

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

A92-29304* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AEROBRAKE GUIDANCE LAW SYNTHESIS USING FEEDBACK LINEARIZATION
P. K. A. MENON (NASA, Ames Research Center, Moffett Field, CA; Georgia Institute of Technology, Atlanta) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2250-2255. refs
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Aerobraking maneuvers are currently being considered for use in several space missions. The development of a guidance law for performing simultaneous change of both in-plane and out-of-plane orbital elements with least energy loss is described. The analysis is based on a sixth-order nonlinear point-mass vehicle model with lift, bank angle and drag modulation as the three control variables. The guidance law uses detailed vehicle aerodynamic and the atmosphere models in the feedback loop. The effects of planet oblateness, atmospheric rotation and ambient winds are included in the formulation. The guidance law is in nonlinear feedback form and is simple enough to be implemented on-board an orbit transfer vehicle. I.E.

A92-29956# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ACTS AERONAUTICAL EXPERIMENTS
TIEN M. NGUYEN, POLLY ESTABROOK, BRIAN ABBE, MILES K. SUE (JPL, Pasadena, CA), and CHARLES A. RAQUET (NASA, Lewis Research Center, Cleveland, OH) IN: AIAA International Communication Satellite Systems Conference and Exhibit, 14th, Washington, DC, Mar. 22-26, 1992, Technical Papers. Pt. 3. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1769-1781. refs
(AIAA PAPER 92-2042) Copyright

A description of the two aeronautical mobile satellite experiments utilizing NASA's Advanced Communications Technology Satellite (ACTS) is presented. The low bit rate experiment is principally a Ka-band technology demonstration of

a prototype 4.8 Kbps aeronautic mobile terminal employing three experimental active electronically steered arrays. The high bit rate experiment can demonstrate a 64 Kbps to 384 Kbps satellite link between a ground terminal and an aircraft. R.E.P.

A92-30139
A METHOD FOR ESTIMATING THE MINIMUM DISTANCE BETWEEN TWO FLIGHT VEHICLES DURING THEIR SEPARATION [METOD OTSENKI NAIMEN'SHEGO RASSTOIANIIA MEZHDU LETATEL'NYMI APPARATAMI V PROTSESSE IKH RAZDELENIIA]
V. A. IL'IN and A. P. LEUTIN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 107-111. In Russian. refs
Copyright

A method is proposed for estimating the minimum distance between two flight vehicles (the carrier and the cargo) that are in the process of separation. For this purpose, the surface areas for which the contact is most probable are approximated by a set of triangular and a set of quadrilateral facets, and the minimum distance between these sets is determined through an exhaustive search. Two methods are proposed for reducing the number of combinations that need to be processed: (1) by examining the elements of both sets in the vicinities of 'dangerous' points (which are few); and (2) by examining only those 'facet-apex' combinations where the outer surface of a facet could be illuminated by light beams emanating from the apex as a source. The efficiencies of these methods are compared. I.S.

A92-30685
ACQUISITION OF AN AEROTHERMODYNAMIC DATA BASE BY MEANS OF A WINGED EXPERIMENTAL REENTRY VEHICLE
E. H. HIRSCHEL, H. GRALLERT (MBB GmbH, Munich, Federal Republic of Germany), J. LAFON, and M. RAPUC (Dassault Aviation, Saint-Cloud, France) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 16, no. 1, 1992, p. 15-27. refs
(Contract ESA-H-ST-13-01-AS)
Copyright

A winged aerothermodynamic experimental reentry vehicle for the Hermes project is discussed. The main objective of the vehicle is to obtain the data base for improving and validating methods of numerical aerothermodynamics. Major past efforts to develop such vehicles are reviewed, the needed aerothermodynamic characteristics of a winged reentry vehicle are examined, and ground simulation problems are addressed. A possible configuration and trajectory of the proposed vehicle are described. C.D.

A92-31676*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SIX-DEGREE-OF-FREEDOM GUIDANCE AND CONTROL ANALYSIS OF MARS AEROCAPTURE
RICHARD W. POWELL and ROBERT D. BRAUN (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0736)

A six-degree-of-freedom (6DOF) simulation is developed to investigate the control and guidance issues of a Mars aerobraking vehicle. The guidance algorithm used is a predictor-corrector guidance formulation designed to control the exit orbital apoapsis and wedge angle using bank-angle modulation. Major features of this predictor-corrector guidance algorithm include: (1) integration of the 3DOF equations of motion within an inner-loop simulation; (2) load-relief logic; (3) finite roll rates; and (4) an aerodynamic feedback multiplier. The algorithm is capable of successfully guiding the vehicle through combinations of atmospheric density dispersions, aerodynamic mispredictions, and off-nominal atmospheric interface conditions. This study demonstrated that the addition of vehicle dynamics to the Mars aerobraking simulation does not significantly impact mission feasibility. That is, a robust control system design coupled with an adaptive guidance algorithm can assure mission success in the presence of numerous off-nominal conditions. Author

A92-31697#
STRUCTURES AND MATERIALS TECHNOLOGIES FOR HYPERSONIC VEHICLES - LESSONS FROM HERMES EXPERIENCE
J. F. JAMET (Aerospatiale, Paris, France), D. CHAUMETTE (Dassault Aviation, Saint-Cloud, France), M. DESNOYER (SEP, Neuily, France), and P. COSTA (ONERA, Chatillon, France) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 13 p.
(AIAA PAPER 91-5098) Copyright

Consideration is given to the use of ceramic matrix composites and protected carbon-carbon materials for hypersonic vehicles and specific technology problems related to the manufacturing of large components made of these materials. The thermal protection system for Hermes includes nose and leading edges made of protected carbon-carbon; winglets, elevons, and body flap made of C-SiC; and external insulation of the cold structure with shingles made of C-SiC covering an internal multiscreen insulation. Particular attention is given to the possible use and extension of the Hermes structure and materials experience to an hypersonic aerospace plane with airbreathing propulsion. O.G.

A92-31698#
STRUCTURAL MATERIALS FOR NASP
TERENCE M. F. RONALD (NASP Joint Program Office, Wright-Patterson AFB, OH) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 5 p.
(AIAA PAPER 91-5101) Copyright

Structural materials for the NASP X-30 experimental vehicle are briefly reviewed including titanium alloys, titanium-based metal-matrix composites, carbon-carbon composites, ceramic-matrix composites, and copper-matrix composites. Areas of application of these materials include the airframe where these materials would be used as lightweight skin panels for honeycomb-core, truss-core, or integrally stiffened thin sheet configuration; and the engine, where they would be used in the hot gas path of the ramjet/scramjet, and in the inlet and nozzle areas. O.G.

N92-20666*# Case Western Reserve Univ., Cleveland, OH.
CONCEPTUAL DESIGN OF TWO-STAGE-TO-ORBIT HYBRID LAUNCH VEHICLE
1 Jul. 1991 275 p
(Contract NASW-4435)
(NASA-CR-190006; NAS 1.26:190006) Avail: NTIS HC/MF A12
CSCL 22/2

The object of this design class was to design an earth-to orbit vehicle to replace the present NASA space shuttle. The major motivations for designing a new vehicle were to reduce the cost of putting payloads into orbit and to design a vehicle that could better service the space station with a faster turn-around time. Another factor considered in the design was that near-term technology was to be used. Materials, engines and other important technologies were to be realized in the next 10 to 15 years. The first concept put forth by NASA to meet these objectives was the National Aerospace Plane (NASP). The NASP is a single-stage earth-to-orbit air-breathing vehicle. This concept ran into problems with the air-breathing engine providing enough thrust in the upper atmosphere, among other things. The solution of this design class is a two-stage-to-orbit vehicle. The first stage is air-breathing and the second stage is rocket-powered, similar to the space shuttle. The second stage is mounted on the top of the first stage in a piggy-back style. The vehicle takes off horizontally using only air-breathing engines, flies to Mach six at 100,000 feet, and launches the second stage towards its orbital path. The first stage, or booster, will weigh approximately 800,000 pounds and the second stage, or orbiter will weigh approximately 300,000 pounds. The major advantage of this design is the full recoverability of the first stage compared with the present solid rocket booster that are only partially recoverable and used only a few times. This reduces the cost as well as providing a more reliable and more readily available design for servicing the space station. The booster

can fly an orbiter up, turn around, land, refuel, and be ready to launch another orbiter in a matter of hours. Author

N92-20776# Booz-Allen and Hamilton, Inc., Houston, TX. Space Systems Div.
ATTRIBUTES OF WINGED MANNED SPACE VEHICLES AND THEIR RELATIONSHIP TO GROUND SITE CHARACTERISTICS AND FACILITIES
KAROL J. BOBKO *In* ESA, Launch Bases and Control Infrastructures for Spacecraft p 403-408 Oct. 1991
Copyright Avail: NTIS HC/MF A21; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 guilders

The task of safely landing a winged space vehicle and returning it to the processing facility is a demanding and complicated process. Unconventional ground facilities are required because of the characteristics of this vehicle type. The approach trajectory dictated by the high speed gliding flight requires special runway outfitting. The Space Shuttle and Hermes have a similar approach and landing trajectory. The one used by the Space Shuttle is described. The systems designed to operate in space require special support on the ground. The preparation of the spacecraft and the ferry flight back to the processing facility take special equipment and trained personnel. All of these items must be planned to ensure that the landing and subsequent activities are safe and efficient. ESA

N92-21526*# National Aeronautics and Space Administration, Washington, DC.
CRYOGENIC HYDROGEN-INDUCED AIR-LIQUEFACTION TECHNOLOGIES FOR COMBINED-CYCLE PROPULSION APPLICATIONS
WILLIAM J. D. ESCHER *In* NASA. Lewis Research Center, Rocket-Based Combined-Cycle (RBCC) Propulsion Technology Workshop. Tutorial Session 19 p 1992
Avail: NTIS HC/MF A12 CSCL 21/8

Given here is a technical assessment of the realization of cryogenic hydrogen induced air liquefaction technologies in a prospective onboard aerospace vehicle process setting. The technical findings related to the status of air liquefaction technologies are reviewed. Compact lightweight cryogenic heat exchangers, heat exchanger atmospheric constituent fouling alleviation measures, para/ortho-hydrogen shift-conversion catalysts, cryogenic air compressors and liquid air pumps, hydrogen recycling using slush hydrogen as a heat sink, liquid hydrogen/liquid air rocket-type combustion devices, and technically related engine concepts are discussed. Much of the LACE work is related to aerospaceplane propulsion concepts that were developed in the 1960's. Emphasis is placed on the Liquid Air Cycle Engine (LACE). Author

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CHEMISTRY AND MATERIALS

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

A92-29639*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STRAIN-INDUCED EXTINCTION OF HYDROGEN-AIR COUNTERFLOW DIFFUSION FLAMES - EFFECTS OF STEAM, CO2, N2, AND O2 ADDITIVES TO AIR
G. L. PELLETT, G. B. NORTHAM (NASA, Langley Research Center, Hampton, VA), and L. G. WILSON (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 16 p. refs
(AIAA PAPER 92-0877)

A fundamental study was performed using axisymmetric nozzle and tubular opposed jet burners to measure the effects of laminar plug flow and parabolic input velocity profiles on the extinction limits of H2-air counterflow diffusion flames. Extinction limits were quantified by 'flame strength', (average axial air jet velocity) at blowoff of the central flame. The effects of key air contaminants, on the extinction limits, are characterized and analyzed relative to utilization of combustion contaminated vitiated air in high enthalpy supersonic test facilities. R.E.P.

A92-29725
EXPERIMENTAL INVESTIGATION ON THE MECHANISM OF FLAME STABILIZATION IN AFTERBURNER WITH V-GUTTER FLAMEHOLDER
JIAHUA WANG, ZHIGANG LIU, and GAIQI LI (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 159-168. refs

The present experimental study of V-gutter flameholder-based afterburner stabilization is pertinent to flameholding requirements of both low-bypass turbofans and ramjet engine combustors. Attention is given to the atomizing characteristics of a plain orifice, as well as fuel-droplet capture, fuel film vaporization on the surface of the flameholder, the atomizing characteristics of the fuel film at the trailing edge of the flameholder, and flame stability in a two-phase mixture. O.C.

A92-29728
THE AVIATION KEROSENE BURNING IN THE NON-UNIFORM AIR FLOW
V. N. GRUZDEV IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 187-201.

A study is conducted of the influence exerted by kerosene combustion nonuniformities on the primary characteristics of combustion chamber operation, depending on both temperature and flow velocity. These effects extend to both flame-stabilization limits, and combustion completeness. Attention is given to the mixing intensity of forward-flow nonuniformities in the near wake, behind the flame stabilization region designated the 'backward flow zone' (BFZ); tests were conducted on transverse stabilizer orientation relative to the nozzle edge, in the presence and absence of a BFZ. BFZ burning sharply decreased the smoothing intensity of the flow nonuniformities. O.C.

A92-30596
A PRELIMINARY STUDY OF THE MICROSTRUCTURE-PROPERTY RELATIONSHIPS IN CAST GAMMA TITANIUM ALUMINIDE ALLOYS
B. LONDON (Howmet Corp., Whitehall, MI) and T. J. KELLY (GE Aircraft Engines, Cincinnati, OH) IN: Microstructure/property relationships in titanium aluminides and alloys; Proceedings of the Symposium, Fall Meeting of the Minerals, Metals, and Materials Society, Detroit, MI, Oct. 7-11, 1990. Warrendale, PA, Minerals, Metals, and Materials Society, 1991, p. 285-295. Research supported by Howmet Corp. and General Electric Co. refs
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The investment casting process as applied to gamma alloys is reviewed, with emphasis on three gamma alloys: Ti-48Al-2V, Ti-48Al-2Mn-2Nb, and Ti-48Al-2Nb-2Cr (at. pct). Heat treatments that produce microstructures consisting of equiaxed gamma, lamellar alpha-2/gamma, and a combination of the equiaxed and lamellar constituents are described. Room and elevated temperature mechanical properties of the heat-treated gamma alloys are given. The Mn-Nb and Nb-Cr alloys are shown to have good room temperature ductility (greater than 2.0 percent) and moderate strength (300 MPa yield, 450 MPa ultimate). The highest ductility values were obtained from the equiaxed gamma structure. Both alloys have excellent fracture toughness values approaching 20 MPa sq rt m. Elevated temperature strength is improved slightly in the lamellar structure. The production of full-size components in gamma alloys is discussed and two examples are provided. C.A.B.

A92-30611
A CRITICAL APPRAISAL OF THERMOMECHANICAL PROCESSING OF STRUCTURAL TITANIUM ALLOYS
G. W. KUHLMAN (Aluminum Company of America, Forging Div., Cleveland, OH) IN: Microstructure/property relationships in titanium aluminides and alloys; Proceedings of the Symposium, Fall Meeting of the Minerals, Metals, and Materials Society, Detroit, MI, Oct. 7-11, 1990. Warrendale, PA, Minerals, Metals, and Materials Society, 1991, p. 465-491. refs
Copyright

Reviewed are the thermomechanical processes, including controlled chemical composition, and strength, toughness, fatigue and fracture-related properties relationships exploited in prevalent (alpha + beta) structural titanium alloys: Ti-6Al-4V, Ti-6Al-6V-2Sn, IMI550, Ti-6Al-2Sn-4Zr-6Mo and Ti-6Al-2Sn-2Zr-2Cr-2Mo. Examined also are similar TMP and mechanical properties relationships in beta and near-beta structural alloys: Ti-10V-2Fe-3Al, Beta C, Beta III and others. Critical comparisons of these two titanium-alloy structural classes are made in terms of optimal fracture mechanics and durability service capabilities. Author

A92-32253* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
DIAGONAL IMPLICIT SCHEME FOR COMPUTING FLOWS WITH FINITE RATE CHEMISTRY
SCOTT EBERHARDT (Washington, University, Seattle) and SCOTT IMLAY (Amtec Engineering, Inc., Bellevue, WA) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722), vol. 6, Apr.-June 1992, p. 208-216. Previously cited in issue 16, p. 2519, Accession no. A90-38715. refs
(Contract NAS8-37406)
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A92-32394
THERMALLY SPRAYED COATING SYSTEMS FOR SURFACE PROTECTION AND CLEARANCE CONTROL APPLICATIONS IN AERO ENGINES
T. N. RHYS-JONES (Rolls-Royce, PLC, Bristol, England) IN: Metallurgical coatings and thin films 1990; Proceedings of the 17th International Conference on Metallurgical Coatings and 8th International Conference on Thin Films, San Diego, CA, Apr. 2-6, 1990. Vol. 1. London and New York, Elsevier Applied Science, 1990, p. 402-415. refs
Copyright

The principal current and new thermal spray coating processes used for compressor, combustion chamber and turbine applications in aero engines are described with particular reference to high velocity combustion and plasma spraying techniques. The uses of coatings for wear and erosion resistance, oxidation and corrosion control, thermal barrier applications and gas path sealing (clearance control) are discussed. Author

N92-20132# Sandia National Labs., Albuquerque, NM.
IN SITU MEASUREMENT OF PARTICLE FORMATION IN HEATED JET FUELS: A NEW APPLICATION OF PHOTON CORRELATION SPECTROSCOPY
W. M. TROTT, T. J. OHERN, and E. A. KLAVETTER 1991 9 p Presented at the American Chemical Society National Meeting, San Francisco, CA, 5-10 Apr. 1992
(Contract DE-AC04-76DP-00789)
(DE92-003641; SAND-91-2444C; CONF-920444-2) Avail: NTIS HC/MF A02

A noninvasive dynamic light scattering technique, photon correlation spectroscopy, has been used to examine the formation of submicron diameter particles in thermally stressed JP-8 and Jet A-1 fuels. An understanding of the particle formation processes is needed in order to characterize jet fuel thermal degradation and to assist in the development of highly stable fuel compositions. In situ measurements in pre-stressed fuel samples have shown that relatively large particles (200-800 nm mean hydrodynamic diameter) are formed at temperatures less than 200 C and indicate a trend toward increasing particle size with increasing stress temperature. Real-time PCS measurements during fuel heating tests have also been performed. These tests suggest that incipient particle formation occurs at temperatures as low as 110 C. At 150-170 C, scattering from large (0.3-1 micron) particles dominates the real-time PCS signal. Observed trends in particle size distribution with maximum stress temperature and exposure time will be discussed. DOE

N92-20164# Rolls-Royce Ltd., Derby (England).
PRESENT AND FUTURE TRENDS IN TURBINE BLADE MATERIAL AND MANUFACTURING TECHNOLOGY
G. J. S. HIGGINBOTHAM and D. A. FORD 1 Nov. 1990 10 p Repr. from Materials and Design, v. 11, no. 5, Oct. 1990 p 247-255 Presented at European Investment Casting Federation, Lugano, Italy, Jun. 1990
(PNR-90825; ETN-92-90847) Copyright Avail: NTIS HC/MF A02

A review of Directionally Solidified (DS) and Single Crystal (SC) casting technology is given and the development of a successful industrial process and subsequent engine testing is outlined. A look ahead to some of the challenges for the future is made and further required development is outlined. ESA

N92-20193*# Arizona State Univ., Tempe. Telecommunications Research Center.
ADVANCED ELECTROMAGNETIC METHODS FOR AEROSPACE VEHICLES Semiannual Progress Report, 1 Jul. - 31 Dec. 1991
CONSTANTINE A. BALANIS, EL-BUDAWY EL-SHARAWY, SHAHROKH HASHEMI-YEGANEH, JAMES T. ABERLE, and CRAIG R. BIRTCHER 31 Dec. 1991 64 p
(Contract NAG1-1082)
(NASA-CR-188630; NAS 1.26:188630) Avail: NTIS HC/MF A04 CSCL 11D

The Advanced Helicopter Electromagnetics is centered on issues that advance technology related to helicopter electromagnetics. Progress was made on three major topics: composite materials; precipitation static corona discharge; and antenna technology. In composite materials, the research has focused on the measurements of their electrical properties, and the modeling of material discontinuities and their effect on the radiation pattern of antennas mounted on or near material surfaces. The electrical properties were used to model antenna performance when mounted on composite materials. Since helicopter platforms include several antenna systems at VHF and UHF bands, measuring techniques are being explored that can be used to measure the properties at these bands. The effort on corona discharge and precipitation static was directed toward the development of a new two dimensional Voltage Finite Difference Time Domain computer program. Results indicate the feasibility of using potentials for simulating electromagnetic problems in the cases where potentials become primary sources. In antenna technology the focus was on Polarization Diverse Conformal Microstrip Antennas, Cavity Backed Slot Antennas, and Varactor Tuned Circular Patch Antennas. Numerical codes were developed for the analysis of two probe fed rectangular and circular microstrip patch antennas fed by resistive and reactive power divider networks. Author

N92-20329# Sandia National Labs., Livermore, CA. Computational Mechanics Div.
SIMULATION OF CHEMICAL KINETICS IN TURBULENT NATURAL GAS COMBUSTION Annual Report, Apr. 1990 - Mar. 1991
A. E. LUTZ Sep. 1991 55 p
(Contract GRI-5089-260-1893)
(PB92-123660; GRI-91/0282) Avail: NTIS HC/MF A04 CSCL 21B

A computationally efficient model that predicts chemical kinetic phenomena in a turbulent natural gas jet was developed. It was used to compute the nitric oxide (NOx) emissions measured in the lab jet flames. The model explains qualitatively the variation in the emissions with nozzle diameter, jet velocity, and fuel type. The predicted emission levels are consistently higher than the

measured values; uncertainties in the radiative heat transfer and turbulent mixing rates can account for the discrepancy. The objective is to develop chemical kinetic models that are computationally efficient, yet retain the detailed chemistry model necessary to predict kinetically controlled phenomena, such as NOx formation in turbulent natural gas combustion. To do this, the first model uses two perfectly stirred reactors to represent combustion in the homogeneous eddies and the diffusion flame sheets that are observed in the large scale structure of turbulent jets. The entrainment and mixing of surrounding fluid with the jet stream is modeled using empirical correlations derived from experimental observations. These entrainment correlations take into account both momentum dominated and buoyant flow regimes. An important part of the model is the radiative energy loss, because the NOx emission is very sensitive to the flame temperature.
Author

N92-20679*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPTIMIZATION OF COMPOSITE SANDWICH COVER PANELS SUBJECTED TO COMPRESSIVE LOADINGS
JUAN R. CRUZ Dec. 1991 13 p
(NASA-TP-3173; L-16942; NAS 1.60:3173) Avail: NTIS HC/MF A03 CSCL 11/4

An analysis and design method is presented for the design of composite sandwich cover panels that include the transverse shear effects and damage tolerance considerations. This method is incorporated into a sandwich optimization computer program entitled SANDOP. As a demonstration of its capabilities, SANDOP is used in the present study to design optimized composite sandwich cover panels for for transport aircraft wing applications. The results of this design study indicate that optimized composite sandwich cover panels have approximately the same structural efficiency as stiffened composite cover panels designed to satisfy individual constraints. The results also indicate that inplane stiffness requirements have a large effect on the weight of these composite sandwich cover panels at higher load levels. Increasing the maximum allowable strain and the upper percentage limit of the 0 degree and +/- 45 degree plies can yield significant weight savings. The results show that the structural efficiency of these optimized composite sandwich cover panels is relatively insensitive to changes in core density. Thus, core density should be chosen by criteria other than minimum weight (e.g., damage tolerance, ease of manufacture, etc.). Author

N92-20695# Yale Univ., New Haven, CT. High Temperature Chemical Reaction Engineering Lab.
TRANSPORT PHENOMENA AND INTERFACIAL KINETICS IN MULTIPHASE COMBUSTION SYSTEMS Final Report, 1 Jan. 1989 - 31 Dec. 1990
DANIEL E. ROSNER Feb. 1991 148 p
(Contract AF-AFOSR-0223-89)
(AD-A244849; AFOSR-91-1035TR) Avail: NTIS HC/MF A07 CSCL 21/2

The performance of ramjets burning slurry fuels (leading to condensed oxide aerosols and liquid film deposits), gas turbine engines in dusty atmospheres, or when using fuels from nontraditional sources (e.g., shale-, or coal-derived), depends upon the formation and transport of small particles across non-isothermal combustion gas boundary layers (BLs). Even airbreathing engines burning clean hydrocarbon fuels can experience soot formation/deposition problems (e.g., combustor liner burnout, accelerated turbine blade erosion and hot corrosion). Moreover, particle formation and transport are important in many chemical reactors used to synthesize or process aerospace materials (turbine blade coatings, optical waveguides, etc.). Accordingly, our research is directed toward providing chemical propulsion system engineers and materials-oriented engineers with new techniques and quantitative information on important particle- and vapor-mass transport mechanisms and rates. An interactive experimental/theoretical approach has been used to gain understanding of performance-limiting chemical-, and mass/energy transfer-phenomena at or near interfaces. This included the further development and exploitation of seeded laboratory flat flame burners, flow-reactors, and new optical diagnostic techniques.
GRA

N92-20858# Sandia National Labs., Albuquerque, NM.
MONITORING JET FUEL DEGRADATION USING QUARTZ CRYSTAL MICROBALANCES
S. J. MARTIN, G. C. FRYE, E. A. KLAVETTER, and A. J. RICCO 1991 8 p Presented at the American Chemical Society National Meeting, San Francisco, CA, 5-10 Apr. 1992
(Contract DE-AC04-76DP-00789)
(DE92-004730; SAND-91-2422C; CONF-920444-6) Avail: NTIS HC/MF A02

A sensor system using a quartz crystal microbalance (QCM) was developed to monitor, in real-time, the deposition of degradation by-products from thermally-stressed jet fuels at elevated temperatures. The QCM is an electrically excited quartz resonator that can be operated while suspended in jet fuel. The resonant frequency and damping are monitored to indicate accumulation on both crystal faces. The buildup of degradation by-products causes both a decrease in resonant frequency as well as damping of the crystal resonance. The change in resonant frequency indicates the mass density of the accumulated layer, while resonance damping arises from the viscoelastic properties of the deposit, indicating its polymeric nature. Jet A-1 and JP-8 fuels have been monitored under conditions of continuous oxygenation at 175 and 190 C for several hours, yielding average mass deposition rates of 54 and 112 ng/sq cm-min, respectively.
DOE

N92-21015# Pratt and Whitney Aircraft, West Palm Beach, FL.
FATIGUE IN SINGLE CRYSTAL NICKEL SUPERALLOYS Technical Progress Report, 16 Sep. - 15 Dec. 1991
20 Dec. 1991 13 p
(Contract N00014-91-C-0124)
(AD-A244815; P/W-FR21998-2) Avail: NTIS HC/MF A03 CSCL 11/6

This program investigates the behavior of single crystal airfoil materials. The fatigue initiation processes in single crystal (SC) materials are significantly more complicated and involved than fatigue initiation and subsequent behavior of a (single) macrocrack in conventional, isotropic materials. To understand these differences, it is helpful to review the evolution of high temperature airfoils. Modern gas turbine flight propulsion systems employ single crystal materials for turbine airfoil applications because of their superior performance in resisting creep, oxidation, and thermal mechanical fatigue (TMF). These properties have been achieved by composition and alloying, and by appropriate crystal orientation and associated anisotropy. GRA

N92-21018# National Research Council of Canada, Ottawa (Ontario). Inst. for Aerospace Research.
PHOTOELASTIC COATING STUDY OF CT-114 COUPON JOINT TEST SPECIMEN FOR HORIZONTAL STABILIZER REAR ATTACHMENT FITTING TO VERTICAL STABILIZER REAR SPAR
J. P. KOMOROWSKI 15 Sep. 1988 19 p
(Contract DND-FE-847787FACBF; NAE PROJ. 03336)
(NRC-LTR-ST-1689; CTN-91-60291) Copyright Avail: NTIS HC/MF A03

As part of a program of life extension of Canadian Forces CT-114 Tutor jet trainer aircraft, an experimental investigation was initiated on the durability and damage tolerance of the horizontal stabilizer rear attachment fitting and its attached components from the vertical stabilizer rear spar. A photoelastic coating study of a coupon test specimen is described. The method is briefly explained to aid in interpretation of results. Additional fasteners will have to be included in the coupon test specimen to prevent skin buckling and to better simulate actual structure. Load transfer in the joint is mainly through friction generated by rivet clamp up. The use of rivets with larger heads for the test specimen may influence results by providing better clamp up. Author (CISTI)

N92-21063# Oak Ridge National Lab., TN.
FABRICATION AND TESTING OF CORROSION RESISTANT COATINGS
D. P. STINTON, J. C. MCLAUGHLIN, and L. RIESTER 1991 9 p Presented at the 4th International Symposium on Ceramic Materials and Components for Engines, Goeteborg (Sweden), 10-12 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE92-003553; CONF-910617-7) Avail: NTIS HC/MF A02

The susceptibility of SiC and Si3N4 to sodium corrosion mandates that corrosion resistant coatings be developed to protect silicon-based turbine engine components. Materials with good corrosion resistance and thermal expansions that nearly match SiC and Si3N4 have been identified. Corrosion testing of hot-pressed pellets of these compounds has identified the most promising materials. Development of chemical vapor deposition systems to apply these materials has been initiated. DOE

N92-21159# Northrop Corp., Hawthorne, CA. Aircraft Div.
DURABILITY AND DAMAGE TOLERANCE OF ALUMINUM CASTINGS Final Report
M. W. OZELTON, S. J. MOCARSKI, and P. G. PORTER Oct. 1991 425 p
(Contract F33615-85-C-5015)
(AD-A245237; NOR-91-25; WL-TR-91-4111) Avail: NTIS HC/MF A18 CSCL 11/6

A durability and damage tolerance (DADT) data base for aluminum casting alloys D357-T6 and B201-T7 was developed and the applicability of ultrasonic and low frequency eddy-current NDI methods to castings was assessed. Relationships among composition, heat treatment, solidification rate, microstructure, and mechanical properties were investigated using multiple regression analyses. Strontium (silicon modifier) and silver had the most significant impact on the properties of D357-T6 and B201-T7 respectively. Constant amplitude fatigue data were used to calculate an equivalent initial flaw size for both alloys. Spectrum fatigue results for D357-T6 were used to assess the applicability of current military DADT specifications to aluminum castings. The effect of intentionally-added defects (D357-T6) and nonoptimum microstructure (D357-T6 and B201-T7) on mechanical properties was determined. Four large, complex aerospace castings were produced and tested to confirm that the property data base, which was obtained for cast plates, is applicable to aircraft applications. A D357 specification for durability and damage tolerance applications was submitted to the Society of Automotive Engineers. GRA

N92-21744# Rolls-Royce Ltd., Derby (England).
THE SEARCH FOR NEW MATERIALS
S. C. MILLER 1 Oct. 1990 9 p
(PNR-90777; ETN-92-90765) Copyright Avail: NTIS HC/MF A02

The technology of advanced materials is considered and their great potential for improving the industry's operations is stressed. Their use in avionics, structural applications to airframes and in the aeroengine scene is considered. Families of materials and their development are traced and the 747-524 combination's performance as it could be improved by the materials which will become available in about 15 years time are considered. ESA

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ENGINEERING

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

A92-28556
EVOLVING PARTNERSHIP FOR NDE IN MATERIALS ENGINEERING AND EXTENDED LIFE CYCLE PERFORMANCE
DON M. FORNEY, JR. (USAF, Materials Laboratory, Wright-Patterson AFB, OH) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10A. New York, Plenum Press, 1991, p. 13-33.
Copyright

The expanding role of NDI and NDE in the 1990s is discussed. Emphasis is given to the use of NDI/E as an interactive evaluation tool during advanced materials development and applications and as an essential ingredient of any comprehensive integrated life cycle engineering process. Software gating and laser-generated and laser detected ultrasonics are discussed as examples of advanced NDI/E techniques, and the NDI/E of reactor pressure vessels in nuclear power plants, bridges, and offshore drilling platforms are addressed. The use in NDI/E of technology from other fields is discussed. C.D.

A92-28588
NEW DEVELOPMENTS IN THE COMPUTER SIMULATION OF X-RAY NONDESTRUCTIVE EVALUATION PROCESS
F. INANC and J. GRAY (Iowa State University of Science and Technology, Ames) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10A. New York, Plenum Press, 1991, p. 355-362. Research supported by Iowa State University of Science and Technology. refs
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A new simulation code approach has been implemented to treat the energy dependency of photon-sample interactions in NDE. The dependency is handled through a multigroup model where the energy domain is divided into G groups which results in G energy independent systems. A new interface between the code and the CAD package enables speedy extraction of part information from designs. Examples are used to show that the code performs various tasks in a more realistic and efficient manner. C.D.

A92-28592
THE USE OF CT FOR DIMENSIONAL MEASUREMENTS OF GREEN AND SINTERED CERAMIC COMPONENTS
W. D. FRIEDMAN, P. ENGLER, M. W. SANTANA (BP Research, Cleveland, OH), R. W. OHNSORG, and D. A. WHITE (Carborundum Corp., Niagara Falls, NY) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10A. New York, Plenum Press, 1991, p. 419-426. Research sponsored by DOE. refs
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CT is shown here to be a useful method for the accurate measurement of the shape of complicated parts, including green and sintered ceramic components. The accuracy is 0.035 mm for given scan parameters, based on a 1 sigma variation in the thickness measurements of a SiC step wedge. The precision is based on the measurement consistency and approaches 0.020 mm. C.D.

A92-28633
A NEW METHOD TO ESTIMATE THE EFFECTIVE GEOMETRIC FOCAL LENGTH AND RADIUS OF ULTRASONIC FOCUSED PROBES
F. AMIN, T. A. GRAY, and F. J. MARGETAN (Iowa State University

of Science and Technology, Ames) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10A. New York, Plenum Press, 1991, p. 861-865. refs
(Contract F33615-87-C-5232)
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A new technique is presented for determining the effective radius and effective geometric focal length (i.e., the asymptotic high frequency, or optical limit) of an ultrasonic focused transducer. In this method, the effective radius and the focal length are extracted by optimizing the agreement between experimental data measured from a target at normal incidence and the computer model of the same phenomena. The method was found to be quite successful in estimating these two parameters at the probe's center frequency. The technique requires a relatively simple experimental setup and only modest computational resources. I.S.

A92-28655* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THERMAL IMAGING OF GRAPHITE/EPOXY COMPOSITE SAMPLES WITH FABRICATED DEFECTS
JOSEPH N. ZALAMEDA (NASA, Langley Research Center; U.S. Army, Aviation Research and Technology Activity, Hampton, VA) and WILLIAM P. WINFREE (NASA, Langley Research Center, Hampton, VA) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10A. New York, Plenum Press, 1991, p. 1065-1072. refs
Copyright

Consideration is given to a thermal inspection system for quickly inspecting large area composites for increased reliability and maintainability of helicopters resulting from improved quality assurance manufacturing. The infrared camera/image processor-based inspection system was used to image defects in composites. Noncontacting and single-sided measurements were performed on graphite/epoxy samples with fiber volume fraction variations, fabricated porosity, impact damage, and inclusions in incurred lay ups. These defects were imaged by determining the variations in the cooling rates caused by differences in through ply thermal diffusivity. Attention is also given to the system's sensitivity to measuring the defects due to sample thickness. O.G.

A92-28669
THE DETECTION OF DAMAGE AND THE MEASUREMENT OF STRAIN WITHIN COMPOSITES BY MEANS OF EMBEDDED OPTICAL FIBER SENSORS
RAYMOND M. MEASURES (Toronto, University, Downsview; Ontario Laser and Lightwave Research Centre, Canada) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 1247-1258. Research supported by Ontario Laser and Lightwave Research Centre, NSERC, Institute for Space and Terrestrial Science, and Ontario Centre for Materials Research. refs
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A fiber-optic damage assessment test system has been devised within the leading edge of a commercial aircraft, demonstrating the ability to embed optical fiber systems within practicable composite structures. The Michelson fiber-optic sensors thus realized and calibrated have detected damage-induced acoustic emission. An optical strain rosette has also been embedded within a composite host and tested; the comparatively limited applicability of a Michelson device in prospective smart structures then led to the development of a composite-embedded Fabry-Perot fiber-optic sensor. O.C.

A92-28672
SMART STRUCTURES - A DAMAGE DETECTION CONCEPT
JEAN E. OTT (LTV Aircraft Products Group, Dallas, TX) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 1273-1280. refs
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A damage-detection conceptual framework is presently developed for the interpretation of smart structure strain data measurements. It is analytically demonstrated that normalized strain distribution can be used to determine damage by comparison of baseline distributions with distributions where damage is present. This approach greatly simplifies total-area requirements by eliminating exact flight data identification. Both fiber-optic point-strain sensors and neural-network pattern recognition are employed in the present system. O.C.

A92-28684
THIN BONDLINE MEASUREMENT OF ADHESIVELY BONDED METALLIC AIRCRAFT STRUCTURES USING AN ULTRASONIC ANALYZER
WOODY WONGWIWAT (Rohr Industries, Inc., Chula Vista, CA), ROBERT RIZZO (Grumman Corp., Bethpage, NY), and DONALD RIQNEY (Decilog, Inc., Melville, NY) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 1375-1382. refs
Copyright

An NDE process capable of rapidly and accurately discerning bondlines in the 0.002-0.006 range has been developed which operates ultrasonically in both the through-transmission and pulse-echo modes. A computer code is used to analyze the ultrasonic waveforms captured by specially designed contact transducers and a digitizing oscilloscope. Key peaks associated with the reflected energy paths through the structure were identified. The through-transmission mode was used to calculate bondlines by comparing the time-delay shift between a waveform captured in a known standard and the waveform of an unknown; the standards were created to simulate single-, double-, and triple-bondline sandwich structure manufactured from 2024-T3 Al alloy sheet and FM-73 adhesive. When automated, the process allowed quantitative NDE to be conducted at 1 point every 5 sec with through-transmission, and 1 point per sec with the pulse-echo technique, on average. O.C.

A92-28686
CHARACTERIZATION OF DIFFUSION BONDS USING AN ACOUSTIC MICROSCOPE
AMIT K. SOM (University College, London, England), LEONARD J. BOND (Colorado, University, Boulder), and KEVIN J. TAYLOR (British Aerospace, PLC, Preston, England) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 1391-1398. Research supported by Ministry of Defence of England. refs
(Contract SERC-XG/10909; SERC-GR/F/27062)
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A pulsed digital reflection acoustic microscope (PDRAM) operating in the 25-100 MHz is presently used to characterize the diffusion-bond lines of Ti-Ti bonded sheet materials at 50 MHz. Acceptable diffusion bonds are found to be distinguishable from unacceptable ones via PDRAM. It is also found that the leaky Rayleigh-wave inspection technique, when applied to micrographic samples, allows calibration of the response of various types of diffusion bonds; this data can then be related to the response obtainable via conventional compression-wave inspections conducted at the same frequency. O.C.

A92-28690
ULTRASONIC NDE FOR CERAMIC- AND METAL-MATRIX COMPOSITE MATERIAL CHARACTERIZATION
MANOHAR BASHYAM (GE Aircraft Engines, Cincinnati, OH) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 1423-1430. refs

(Contract F33615-88-C-5433)
Copyright

Ultrasonic NDE methods are presently defined for an SiC fiber-reinforced plasma-sprayed Ti-6Al-4V matrix MMC and two calcium aluminum silicate-matrix CMCs respectively reinforced by SCS6 and Nicalon SiC fibers. Internal features of these materials are addressed via ultrasonic velocity, attenuation, backscatter, and surface wave techniques, giving attention to uneven fiber distributions, incomplete bonding or cracking between fibers, and such defects as fiber breakage, fiber misalignment, incorrect fiber volume fraction, matrix porosity, and delamination. O.C.

A92-28725
X-RAY COMPUTED TOMOGRAPHIC INSPECTION OF CASTINGS
R. H. BOSSI, J. L. CLINE, and G. E. GEORGESON (Boeing Aerospace and Electronics, Seattle, WA) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 1783-1790. Research sponsored by USAF. refs
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The use of CT scans to inspect castings is addressed. The sensitivity of CT scans and radiographic tests are compared for small casting defect coupons and for full scale castings. Correlations of CT system performance criteria such as resolution and noise with anomaly detection sensitivity are established. Dimensional measurement accuracy of CT for configuration control of castings is evaluated. C.D.

A92-28737
ACOUSTIC EMISSION MONITORING OF A GROUND DURABILITY AND DAMAGE TOLERANCE TEST
STUART MCBRIDE, MELVYN VINER, and MICHAEL POLLARD (Royal Military College of Canada, Kingston) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 1913-1919. Research supported by DND. refs
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A large area of the lower wing skin of a fighter aircraft was monitored while conducting a ground durability and damage tolerance test. The presence of cracks in the lower wing skin and inner spar structure is predicted by AE. All AE predictions of crack locations were confirmed employing conventional NDT methods which were not predicted by AE. This study shows the superior sensitivity of AE compared to more conventional sensitive NDT techniques in this application. R.E.P.

A92-28745
NORTEC 30 EDDYSCAN - PORTABLE FLAW IMAGING FOR AGING AIRCRAFT
JOE CAMPBELL and MARTIN GIBBS (Staveley Instruments, Inc., Kennewick, WA) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 2061-2068.
Copyright

A new type of eddy current inspection instrument, the Nortec 30 Eddyscan, is presented. This battery powered instrument combines microprocessor-based iterative video display, signal processing, and automatic data logging functions. It uses a rotating Hall effect scanner and other inspection and imaging techniques to simplify in-plane inspection for fatigue cracks in aircraft skins and structures. Advantages over conventional eddy current testing techniques include reduced operator interpretation, inspection of many layers simultaneously, excellent accuracy and sensitivity, speed and simplicity of operation, and no surface preparation. Inspections are conducted with ferrous or nonferrous fasteners left in place. Radial position, approximate depth, and relative size of defects are determined in any layer, including the countersunk area hidden directly under a fastener head, to as deep as 7 mm with nonferrous and 13 mm with ferrous fasteners. O.G.

A92-28747
NEUTRON RADIOGRAPHY WITH SNRS
KENNETH ALVAR, ROBERT CUNNINGHAM, RAULF POLICHAR, and DOUGLAS SMITH (Science Applications International Corp., San Diego, CA) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 2077-2084.
Copyright

An overview of the operation of the Stationary Neutron Radiography System (SNRS) to be used for the inspection of F-111 aircraft components for corrosion is presented. The SNRS is a real-time neutron radiography system to examine components, including complete wings transported past a thermal neutron beam and viewed in real-time for the presence of hydrogen in the form of aluminum hydride corrosion or free water. The neutron imaging system acquires images and sends them to the image interpretation system for storage and analysis. R.E.P.

A92-28748
AN ADVANCED NEUTRON RADIOGRAPHY SYSTEM
W. J. RICHARDS (USAF, Air Logistics Center, McClellan AFB, CA) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 2085-2090. refs
Copyright

The Stationary Neutron Radiography System (SNRS) nuclear reactor and radiography systems and their performance are described. The primary mission of the SNRS is to conduct neutron radiographic inspections of aircraft components to detect corrosion and moisture. Preliminary measurements indicate that the facility is capable of producing high quality real-time and film radiography. The reactor is capable of providing various additional services including sample irradiations, nuclear harness testing, in-core irradiations, in-core pneumatic rabbit system irradiations, neutron activation analysis, and pulse and square wave operation. R.E.P.

A92-28750
X-RAY COMPUTED TOMOGRAPHY FOR THE AIRCRAFT/AEROSPACE INDUSTRY
R. H. BOSSI, B. W. KNUTSON, J. L. CLINE, R. J. KRUSE, and G. E. GEORGESON (Boeing Aerospace and Electronics, Seattle, WA) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 2121-2127. Research sponsored by USAF. refs
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Results are presented from experiments in which X-ray computed tomography (CT) was used for detecting anomalies in aircraft components. It is shown that CT could detect a misaligned core in a potted transformer and a delamination in a graphite/epoxy pultruded Z stiffener, could be used to nondestructively scan a graphite/epoxy woven J stiffener, and could produce an image of a drum casting showing a defect. It is suggested that the most beneficial application of CT will be in using CT data for component acceptance by engineering criteria rather than by inspection standards. I.S.

A92-29504
BRAZING METHOD HELPS REPAIR AIRCRAFT GAS-TURBINE NOZZLES
WAYNE A. DEMO and STEPHEN J. FERRIGNO (GE Aircraft Engines, Cincinnati, OH) Advanced Materials and Processes (ISSN 0882-7958), vol. 141, March 1992, p. 43-45.
Copyright

The brazing-based method of activated diffusion healing (ADH) is a cost-effective means for the extension of gas turbine hot-section hardware service life. ADH consists of cleaning, crack-filling, brazing, and postprocessing steps. Relative to GTA welding, ADH involves less operator skill, easier control, and simultaneous 'batch' control of as many as 60 gas turbine high

pressure section nozzles at a time; GTA can process only a single unit at a time. O.C.

A92-29609# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
EXPERIMENTAL RESULTS AND NUMERICAL MODELING OF SOLIDIFICATION DURING AIRCRAFT HIGH-G ARCS
P. A. CURRERI (NASA, Marshall Space Flight Center, Huntsville, AL), N. RAMACHANDRAN (Universities Space Research Association, Huntsville, AL), J. P. DOWNEY (NASA, Marshall Space Flight Center, Huntsville, AL), and J. C. JONES (Wyle Laboratories, Huntsville, AL) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. Research supported by NASA. refs
(AIAA PAPER 92-0843) Copyright

The question of how the Coriolis and gravity gradient forces during high-gravity maneuvers compare to that for common centrifuges is addressed. Microstructural examination of samples solidified during high-gravity arcs reveals no evidence of convection dampening. As a first approximation, the high-gravity arc is modeled as a centrifuge with a radius of 20,480 ft and angular speed of 0.318 rpm. Scaling analysis indicates that the Coriolis and gravity gradient expected on the aircraft high gravity arc are less than that for the centrifuges by a factor of 100. Detailed Navier-Stokes analysis of the fluid flow and thermal fields during solidification of aluminum and Cd-Te during KC-135 high gravity show that convective flows of about 1 mm/s are induced. The thermal field is only slightly modified by the convection. Coriolis and gravity gradient during solidification in KC-135 high-gravity arcs, even at accelerations that have been shown to produce significant convective flow dampening in the centrifuge systems, are found to have no significant influence on the melt thermal and flowfields. P.D.

A92-29610*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
CONVECTIVE FLOW ANALYSIS ON THE KC-135 AIRCRAFT
GARY L. WORKMAN and WILLIAM F. KAUKLER (Alabama, University, Huntsville) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(Contract NAS8-36955)
(AIAA PAPER 92-0844) Copyright

A study conducting bouyancy driven convective flow experiments on the NASA KC-135 aircraft is presented. The response of a contained fluid (with an imposed temperature gradient) to changing g-levels during parabolic flight was obtained. Models for both transient and steady state flows were developed utilizing PC-based CFD software. Comparisons between the theoretical models and the physical observations are quite good. R.E.P.

A92-29722
FLOW PATTERN CHARACTERIZATION AND HEAT TRANSFER BEHAVIOR IN A BOILING TWO-PHASE FLOW IN AN INCLINED PIPE
NING OUYANG and DEZHANG LIU (Nanjing Aeronautical Institute, People's Republic of China) IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 124-133. Research supported by National Aeronautical Science and Research Fund. refs

The movable electrical conducting probe (MECP) is a simple and reliable technique for ascertaining full-path flow patterns in a boiling liquid/vapor, two-phase flow. Bubbling, intermittent and annular flow regimes have been characterized via MECP. The flow pattern analyses thus facilitated have led to the determination of heat transfer coefficients along the full-flow path. A substantial potential for the augmentation of heat-transfer efficiency is identified in several flow pattern zones. O.C.

A92-30147
GASDYNAMIC CALCULATION OF AN IMPULSE WIND TUNNEL WITH A TWO-SECTION PLENUM [GAZODINAMICHESKII RASCHET IMPUL'SNOI USTANOVKI S DVUKHSEKTSIONNOI FORKAMEROI]
V. A. ZHOKHOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 50-60. In Russian. refs
Copyright

An approximate method is proposed for calculating the process taking place in an impulse wind tunnel with a two-section plenum. A comparative analysis is made of the approximate and exact solutions to the system of equations describing the wind tunnel process. Possible applications of the approach proposed here are discussed. V.L.

A92-30152
STABILITY OF STIFFENED PANELS WITH ALLOWANCE FOR PLASTICITY UNDER NONSTATIONARY HEATING AND LOADING [USTOICHIVOST' PODKREPLENNYKH PANELEI S UCHETOM PLASTICHNOSTI PRI NESTATSIONARNOM NAGREVE I NAGRUZHENII]
A. A. IONOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 101-110. In Russian. refs
Copyright

A method and an algorithm are proposed for determining the critical buckling state of plates stiffened by elastic ribs under nonstationary heating and loading with allowance for the plastic behavior of the material. The efficiency of the mathematical formalism and software developed here is demonstrated using theoretical and practical problems. V.L.

A92-30161
INVESTIGATING THE FEASIBILITY OF CONTROLLING THE LAMINAR-TURBULENT TRANSITION BY MEANS OF LAMINARIZING PLATES [ISSLEDOVANIE VOZMOZHNOSTI UPRAVLENIIA LAMINARNO-TURBULENTNYM PEREKHODOM S POMOSHCH'IU LAMINARIZIRUIUSHCHIKH PLASTIN]
I. A. BELOV and V. M. LITVINOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 3, 1990, p. 39-46. In Russian. refs
Copyright

The effect of installing plane-parallel laminarizing plates into the laminar boundary layer on the development of artificially induced vortex disturbances and on the position of the laminar-turbulent transition was investigated in experiments performed in a subsonic 1.2-m-diam tunnel. The laminarizing plate was a 1000 x 500 x 20 mm flat metal plate with an ellipsoidal frontal edge. It was found that the introduction of the plate resulted in damping of the near-wall velocity fluctuations and, under certain conditions, in a downstream displacement of the laminar-turbulent transition. I.S.

A92-30162
EFFECT OF TURBULENT MIXING ON THE CHARACTERISTICS OF A TURBOFAN-ENGINE NOZZLE [VLIIANIE TURBULENTNOGO PEREMESHIVANIIA NA KHARAKTERISTIKI SOPL DVUKHKONTURNYKH TRD]
V. L. ZIMONT and O. V. MAKASHEVA TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 3, 1990, p. 47-55. In Russian. refs
Copyright

Using the hydraulic nozzle theory, the effect of mixing, using a lobed mixer, on the momentum flux, the flow discharge coefficient, and the cross section area of a turbofan-engine nozzle is investigated for the direct and the inverse problems. Results are presented from computations of the effects of mixing and gas-dynamic nonuniformities on the momentum flux and the flow coefficients in an axisymmetric flow. I.S.

A92-30170
DETERMINATION OF THE OBJECTIVE-FUNCTION GRADIENT IN THE PROBLEM OF MINIMIZING STRESS CONCENTRATION USING THE FINITE ELEMENT METHOD [OPREDELENIE GRADIENTA TSELEVOI FUNKTSII V ZADACHE O MINIMUME KONTSENTRATSII NAPRIAZHENII NA OSNOVE METODA KONECHNYKH ELEMENTOV]
V. I. GRISHIN and F. V. RYBAKOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 3, 1990, p. 128-134. In Russian. refs
Copyright

The paper examines the problem of optimizing the shape of an elastic body for the purpose of minimizig the stress concentration. Using implicit functions to represent the body contour, a method was developed for calculating the objective-function gradient from the body-shape parameters. The effect of the internal node position in the finite-element model on the accuracy of the gradient computations was investigated. Recommendations are proposed concerning the application of the method to solutions of practical problems. I.S.

A92-30208
EFFECT OF SHOCK WAVES ON THE CRITICAL RATE OF BENDING-TORSIONAL FLUTTER OF AN AIRFOIL [VLIIANIE SKACHKOV UPLOTNENIIA NA KRITICHESKUIU SKOROST' IZGIBNO-KRUTIL'NOGO FLATTERA AERODINAMICHESKOGO PROFILIA]
A. V. SAFRONOV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 90-97. In Russian. refs
Copyright

An analytical approximation is presented for the critical dynamic pressure of the bending-torsional flutter of a thin airfoil in a transonic flow with shock waves. It is shown that in this case the critical dynamic pressure can be much less than in the case of shock-free flow. L.M.

A92-30476
ENCLOSING SHAPES FOR SINGLE-DOPPLER RADAR FEATURES
F. W. WILSON, JR., R. K. GOODRICH, and K. BRISLAWN (NCAR, Boulder, CO) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 9, April 1992, p. 97-107. Research supported NCAR and NSF. refs
(Contract DTFA01-82-Y-10513)
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The primary function of the Terminal Doppler Weather Radar (TDWR) system is to issue microburst alerts when a microburst hazard endangers aircraft. The steps of the algorithm process include determining that a microburst hazard is present and composing a microburst-alert message when it is determined that the hazard region encroaches on the runway corridor. The microburst hazard region is described as a family of simple stylized shapes. This paper presents the computational procedure used to generate these shapes from primitive TDWR microburst algorithm products and describes the generation of alert messages from the shapes. Author

A92-30501
FLUID DYNAMICS CONFERENCE, 22ND, OSAKA, JAPAN, NOV. 15, 1990, PROCEEDINGS
Conference sponsored by Japan Society for Aeronautical and Space Sciences. Tokyo, Japan Society for Aeronautical and Space Sciences, 1990, 257 p. In Japanese and English. For individual items see A92-30502 to A92-30560.

Papers are presented on such topics as supersonic multiphase flow, continuum and rarefied gas flow, the numerical simulation of hypersonic rarefied gas flow around a reentry vehicle, the DSMC analysis of hypersonic rarefied gas flow, application of the null collision direct simulation Monte Carlo (DSMC) methods, the use of 2D curved pipes to reduce shock waves, and shock wave diffraction at a 90-deg corner. Consideration is also given to a numerical study of mixing layer control, numerical simulation of hypersonic flow around HOPE, the unstructured upwind method, boundary layer flow around a cylinder, evaporation and condensation of a polyatomic molecular gas flow, a study of cavity pumping in supersonic internal flow, computation of scramjet inlet flow, and a numerical analysis of laminar flow control of transonic airfoils. Y.P.Q.

A92-30603
MANUFACTURE OF XD GAMMA TITANIUM ALUMINIDE AIRFOILS VIA INVESTMENT CASTING AND MACHINING
G. COLVIN, M. CIANCI, B. KLEYN, and L. VANDERLEEST (Howmet Corp., Whitehall, MI) IN: Microstructure/property relationships in titanium aluminides and alloys; Proceedings of the Symposium, Fall Meeting of the Minerals, Metals, and Materials Society, Detroit, MI, Oct. 7-11, 1990. Warrendale, PA, Minerals, Metals, and Materials Society, 1991, p. 361-369. refs
(Contract MDA972-88-C-0047)
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Thirty turbine blades were manufactured from the Ti-48Al-2V (at. pct) + 7.5 vol pct TiB2 'XD' gamma alloy. Investment casting, postcast processing, electrochemical machining, and conventional grinding methods were developed representing the first time these processes were demonstrated on a scale large enough to manufacture aerospace components from this titanium aluminide material. A total of nine 250-lb ingots were manufactured. A sponge was incorporated into the alloy during ingot manufacturing to provide a dispersion of TiB2 particulates. The ingots were remelted using vacuum-arc technology and investment cast into overstocked blade preforms. The blades were postcast-processed including hot isostatic pressing, heat treatment, chemical milling, and dimensional inspection. The gas-path flow surfaces and the root and outer shroud regions were machined to blueprint dimensions. Author

A92-31071
HIGH-FREQUENCY TECHNIQUES FOR ANTENNA ANALYSIS
PRABHAKAR H. PATHAK (Ohio State University, Columbus) IEEE, Proceedings (ISSN 0018-9219), vol. 80, Jan. 1992, p. 44-65. refs
(Contract N00014-88-K-0004)
Copyright

A summary of various high-frequency techniques is presented for analyzing the electromagnetic radiation from antennas in the presence of their host environment. These techniques provide physical insight into antenna radiation mechanisms and are found to be highly efficient and accurate for treating a variety of practical antenna configurations. Examples to which these techniques were applied include open-ended waveguide antennas, horn and reflector antennas, and antennas on aircraft and spacecraft. The accuracy of these techniques is established via numerical results which are compared with those based on other independent methods or with measurements. These high-frequency methods can be combined with other techniques through a hybrid scheme to solve an even greater class of problems than those which can be solved in an efficient and tractable manner by any one technique alone. I.E.

A92-31084
ANTENNAS ON COMPLEX PLATFORMS
RONALD J. MARHEFKA and WALTER D. BURNSIDE (Ohio State University, Columbus) IEEE, Proceedings (ISSN 0018-9219), vol. 80, Jan. 1992, p. 204-208. Research supported by Ohio State University Research Foundation. refs
Copyright

The modeling of antennas on complex platforms is reviewed. The objective is to analyze the modification of the basic antenna performance due to its environment. This includes pattern distortion, antenna-to-antenna spacial coupling, and radiation-hazard predictions. High frequency methods are used to develop computer codes to accomplish these tasks. Several types of generally available codes are discussed. I.E.

A92-31164
CALCULATIONS OF THE DILUTION SYSTEM IN AN ANNULAR GAS TURBINE COMBUSTOR

J. J. MCGUIRK and J. M. L. M. PALMA (Imperial College of Science, Technology, and Medicine, London, England) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 963-972. Research supported by Ministry of Defence of England. refs
Copyright

The present work is concerned with the ability of a two-equation turbulence model (K-epsilon) of predicting accurately the mixing parameters at the outlet of an annular gas turbine combustor. A comparison between numerical and experimental results is presented with attention paid to numerical accuracy and boundary condition sensitivity. A numerical grid with 36,000 nodes was needed to resolve the flow inside a 7.5-deg annular sector. It was found that an insufficient number of grid nodes led to the underprediction of the streamwise vorticity and a different flow pattern in the wake and downstream of the jets. Two basic sets of calculations with constant and variable density are included. The calculations could predict the general features of the flow, but evidenced lower levels of mixing compared to the experiments, even with a reduction of the turbulent Prandtl number from 0.9 to 0.5. Author

A92-31173
SEMICONDUCTOR LASER DOPPLER ANEMOMETER FOR APPLICATIONS IN AERODYNAMIC RESEARCH
FRANZ DURST, REINER MUELLER, and AMIR A. NAQWI (Erlangen-Nuernberg, Universitaet, Erlangen, Federal Republic of Germany) (ICIASF '89 - International Congress on Instrumentation in Aerospace Simulation Facilities, 13th, Goettingen, Federal Republic of Germany, Sept. 18-21, 1989, Record, p. 215-225) AIAA Journal (ISSN 0001-1452), vol. 30, April 1992, p. 1033-1038. Previously cited in issue 11, p. 1674, Accession no. A90-28273. refs
Copyright

A92-31194* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STABILITY OF A NONORTHOGONAL STAGNATION FLOW TO THREE-DIMENSIONAL DISTURBANCES
D. G. LASSEIGNE and T. L. JACKSON (Old Dominion University, Norfolk, VA) Theoretical and Computational Fluid Dynamics (ISSN 0935-4964), vol. 3, Feb. 1992, p. 207-218. Previously announced in STAR as N91-27501. refs
(Contract NAS1-18605)
Copyright

A similarity solution for a low Mach number nonorthogonal flow impinging on a hot or cold plate is presented. For the constant density case, it is known that the stagnation point shifts in the direction of the incoming flow and that this shift increases as the angle of attack decreases. When the effects of density variations are included, a critical plate temperature exists; above this temperature the stagnation point shifts away from the incoming stream as the angle is decreased. This flowfield is believed to have application to the reattachment zone of certain separated flows or to a lifting body at a high angle of attack. Finally, the stability of this nonorthogonal flow to self similar, 3D disturbance is examined. Stability properties of the flow are given as a function of the parameters of this study; ratio of the plate temperature to that of the outer potential flow and angle of attack. In particular, it is shown that the angle of attack can be scaled out by a suitable definition of an equivalent wavenumber and temporal growth rate, and the stability problem for the nonorthogonal case is identical to the stability problem for the orthogonal case. Author

A92-31198
NON-HOMOGENEOUS BARS UNDER TENSION, PURE BENDING AND THERMAL LOADS
HELMUT RAPP (MBB GmbH, Munich, Federal Republic of Germany) Composites Science and Technology (ISSN 0266-3538), vol. 44, no. 1, 1992, p. 21-28. refs
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Nonhomogeneous bars may show discrepancies in stiffness and thermal expansion between the engineering theory of bending and experiment. The cause of this is the additional stresses perpendicular to the bar axis if materials with different Poisson's ratios are used. When fiber-reinforced materials are used, these stresses, in particular, have to be taken into account. In the engineering theory of bending, these stresses are always neglected so that the influence they may have cannot be determined. A theory based on the generalized state of plane strain is given for evaluating the effective bar stiffnesses. Theoretical and test results for a special test bar show the large influence these stresses may have. Author

A92-31486
CFD STATE-OF-THE-ART IN THE U.S.S.R
O. M. BELOTSERKOVSKII (Russian Academy of Sciences, Institute of Computer Aided Design, Moscow, Russia) (International Association for Computational Mechanics, World Congress of Computational Mechanics, 2nd, Stuttgart, Federal Republic of Germany, Aug. 27-31, 1990) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 34, March 30, 1992, p. 395-415. refs
Copyright

Numerical methods for modern problems of CFD are described. Steady and unsteady aerodynamic flows, different turbulent regimes, and motion around complex-shape bodies (aircraft as a whole) are investigated. These approaches sharply reduce the level of demand on computer sources. P.D.

A92-31552
A TORQUE-FREE FLEXIBLE MODEL GYRO
F. P. J. RIMROTT and F. JANABI-SHARIFI (Toronto, University, Canada) ASME, Transactions, Journal of Applied Mechanics (ISSN 0021-8936), vol. 59, March 1992, p. 7-15. refs
Copyright

The present investigation is concerned with the behavior of an elastic, oblate, torque-free gyro model. The model has been devised such that it represents accurately arbitrarily large attitudes and arbitrarily large deformations. The expressions for inertia moments, angular moments, kinetic and elastic energies are all exact, and the mass center of the model gyro does not shift within the gyro. The model is composed of a rigid massless rod connected elastically to a rigid massive disk. At the tip of each rod there is a point mass. The nonlinear equations of quasi-static motion are derived using Euler's law, and a floating coordinate frame. Following the analysis, various numerical examples are investigated and the results are plotted. The total mechanical energy of the system is determined, and the condition for existence of an energy trap state is obtained. When trapped, the gyro is in effect rigid, has a stable attitude, and rotates around the principal axis of maximum inertia, which in turn is collinear with the space-fixed angular momentum vector. Author

A92-31564
ON THE BEHAVIOR OF PRETWISTED BEAMS WITH IRREGULAR CROSS-SECTIONS
J. B. KOSMATKA (California, University, La Jolla) ASME, Transactions, Journal of Applied Mechanics (ISSN 0021-8936), vol. 59, March 1992, p. 146-152. refs
(Contract NSF MSM-88-09132)
Copyright

An analytical model is developed to study the extension-bending-torsion coupling behavior of an initially twisted elastic beam with an irregular cross-section. The determination of the complete displacement field requires solving a coupled two dimensional boundary value problem in a curvilinear coordinate system for the local deformations in the section plane and warping out of the section plane. The principle of minimum potential energy is applied to a discretized representation of the cross-section (Ritz method) to calculate solutions to this problem. Numerical results illustrate the pronounced effects pretwist, initial twist axis location, and in-plane deformation have on the behavior of solid and single and multi-celled sections, including airfoil sections. Author

A92-31630* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A PARALLEL-SERIES-FED MICROSTRIP ARRAY WITH HIGH EFFICIENCY AND LOW CROSS-POLARIZATION
JOHN HUANG (JPL, Pasadena, CA) Microwave and Optical Technology Letters (ISSN 0895-2477), vol. 5, May 1992, p. 230-233. refs
Copyright

The requirements of a microstrip array with a vertically polarized fan beam are addressed that correspond to its use in C-band interferometric SAR. A combination of parallel- and series-feed techniques are utilized in an array design with a three-stage parallel-fed configuration to enhance bandwidth performance. The linearly polarized traveling-wave microstrip array antenna is fed by microstrip transmission lines in two rows of 36 elements that resonate at 5.30 GHz. The transmission lines are impedance-matched at every junction for all the waves that travel toward the two ends of the array. The two measured principal-plane patterns are shown, and the measured narrow-beam pattern is found to agree with the calculated values. The VSWR bandwidths and narrow and broad beamwidths of the antenna are found to permit efficient performance. The efficiency is attributed to the parallel and series-feed configuration which allows proper impedance matching, and low cross-polarization is a result of the antiphase feed technique employed in the configuration. C.C.S.

A92-31655#
THREE-DIMENSIONAL FLOW COMPUTATION FOR TWO INTERACTING, MOVING DROPLETS
I. KIM, S. ELGHOBASHI, and W. A. SIRIGNANO (California, University, Irvine) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. Research supported by San Diego Supercomputer Center and Pittsburgh Supercomputing Center. refs
(Contract AF-AFOSR-90-0064)
(AIAA PAPER 92-0343) Copyright

A numerical simulation is performed for the three-dimensional interaction of two moving droplets which are injected into an initially quiescent fluid medium. The pressure and velocity fields around each of the droplet are modified due to the presence of the other droplet. Drag and lift are therefore different from the values for an axisymmetric flow around a single isolated droplet. The droplets decelerate due to the drag and changing their direction of motion due to the lift. By choosing the origin of a noninertial reference frame at the center of mass of the two droplets, the Navier-Stokes equations are solved with a noninertial term in an iterative manner. For small initial separation, the lift forces are repelling, thereby increasing the separation. For larger initial separation, a slight attraction occurs. Author

A92-31778
NAVIGATION - LAND, SEA, AIR, AND SPACE
MYRON KAYTON, ED. (Kayton Engineering Co., Santa Monica, CA) New York, IEEE Press, 1990, 478 p. No individual items are abstracted in this volume.
(ISBN 0-87942-257-2) Copyright

This work strives to be a comprehensive tutorial on navigation for all vehicles; it comprises eight original introductions and 39 reprints selected to illustrate modern navigation technology. The topics addressed are cartography, land navigation, ship navigation, aircraft navigation, space navigation, animal navigation and its applications to man, and predictions on navigation in the 21st century. B.J.

A92-31858
REDUCTION OF COMPUTATIONAL MODELS IN STRENGTH PROBLEMS [REDUTSIROVANIE RASCHETNYKH MODELEI V ZADACHAKH PROCHNOSTI]
D. D. EVSEEV, E. K. LIPIN, and V. V. CHEDRIK TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 1, 1991, p. 61-71. In Russian. refs
Copyright

A method is proposed for reducing discrete finite element models for thin-walled structures to discrete-continuous computational models for strength problems. The method is based on the reduction of the stiffness matrix of a discrete structure model by using a transition matrix obtained during the derivation of the node displacement vector from the specified forms of displacements of the discrete-continuous model. The efficiency of the approach is demonstrated for the reduction of the stiffness matrix of a finite element model of a wing structure to generalized stiffness matrices of a structurally anisotropic plate and a set of such plates. V.L.

A92-31892
A STUDY OF FLOW OF A FLUID FILM ON THE SURFACE OF A PLATE IN THE CASE OF SLOT INJECTION [ISSLEDOVANIE TECHENIIA ZHIDKOI PLENKI NA POVERKHNOSTI PLASTINY PRI SHCHELEVOM VDUVE]
P. E. BABIKOV, IU. N. ERMAK, and M. A. NAIDA TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 22, no. 3, 1991, p. 51-60. In Russian. refs
Copyright

The problem of flow of a fluid film injected through a slot on the surface of a plate in the path of supersonic flow of a viscous thermally conducting gas is investigated analytically. The effect of the initial and boundary conditions on the length and shape of the film is determined. The initial-boundary value problem is formulated and solved numerically. V.L.

A92-31988
RELATIONSHIP BETWEEN THE ROTATING STALL AND VIBRATIONS OF A BLADE ROW [VZAIMOSVIAZ' VRASHCHAIUSHCHEGOSIA SRYVA I VIBRATSII LOPATOCHNOGO VENTSA]
N. P. ALESHIN (Zaporozhskoe Mashinostroitel'noe Konstruktorskoe Biuro Progress, Zaporozhe, Ukraine) Problemy Prochnosti (ISSN 0556-171X), no. 1, 1992, p. 82-87. In Russian. refs
Copyright

Based on an analysis of experimental data obtained for transonic fans and multistage axial-flow compressors, a relationship is established between the rotating stall phenomenon and the associated vibration of blade rows. Expressions describing this relationship are derived. Details of the analytical procedure and graphic representations of the experimental results are presented. V.L.

A92-32130
FEATURE EXTRACTION FROM TWO-DIMENSIONAL IMAGES USING FRACTAL ANALYSIS
DARREL BAUMGARDNER (NCAR, Boulder, CO) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. J85-J87. refs
Copyright

The paper discusses the application of fractal analysis for the extraction of features from irregular 2D images in order to better quantify the characteristic structure of crystal aggregates. The formation of an aggregate is simulated, and the way in which features are lost as the imaging resolution becomes coarser is shown. It is suggested that at least qualitative information may be obtained about the underlying structure of aggregates. P.D.

A92-32177* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LIQUID CRYSTAL COATINGS FOR SURFACE SHEAR-STRESS VISUALIZATION IN HYPERSONIC FLOWS
D. C. REDA (NASA, Ames Research Center, Moffett Field, CA; Sandia National Laboratories, Albuquerque, NM) and D. P. AESCHLIMAN (Sandia National Laboratories, Albuquerque, NM) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Mar.-Apr. 1992, p. 155-158. Previously cited in issue 16, p. 2481, Accession no. A90-38660. refs
(Contract DE-AC04-76DP-00789)
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A92-32183* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THERMAL PROTECTION ANALYSIS OF MARS-EARTH RETURN VEHICLES
WILLIAM D. HENLINE (NASA, Ames Research Center, Moffett Field, CA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Mar.-Apr. 1992, p. 198-207. Previously cited in issue 06, p. 818, Accession no. A91-19418. refs
Copyright

A92-32232* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TWENTY-FIVE YEARS OF AERODYNAMIC RESEARCH WITH INFRARED IMAGING
EHUD GARTENBERG and A. S. ROBERTS, JR. (Old Dominion University, Norfolk, VA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 161-171. refs
(Contract NAS1-18584)
Copyright

A review is presented of the commercial introduction of IR imaging systems in the midsixties that has opened the possibilities to visualize viscous interactions between a body and the surrounding airflow by mapping the surface temperature distributions on configurations of interest. The capability of IR imaging systems to produce in real-time thermograms, which can be interpreted both locally and globally, makes them useful for heat transfer and skin-friction aerodynamic studies. Attention is given to IR systems and data processing, supersonic and hypersonic studies, Space Shuttle flight experiments, subsonic and transonic studies, and propulsion studies. R.E.P.

A92-32240
HEAT TRANSFER EFFECTS ON AERODYNAMICS AND IMPLICATIONS FOR WIND-TUNNEL TESTS
D. G. MABEY (Royal Aerospace Establishment, Bedford, England) Journal of Aircraft (ISSN 0021-8669), vol. 29, Mar.-Apr. 1992, p. 224-230. Previously cited in issue 23, p. 4069, Accession no. A91-53758. refs
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A92-32264
HEAT TRANSFER IN THE ENTRANCE REGION OF SEMICIRCULAR DUCTS WITH INTERNAL FINS
H. Y. ZHANG and M. A. EBADIAN (Florida International University, Miami) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722), vol. 6, Apr.-June 1992, p. 296-301. refs
(Contract NSF CTS-90-17732)
Copyright

This paper investigates numerically the fluid flow and heat transfer of steady laminar forced convection in the entrance region of semicircular ducts with longitudinal internal fins subjected to a constant wall temperature. The hydrodynamically fully developed flow and developing temperature are solved in this paper for nine geometries. The developing temperature field in the semicircular duct with longitudinal fins is obtained analytically/numerically by solving the energy equation employing the method of line (MOL). The energy equation is reformulated into a system of first-order differential equations controlling the temperature along each line. The representative curves illustrating the isotherms, variations of the bulk temperature and Nusselt number in the entire thermal region of the duct comprised of 3, 7, and 11 fins, and the fin height to duct radius ratio of 0.3, 0.6, and 1.0 are presented graphically. In addition, the number of lines used in the computational domain, the estimate of the thermal entrance length, and the fully developed Nusselt numbers are shown in tabular form for the above-mentioned fin parameters. Author

A92-32265
EXPERIMENTAL INVESTIGATION OF FILM COOLING EFFECTIVENESS FOR SLOTS OF VARIOUS EXIT GEOMETRIES
M. E. TASLIM (Northeastern University, Boston, MA), S. D. SPRING, and B. P. MEHLMAN (GE Aircraft Engines, Lynn, MA) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722), vol. 6, Apr.-June 1992, p. 302-307. Previously cited in issue 19, p. 3046, Accession no. A90-42763. refs
Copyright

A92-32411
SURFPREP FLASH-LAMP DEPAINT SYSTEM EVALUATION
F. C. TORIZ, A. B. THAKKER, S. K. GUPTA (Rolls Royce, Inc., Atlanta, GA), and ROY DOXSTADER (A & R Industries, Oceanside, CA) IN: Metallurgical coatings and thin films 1990; Proceedings of the 17th International Conference on Metallurgical Coatings and 8th International Conference on Thin Films, San Diego, CA, Apr. 2-6, 1990. Vol. 1. London and New York, Elsevier Applied Science, 1990, p. 1035-1046. refs
Copyright

The study presents the Surfprep machine, a flash-lamp device for divesting surfaces of unwanted matter. The potential uses of the standard paint stripper 'Surfprep machine' are identified, and the fact that there is no negative effect to the substrates treated is verified. Attention is given to: cleaning and corrosive scale removal; paint and varnish removal; coating removal; substrate effects; geometry effects; and chemically assisted blasting. It is demonstrated that the Surfprep system can remove paints and varnishes in a controlled manner with reasonable removal rates, and provides optimism for what can be done with higher energy systems. It is also practical for cleaning engine parts of burnt-on oil and molybdenum disulfide, even though at a slower removal rate. It is shown that geometry effects are not as severe as expected. P.D.

A92-32507
THREE-DIMENSIONAL FLOW VISUALIZATION OF SHOCK WAVE USING DOUBLE-PULSED HOLOGRAPHIC INTERFEROMETRY. II - FLOW VISUALIZATION FOR THREE-DIMENSIONAL SHOCK STRUCTURES IN ROTATING AEROENGINE FAN BLADE ROWS
SHOHACHI YASU, TEIICHI TAMAKI, SUSUMU NAGANO, and TAKAO KASHIWAGI Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016), vol. 56, Sept. 1990, p. 2626-2633. In Japanese. refs

The growing demand for more fuel-efficient aero gas turbine engines has led to the need for a detailed understanding of the aerodynamic behavior of components. The optical technique of holography has recently achieved importance as a means of providing the experimental data necessary for the development and validation of relevant design calculation methods. This paper describes the double-pulsed holographic flow visualization technique which has been developed at IHI and provides information on 3-dimensional shock structures of the transonic flow region between the blades and shock/casing wall boundary layer interaction in rotating aeroengine fan at various rotor speeds and throttling conditions. Author

A92-32508
A STUDY ON THE ROTATING STALL OF CENTRIFUGAL COMPRESSORS. II - EFFECT OF VANELESS DIFFUSER INLET SHAPE ON ROTATING STALL
HIROMI KOBAYASHI, HIDEO NISHIDA, TAKEO TAKAGI, and YASUO FUKUSHIMA Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016), vol. 56, Sept. 1990, p. 2646-2651. In Japanese. refs

Rotating stall induced in a vaneless diffuser is examined. Combinations of several low-specific-speed impellers and three types of diffusers with different inlet shape are tested. In the lower specific-speed stages, the critical inlet-flow angle for rotating stall depends not only on diffuser width ratio and contraction ratio, but also on the inlet shape of the diffuser. As the inlet shape parameter becomes smaller than value of 0.1, the critical inlet-flow angle becomes larger than the predicted value by the Senoo method. The empirical prediction formula of critical inlet-flow angle in the first report is corrected by considering the influence of inlet shape. Influence of inlet shape on rotating stall phenomenon is also shown. Author

A92-32509
PERFORMANCE OF A HIGH-PRESSURE-RATIO CENTRIFUGAL COMPRESSOR INFLUENCED BY DISTRIBUTION OF TIP CLEARANCE OF THE MIXED-FLOW IMPELLER
HIROSHI HAYAMI, YASUTOSHI SENOO, and HIROSHI HASEGAWA Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016), vol. 56, Sept. 1990, p. 2652-2657. In Japanese. refs

To investigate influences of the distribution of tip clearance on the performance of centrifugal compressors, the mixed-flow impeller of a centrifugal compressor with 10:1 pressure ratio was tested with various distributions of the tip clearance varied by not only the axial movement but also the radial reforming of the shroud casing relative to the impeller. Measured data on the decrements of the input head and of the impeller efficiency due to the distribution of tip clearance are compared with the predicted values. The change in the available flow range due to the distribution of tip clearance is also discussed. Author

A92-32523
BOILING HEAT TRANSFER FROM AN EXCAVATED FIN
S. P. LIAW and R. H. YEH (National Taiwan Ocean University, Keelung, Republic of China) International Communications in Heat and Mass Transfer (ISSN 0735-1933), vol. 19, Mar.-Apr. 1992, p. 215-228. refs
(Contract NSCRC-81-0401-E019-01)
Copyright

A single pin fin with excavation at base is proposed to enhance boiling heat transfer. The temperature distribution in the fin is obtained numerically by solving a 2D heat conduction equation. A copper fin boiling in isopropyl alcohol is taken as an example. When the operating temperature exceeds a specific value, the heat duty decreases drastically, and the whole fin is governed by film boiling. This highest operating temperature limit is raised by digging a hole at the fin base. Two distinct solutions are found by using different initial guesses into the code. This hysteresis effect becomes noticeable for a bigger hole. A model is also developed to predict the burnout temperatures. Author

A92-32524
TWO-DIMENSIONAL HEAT TRANSFER FROM A RECTANGULAR FIN WITH ASYMMETRICAL THERMAL BOUNDARY CONDITIONS
A. AZIZ (Gonzaga University, Spokane, WA) and D. R. TESARIK (U.S. Bureau of Mines, Spokane Mining Research Center, WA) International Communications in Heat and Mass Transfer (ISSN 0735-1933), vol. 19, Mar.-Apr. 1992, p. 229-238. refs
Copyright

An example of a heat-transfer fin that extends between two surfaces at different temperatures, so that the fin operates at asymmetric thermal boundary conditions, is found in a compact heat exchanger design whose core consists of finned passages between parallel plates at different temperatures. Attention is given to the results obtained for this configuration's two-dimensional fin unequal base temperature effects, fin heat dissipation effects, and total convection heat losses. O.C.

N92-20072*# Dynamic Engineering, Inc., Newport News, VA.
WEIGHT, CENTER OF GRAVITY AND MODAL TEST REPORT FOR NTF FAN BLADE SET NO. 3 Final Report
INGER P. FRIEDMAN Feb. 1992 67 p
(Contract NAS1-18352)
(NASA-CR-189583; NAS 1.26:189583; DEI-D-425) Avail: NTIS HC/MF A04 CSCL 20K

A complete set of fan blades for the National Transonic Facility (NTF) at the NASA Langley Research Center was recently fabricated by Dynamic Engineering Inc. (DEI). These blades were the third complete set of blades fabricated by the NTF. The first set of blades was fabricated by NASA and installed in the tunnel in December 1981. This original set was destroyed in a mishap in January 1989. The second set of blades is currently in use in the NTF. The third set of blades recently fabricated by DEI is a spare set. In order to ensure that the blades met the requirements, DEI performed a series of tests on each of the completed blades. In addition, a model survey was conducted on each blade to define the dynamic characteristics. Discussed here are the blade tests conducted by DEI and the test results. The test set-ups and procedures are discussed in detail. The results obtained for each of the 27 blades are documented and comparisons are made between this set of blades and similar data for two previous sets of NTF fan blades. Author

N92-20120*# MCAT Inst., San Jose, CA.
ALGORITHM AND CODE DEVELOPMENT FOR UNSTEADY THREE-DIMENSIONAL NAVIER-STOKES EQUATIONS Annual Report
SHIGERU OBAYASHI Mar. 1992 29 p Original contains color illustrations
(Contract NCC2-605)
(NASA-CR-190149; NAS 1.26:190149; MCAT-92-005) Avail: NTIS HC/MF A03; 2 functional color pages CSCL 20D

A code, ENSAERO, is being developed for computing the unsteady aerodynamics and aeroelasticity of aircraft and it solves the Euler and/or Navier-Stokes equations. The code was extended to complicated geometries, such as wing-body configuration, and wing with oscillating control surface. Comparisons with available experimental data show reasonable agreement with the use of relatively coarse grids. Author

N92-20143# Sandia National Labs., Albuquerque, NM.
CENTER OF PRESSURE CALCULATIONS FOR A BENT-AXIS VEHICLE
W. H. RUTLEDGE and G. F. POLANSKY 1992 25 p Presented at the 30th AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992
(Contract DE-AC04-76DP-00789)
(DE92-005186; SAND-91-2936C; AIAA-92-0168; CONF-920157-1) Avail: NTIS HC/MF A03

Bent-axis maneuvering vehicles provide a unique type of control for a variety of supersonic and hypersonic missions. Unfortunately, large hinge moments, incomplete pitching moment predictions, and a misunderstanding of corresponding center of pressure calculations have prevented their application. A procedure is presented for the efficient design of bent-axis vehicles given an adequate understanding of origins of pitching moment effects. In particular, sources of pitching moment contributions will be described including not only normal force, but inviscid axial force and viscous effects as well. Off-centerline center of pressure effects are first reviewed for symmetric hypersonic sphere-cone configurations. Next the effects of the bent-axis geometry are considered where axial force, acting on the deflected tail section, can generate significant pitching moment components. The unique relationship between hinge moments and pitching moments for the bent-axis class of vehicles is discussed. DOE

N92-20147 Purdue Univ., West Lafayette, IN.
INVARIANT BOUNDARY CONDITIONS FOR CASCADE FLOWS Ph.D. Thesis
TERRY LEE CAIPEN 1991 222 p
Avail: Univ. Microfilms Order No. DA9201310

A method of using the phase lagged Riemann invariant boundary conditions was developed to compute the aerodynamic response coefficients for cascade flows. The method is used with a quasi-Newton iteration technique to solve the unsteady full potential equation. The results are compared with a time sheared boundary condition scheme for nonzero interblade phase angles. The current method eliminates the need for using multiple passages in such calculations and automatically gives the proper wake jump conditions for the potential equation. The results are also compared to available theoretical and experimental results for subsonic, transonic, and supersonic (with subsonic leading edge locus) flows to establish the validity and accuracy of the result. The method can be used to more efficiently calculate the flutter boundaries of a cascade geometry at many interblade phase angles.
Dissert. Abstr.

N92-20194*# Vigyan Research Associates, Inc., Hampton, VA.
STRUCTURAL DYNAMICS AND VIBRATIONS OF DAMPED, AIRCRAFT-TYPE STRUCTURES Final Report
MAURICE I. YOUNG Washington NASA. Langley Research Center Feb. 1992 118 p
(Contract NAS1-18585)
(NASA-CR-4424; NAS 1.26:4424) Avail: NTIS HC/MF A06 CSCL 20K

Engineering preliminary design methods for approximating and predicting the effects of viscous or equivalent viscous-type damping treatments on the free and forced vibration of lightly damped aircraft-type structures are developed. Similar developments are presented for dynamic hysteresis viscoelastic-type damping treatments. It is shown by both engineering analysis and numerical illustrations that the intermodal coupling of the undamped modes arising from the introduction of damping may be neglected in applying these preliminary design methods, except when dissimilar modes of these lightly damped, complex aircraft-type structures have identical or nearly identical natural frequencies. In such cases, it is shown that a relatively simple, additional interaction calculation between pairs of modes exhibiting this 'modal response' phenomenon suffices in the prediction of interacting modal damping fractions. The accuracy of the methods is shown to be very good to excellent, depending on the normal natural frequency separation of the system modes, thereby permitting a relatively simple preliminary design approach. This approach is shown to be a natural precursor to elaborate finite element, digital computer design computations in evaluating the type, quantity, and location of damping treatment. Author

N92-20197*# Ohio State Univ., Columbus. ElectroScience Lab.
BISTATIC IMAGE PROCESSING FOR A 32 X 19 INCH MODEL AIRCRAFT USING SCATTERED FIELDS OBTAINED IN THE OSU-ESL COMPACT RANGE
T-H. LEE and W. D. BURNSIDE Feb. 1992 131 p
(Contract NAG2-542)
(NASA-CR-189932; NAS 1.26:189932; REPT-722780-3) Avail: NTIS HC/MF A07 CSCL 20N

Inverse Synthetic Aperture Radar (ISAR) images for a 32 in long and 19 in wide model aircraft are documented. Both backscattered and bistatic scattered fields of this model aircraft were measured in the OSU-ESL compact range to obtain these images. The scattered fields of the target were measured for frequencies from 2 to 18 GHz with a 10 MHz increment and for full 360 deg azimuth rotation angles with a 0.2 deg step. For the bistatic scattering measurement, the compact range was used as the transmitting antenna; while, a broad band AEL double ridge horn was used as the receiving antenna. Bistatic angles of 90 deg and 135 deg were measured. Due to the size of the chamber and target, the receiving antenna was in the near field of the target; nevertheless, the image processing algorithm was valid for this case. Author

N92-20198*# Alabama Univ., Huntsville. Materials Processing Lab.
MATERIALS PROCESSING IN LOW GRAVITY Final Report
GARY L. WORKMAN 19 Nov. 1991 16 p
(Contract NAS8-36955)
(NASA-CR-184280; NAS 1.26:184280) Avail: NTIS HC/MF A03 CSCL 22A

Several NASA facilities are available for low gravity experimentation: the Drop Facilities at NASA Marshall and the KC-135 at NASA Johnson. The use of these facilities allows for a rather inexpensive method of determining whether or not particular experiments will be worthwhile candidates for space experiments. Equipment currently available include various furnaces for the Drop Tube, the Drop Tower, and the KC-135. The furnaces for the Drop Tube include both an electron beam and electromagnetic levitation furnace. A vacuum furnace is used for the Drop Tower. Several furnaces used in performing KC-135 solidification experiments include the Automated Directional Solidification Furnace, the Isothermal Casting Furnace, the Rapid Melt/Rapid Quench and the Polymer/Video Furnaces. Author

N92-20235*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HEAT TRANSFER IN ROTATING SERPENTINE PASSAGES WITH TRIPS SKEWED TO THE FLOW
B. V. JOHNSON, J. H. WAGNER, G. D. STEUBER (Pratt and Whitney Aircraft, East Hartford, CT.), and F. C. YEH 1992 13 p Proposed for presentation at the 37th ASME International Gas Turbine and Aeroengine Congress and Exposition, Cologne, Germany, 1-4 Jun. 1992; sponsored by the 1992 AMSE Turbo Expo-Land, Sea and Air
(NASA-TM-105581; E-6908; NAS 1.15:105581) Avail: NTIS HC/MF A03 CSCL 20D

Experiments were conducted to determine the effects of buoyancy and Coriolis forces on heat transfer in turbine blade internal coolant passages. The experiments were conducted with a large scale, multi-pass, heat transfer model with both radially inward and outward flow. Trip strips, skewed at 45 deg to the flow direction, were machined on the leading and trailing surfaces of the radial coolant passages. An analysis of the governing flow equations showed that four parameters influence the heat transfer in rotating passages: coolant-to-wall temperature, rotation number, Reynolds number, and radius-to-passage hydraulic diameter ratio. The first three of these four parameters were varied over ranges which are typical of advanced gas turbine engine operating conditions. Results were correlated and compared to previous results from similar stationary and rotating models with smooth walls and with trip strips normal to the flow direction. The heat transfer coefficients on surfaces, where the heat transfer decreased with rotation and buoyancy, decreased to as low as 40 percent of the value without rotation. However, the maximum values of the heat transfer coefficients with high rotation were only slightly above the highest levels previously obtained with the smooth wall models. It was concluded that (1) both Coriolis and buoyancy effects must be considered in turbine blade cooling designs with trip strips, (2) the effects of rotation are markedly different depending upon the flow direction, and (3) the heat transfer with skewed trip strips is less sensitive to buoyancy than the heat transfer in models with either smooth or normal trips. Therefore, skewed trip strips rather than normal trip strips are recommended and geometry-specific tests are required for accurate design information. Author

N92-20265# Northern Research and Engineering Corp., Woburn, MA.
CURRENTLY AVAILABLE FUEL GAS BOOSTER COMPRESSOR EQUIPMENT FOR SMALL GAS TURBINE ENGINES Topical Report, Dec. 1989 - May 1991
H. B. FAULKNER Nov. 1991 23 p
(Contract GRI-5086-233-1436)
(PB92-127026; GRI-91/0328) Avail: NTIS HC/MF A03 CSCL 13I

The distribution of natural supply pressures in the United States was briefly reviewed, and 3.0 psig was selected as basis for the study. The characteristics of booster compressors for 104 gas turbine engines of less than 37 MW were estimated, and nine representative engines below 5 MW were selected. A telephone inquiry was made to obtain costs for boosters for these engines from five suppliers. The booster cost, per KW of engine output, rises as the engine size decreases in the size range below 5 MW, and it rises sharply below about 2 MW. The booster equipment is readily available, but the demand for continuous duty compressors in this size range is not large enough to produce great economies of scale. Also frame size coverage is quite coarse, leading to oversizing for many applications. GRA

N92-20301# Ames Lab., IA.
COMPUTERED TOMOGRAPHY: EXPERIMENTAL DATA ACQUISITION AND PARALLELIZATION OF RECONSTRUCTION ALGORITHM Ph.D. Thesis
RICHARD KARL POWELL 12 Nov. 1991 155 p
(Contract W-7405-ENG-82)
(DE92-005151; IS-T-1551) Avail: NTIS HC/MF A08

Nondestructive Evaluation of components is a need throughout much of the manufacturing industry that involves high value parts.

The aircraft companies are a prime example of this need. The fleet of commercial and military aircraft that is in use worldwide today is aging and consequently it has become critical to develop an economical real time inspection of aircraft components such as wing structures, engine mounts, turbine blades, and various other critical components in modern day aircraft. The materials used in aircraft structures vary substantially today, indeed it is commonplace to see exotic composite materials as well as the more conventional materials such as aluminum and titanium. There are three primary methods used at the Center to do NDE inspections: (1) X ray based, (2) Ultrasonics based, and (3) Eddy current based. Eddy currents are widely used in industry for the determination of the existence of surface cracks and their lengths in conductors. Ultrasonics is used extensively in the production and in-service inspection of composite panels for problems such as delamination and for cracks in metals. X ray methods are used during production of composite based materials and with portable generators, for in-service detection of fatigue cracks. X ray computed tomography image analysis of voids, cracks, and inclusions are currently finding widespread usage in both the aircraft industry and in many other industrial applications as well. Although each of these inspection types has its own merits, it is basic research into some of the X ray based methods that will discussed in this thesis. DOE

N92-20341# Oak Ridge National Lab., TN.
BENCHMARK PERFORMANCE ANALYSIS OF AN ECM-MODULATED AIR-TO-AIR HEAT PUMP WITH A RECIPROCATING COMPRESSOR
C. K. RICE Jan. 1992 40 p Presented at the International Air Conditioning, Heating, Refrigerating Exposition, Anaheim, CA, 25-29 Jan. 1992
(Contract DE-AC05-84OR-21400)
(DE92-004478; CONF-920108-2) Avail: NTIS HC/MF A03

A benchmark analysis was conducted to predict the maximum steady- state performance potential of a near-term modulating residential- size heat pump. Continuously variable-speed, permanent-magnet electronically commutated motors (ECMs) were assumed to modulate the compressor and the indoor and outdoor fans in conjunction with existing modulating reciprocating compressor technology. A modulating heat pump design tool was used to optimize this ECM benchmark heat pump, using speed ranges and total heat exchanger sizes per-unit-capacity equivalent to that used by the highest SEER-rated variable-speed unit presently on the market (SEER = 16.4). Parametric steady-state performance optimization was conducted at a nominal design cooling ambient of 95 F (35 C) and at three off-design ambients of 82 F (27.8 C) cooling and 47 F and 17 F (8.3 C and minus 8.3 C) heating. In comparison to the reference commercially available residential unit, the analysis for the ECM benchmark predicted steady-state heating COPs about 35 percent higher and a cooling EER almost 25 percent higher at the nominal design cooling condition. The cooling EER at 82 F (27.8 C) was 13 percent higher than that of the reference unit when a comparable sensible heat ratio of 0.71 was maintained, while an EER gain of 24 percent at the 82 F (27.8 C) rating point was predicted when the sensible heat ratio was relaxed to 0.83. DOE

N92-20485 Toledo Univ., OH.
A LASER VELOCIMETER INVESTIGATION OF THE NORMAL SHOCKWAVE BOUNDARY LAYER INTERACTION Ph.D. Thesis
RANDALL MARSHALL CHRISS 1991 124 p
Avail: Univ. Microfilms Order No. DA9200762

Non-intrusive three-dimensional measurements have been made of a normal shock wave/turbulent boundary layer interaction. The measurements were made throughout a quadrant of a square test section of a continuous flow supersonic wind tunnel in which a normal shock wave was stabilized. Two-dimensional measurements were made throughout the interaction region while three-dimensional measurements were made near the corner in the vicinity of the shock where three-dimensional flow effects were expected to be significant. Laser Doppler velocimetry, surface static pressure measurements and flow visualization techniques were employed for two freestream nominal Mach number test cases: 1.6 and 1.3. No turbulence information was obtained. The mean velocity measurements were converted to Mach number by recording the wind tunnel total temperature. Some shock oscillation was present during both of the test cases. After startup of the wind tunnel, the shock oscillation amplitude was greatly reduced, as evidenced by the laser velocimeter results. The Mach 1.3 test case resulted in a nearly uniform flow without secondary shock waves and with no or very isolated corner separation. The Mach 1.6 test case contained separated flow regions and a system of secondary shock waves. The reported results are believed to accurately describe the flowfield of each case and may find use in the verification of numerical simulation. Dissert. Abstr.

N92-20491# Rolls-Royce Ltd., Derby (England). Optical Sciences Group.
HOLOGRAPHIC FLOW VISUALIZATION IN ROTATING TURBOMACHINERY
R. J. PARKER and M. REEVES 1 Nov. 1990 9 p Sponsored by Ministry of Defence
(PNR-90837; ETN-92-90791) Copyright Avail: NTIS HC/MF A02

Holographic flow visualization has found many applications in rotating turbomachinery. Applications in the design of aeroengine fans, automotive turbochargers, turbines, helicopter rotors, and advanced propfans are discussed. Work in ducted rotating flows and rotating free aerofoils is brought together and new developments in each field are revealed. ESA

N92-20497# Aix-Marseilles Univ. (France). Equipe Aerodynamique et Bruit de Champ Proche.
EXPERIMENTAL STUDY OF THE WALL PRESSURE FLUCTUATIONS UNDER A TURBULENT BOUNDARY LAYER DOWNSTREAM OF TANDEM AEROFOIL EXTERNAL MANIPULATORS Ph.D. Thesis [ETUDE EXPERIMENTALE DES FLUCTUATIONS DE PRESSION PARIETALE SOUS UNE COUCHE LIMITE TURBULENTE EN AVAL D'UN DISPOSTIF DE DEUX MANIPULATEURS EXTERNES DE TYPE PROFIL AVIATION PLACES EN TANDEM]
PHILIPPE OLIVERO 1990 176 p In FRENCH; ENGLISH summary
(REPT-207-90-78; ETN-92-90951) Avail: NTIS HC/MF A09

The boundary layer alteration downstream of a tandem of aerofoil external manipulators was evaluated by mean and turbulent characteristic measurements. The results show that the manipulated boundary layer structure remains identical to the natural one's. The local skin friction reaches a maximum of 20 percent at 36 boundary layer thicknesses downstream the device and then persists up to 100 boundary layer thicknesses, where it is still 10 percent. Technical methods based on two or four transducers, used to remove contamination noise caused by the acoustic sources, allow a better description of the wall pressure convective properties. Auto and interspectral density level reductions are found. They agree with the local skin friction reduction of the high frequency range whereas the spectral level is more reduced in the relaxation zone. Low wavenumber level measurements are performed at the maximum local skin friction reduction zone with a six flush mounted microphones array. They appear more reduced than if it was attempted only by the local skin friction reduction. Conditional averaging techniques were performed to find the link between wall pressure fluctuations field and turbulence producing mechanisms which were attempted to be the most altered by the manipulation. ESA

N92-20653# Federal Aviation Administration, Atlantic City, NJ.
TELEVISION MICROWAVE LINK (TML) OPERATIONAL TEST AND EVALUATION (OT/E)/INTEGRATION TEST REPORT
WAYNE E. BELL and TUAN A. TRAN Mar. 1992 46 p
(DOT/FAA/CT-TN91/57) Avail: NTIS HC/MF A03

Given here are the results of the Operational Test and Evaluation (OT&E)/Integration test on the 15 GHz Television Microwave Link (TML) system. The TML is commercial off the shelf equipment. It provides the capability for air traffic control

information to be relayed to a remote display from the Federal Aviation Administration (FAA) Digital Bright Radar Indicator Tower (DBRITE) system located at the terminal facility. The TML system was integrated and tested with the DBRITE system. Testing was successfully completed and met all of the T&E/Integration requirements. The acceptability of the remote DBRITE display was evaluated by the air traffic controllers and the data displayed on the remote DBRITE display provided the necessary information for air traffic control services. Therefore, the TML system is recommended for deployment. Author

N92-20677*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SIMULATION OF REAL-GAS EFFECTS ON PRESSURE DISTRIBUTIONS FOR AEROASSIST FLIGHT EXPERIMENT VEHICLE AND COMPARISON WITH PREDICTION
JOHN R. MICOL Apr. 1992 70 p
(NASA-TP-3157; L-16923; NAS 1.60:3157) Avail: NTIS HC/MF A04 CSCL 20/4

Pressure distributions measured on a 60 degree half-angle elliptic cone, raked off at an angle of 73 degrees from the cone centerline and having an ellipsoid nose (ellipticity equal to 2.0 in the symmetry plane) are presented for angles of attack from -10 degrees to 10 degrees. The high normal shock density ratio aspect of a real gas was simulated by testing in Mach 6 air and CF sub 4 (density ratio equal to 5.25 and 12.0, respectively). The effects of Reynolds number, angle of attack, and normal shock density ratio on these measurements are examined, and comparisons with a three dimensional Euler code known as HALIS are made. A significant effect of density ratio on pressure distributions on the cone section of the configuration was observed; the magnitude of this effect decreased with increasing angle of attack. The effect of Reynolds number on pressure distributions was negligible for forebody pressure distributions, but a measurable effect was noted on base pressures. In general, the HALIS code accurately predicted the measured pressure distributions in air and CF sub 4. Author

N92-20909# Rolls-Royce Ltd., Derby (England).
THE ROLE OF CRACK GROWTH IN DEFECT ASSESSMENT
JOHN ROCHE and CHRIS HOWLAND Nov. 1990 7 p
(PNR-90798; ETN-92-90772) Copyright Avail: NTIS HC/MF A02

The gas turbine industry is around fifty years old. The technology of the industry has evolved under the twin impulses of safety and direct operating cost. Since safety should not be compromised, (there are rules to ensure it is not) an assessment of material properties becomes essential. One such property is that of crack growth, and this is often referred to generically as 'defect tolerance'. The components concerned are normally those which rotate, and in the event of failure could cause a significant risk to the aircraft and its passengers. Assessment of a compressor or turbine disc is a multidisciplined method. Here it is viewed from the perspective of the measurement of crack rates. The nucleation of a crack, the measurement of small crack growth rates, the measurements of large crack growth rates and fast fracture, and the four components of total life, are discussed. ESA

N92-20954*# Ohio State Univ., Columbus.
A NOVEL APPROACH IN FORMULATION OF SPECIAL TRANSITION ELEMENTS: MESH INTERFACE ELEMENTS Final Report, Jan. 1989
NESRIN SARIGUL Nov. 1991 64 p
(Contract NAG3-790)
(NASA-CR-189050; NAS 1.26:189050) Avail: NTIS HC/MF A04 CSCL 20/11

The objective of this research program is in the development of more accurate and efficient methods for solution of singular problems encountered in various branches of mechanics. The research program can be categorized under three levels. The first two levels involve the formulation of a new class of elements called 'mesh interface elements' (MIE) to connect meshes of traditional elements either in three dimensions or in three and two dimensions. The finite element formulations are based on boolean sum and blending operators. MEI are being formulated and tested in this research to account for the steep gradients encountered in aircraft and space structure applications. At present, the heat transfer and structural analysis problems are being formulated from uncoupled theory point of view. The status report: (1) summarizes formulation for heat transfer and structural analysis; (2) explains formulation of MEI; (3) examines computational efficiency; and (4) shows verification examples. Author

N92-20997# Environmental Research Inst. of Michigan, Ann Arbor. Advanced Concepts Div.
CONCEPT DESIGN PHASE EXPENDABLE HOLOGRAPHIC SENSOR TO MEASURE OCEAN SMALL ANGLE OPTICAL SCATTERING Final Report
FRED J. TANIS 1 Jul. 1991 58 p
(Contract N00012-90-C-0091)
(AD-A245067; ERIM-227000-1-F) Avail: NTIS HC/MF A04 CSCL 20/6

A preliminary design concept has been developed for a holographic instrument to measure scattering and beam transmission optical properties of ocean waters. The expandable instrument is being developed for use with ship or aircraft deployment using the XDT/AXBT technology. The instrument design has been separated into four measurement functions: (1) beam transmission; (2) small angle scattering; (3) large angle scattering; and (4) backscatter. The present research has focussed on developing and demonstrating a holographic design to measure small angle scattering. This instrument measures the modulation transfer function (MTF) of the particles suspended in the water. The MTF can be inverted with a Fourier-Bessel transform procedure to estimate the volume scattering function at small angles. A laboratory demonstration hologram was constructed to focus a sinusoidal pattern scattered by polystyrene spheres onto a linear detector array. The laboratory results showed loss of contrast with increasing spatial frequency. Simulation model results for a 25 cm instrument demonstrated the capability to measure contrast loss at selected spatial frequencies and used that information to derive the volume scattering function for angles from 0.005 to 0.5 deg. Author (GRA)

N92-21232# Duisburg Univ. (Germany, F.R.).
BOUNDARY LAYER FLOW IN AXIAL COMPRESSORS (THEORETICAL PART) Interim Report No. 1, Jan. 1985 - Sep. 1985 [RANDZONENSTROEMUNG IN AXIALVERDICHTERN (THEORETISCHER TEIL). 1: ZWISCHENBERICHT, JAN. 1985 - SEP. 1985]
H.-J. DOHMEN 1985 69 p In GERMAN
(Contract T/RF42/E0013/E1413)
(ETN-92-91006) Avail: NTIS HC/MF A04

The development of a computational process for solving parabolic flow problems is examined. The solution algorithm presented is checked for very simple geometries. It shows satisfactory results for a straight orthogonal channel. ESA

N92-21233# Duisburg Univ. (Germany, F.R.). Fachbereich Maschinenbau.
BOUNDARY LAYER FLOW IN AXIAL COMPRESSORS (THEORETICAL PART) Interim Report No. 2, Oct. 1985 - Mar. 1986 [RANDZONENSTROEMUNG IN AXIALVERDICHTERN (THEORETISCHER TEIL). 2: ZWISCHENBERICHT, OCT. 1985 - MAR. 1986]
H.-J. DOHMEN and M. JANSSEN 1986 43 p In GERMAN
(Contract T/RF42/E0013/E1413)
(ETN-92-91007) Avail: NTIS HC/MF A03

It is shown that the transition from simple geometries to an actual compressor geometry is possible using a transformation which maps the actual compressor geometry on an orthogonal computation field. The theoretical principles of such a transformation and the development of a 'computation aided net generator' are explained. Test computations were carried out for controlling the transformation. The results are presented for a curved channel of constant cross section. ESA

N92-21234# Duisburg Univ. (Germany, F.R.). Fachbereich Maschinenbau.
BOUNDARY LAYER FLOW IN AXIAL COMPRESSORS (THEORETICAL PART) Final Report, Jan. 1985 - Dec. 1986 [RANDZONENSTROEMUNG IN AXIALVERDICHTERN (THEORETISCHER TEIL). ABSCHLUSSBERICHT, JAN. 1985 - DEC. 1986]
H.-J. DOHMEN and M. JANSSEN 1986 97 p In GERMAN
(Contract T/RF42/E0013/E1413)
(ETN-92-91008) Avail: NTIS HC/MF A05

A general differential equation is introduced into a set of conservation equations. The mathematical reprocessing of the fundamental equations for the numerical process is represented using this equation. The transformation of the equation into a general curvilinear coordinate system is explained in detail. The theoretical principles that are necessary for the automatization of the process of net generation are presented. Difficulties associated with net generation are discussed. The solution algorithm for the numerical simulation of flow computation is presented. The algorithm for net generation transformation and flow computation is explained using flow schemes. ESA

N92-21297# Naval Postgraduate School, Monterey, CA.
LASER VELOCIMETRY MEASUREMENTS OF OSCILLATING AIRFOIL DYNAMIC STALL FLOW FIELD
M. S. CHANDRASEKHARA Jun. 1991 14 p Presented at the 22nd AIAA Fluid Dynamics, Plasma Dynamics, and Lasers Conference, Honolulu, HI, 24-26 Jun. 1991 Previously announced in IAA as A91-43648
(Contract MIPR-ARO-114-91)
(AD-A244546; ARO-27894.6-EG) Avail: NTIS HC/MF A03 CSCL 01/1

The phenomenon of dynamic stall is an important case of forced unsteady separated flow and is of great importance to both helicopters and fixed wing aircraft. Ensemble averaged two component velocity measurements over an airfoil experiencing oscillatory dynamic stall under compressibility conditions were obtained. The measurements show the formation of a separation bubble over the airfoil that persists till angles of attack close to when the dynamic stall vortex forms and convects. The fluid attains mean velocities as large as 1.6 times the free stream velocity (FSV) with instantaneous values of 1.8 fsv. The airfoil motion induces these large velocities in regions that are far removed from its surface. Also, depending upon the behavior of the separation bubble, the wall jet profiles near the leading edge region could become wake like over the airfoil in a cycle at different phase angles. Vorticity contours indicate that the levels around the leading edge continuously increase till the vortex begins to convect. Some of the measurement difficulties, especially particle behavior, are discussed as well. GRA

N92-21385*# Virginia Univ., Charlottesville. Dept. of Chemical Engineering.
MICROGRAVITY NUCLEATION AND PARTICLE COAGULATION EXPERIMENTS SUPPORT Status Report No. 7, 1 Jan. - 31 Dec. 1991
L. U. LILLELEHT, F. T. FERGUSON, and J. R. STEPHENS (Matrix Corp., Santa Fe, NM.) Mar. 1992 16 p
(Contract NAG5-865)
(NASA-CR-190159; NAS 1.26:190159; UVA/528260/CHE92/107) Avail: NTIS HC/MF A03 CSCL 22/1

Modifications to the nucleation apparatus suggested by our first microgravity flight campaign are complete. These included a complete 'repackaging' of the equipment into three racks along with an improved vapor spout shutter mechanism and additional thermocouples for gas temperature measurements. The 'repackaged' apparatus was used in two KC-135 campaigns: one during the week of June 3, 1991 consisting of two flights with Mg and two with Zn, and another series consisting of three flights with Zn during the week of September 23, 1991. Our effort then was focused on the analysis of these data, including further development of the mathematical models to generate the values of temperature and supersaturation at the observed points of nucleation. The efforts to apply Hale's Scaled Nucleation Theory to our experimental data have met with only limited success, most likely due to still inadequate temperature field determination. Work on the development of a preliminary particle collector system designed to capture particles from the region of nucleation and condensation, as well as from other parts of the chamber, are discussed. Author

N92-21433*# Virginia Univ., Charlottesville. Dept. of Chemical Engineering.
MICROGRAVITY NUCLEATION AND PARTICLE COAGULATION EXPERIMENTS SUPPORT Status Report No. 6, 1 Mar. - 31 Dec. 1990
L. U. LILLELEHT, F. T. FERGUSON, and J. R. STEPHENS Jan. 1992 25 p Prepared in cooperation with Matrix Corp., Santa Fe, NM
(Contract NAG5-865)
(NASA-CR-189899; NAS 1.26:189899; UVA/528260/CHE92/106) Avail: NTIS HC/MF A03 CSCL 22/1

This project is a part of a program at GSFC to study to formation and growth of cosmic dust grain analogs under terrestrial as well as microgravity conditions. Its primary scientific objective is to study the homogeneous nucleation of refractory metal vapors and a variety of their oxides among others, while the engineering, and perhaps a more immediate objective is to develop a system capable of producing mono-dispersed, homogeneous suspensions of well-characterized refractory particles for various particle interaction experiments aboard the Space Shuttle and Space Station Freedom. Both of these objectives are to be met by a judicious combination of laboratory experiments on the ground and aboard NASA's KC-135 experimental research aircraft. Major effort during the current reporting period was devoted to the evaluation of our very successful first series of microgravity test runs in Feb. 1990. Although the apparatus performed well, it was decided to 'repackage' the equipment for easier installation on the KC-135 and access to various components. It will now consist of three separate racks: one each for the nucleation chamber, the power subsystem, and the electronic packages. The racks were fabricated at the University of Virginia and the assembly of the repackaged units is proceeding well. Preliminary analysis of the video data from the first microgravity flight series was performed and the results appear to display some trends expected from Hale's Scaled Nucleation Theory of 1986. The data acquisition system is currently being refined. Author

N92-21460*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A HISTORICAL OVERVIEW OF TILTROTOR AEROELASTIC RESEARCH AT LANGLEY RESEARCH CENTER
RAYMOND G. KVATERNIK Apr. 1992 33 p Presented at the Fourth Workshop on Dynamics and Aeroelastic Stability Modeling of Rotorcraft Systems, College Park, MD, 19-21 Nov. 1991 1991
(NASA-TM-107578; NAS 1.15:107578) Avail: NTIS HC/MF A03 CSCL 20/11

The Bell/Boeing V-22 Osprey which is being developed for the U.S. Military is a tiltrotor aircraft combining the versatility of a helicopter with the range and speed of a turboprop airplane. The V-22 represents a tiltrotor lineage which goes back over forty years, during which time contributions to the technology base needed for its development were made by both government and industry. NASA Langley Research Center has made substantial contributions to tiltrotor technology in several areas, in particular in the area of aeroelasticity. The purpose of this talk is to present a summary of the tiltrotor aeroelastic research conducted at Langley which has contributed to that technology. Author

N92-21685# Aerospatiale, Toulouse (France). Div. Avions.
METHOD FOR CALCULATING THE THREE-DIMENSIONAL WATER CONCENTRATION COEFFICIENTS AND ITS INDUSTRIAL APPLICATIONS [METHODE DE CALCUL DE COEFFICIENTS DE CONCENTRATION D'EAU EN TRIDIMENSIONNEL ET SES APPLICATIONS INDUSTRIELLES]
P. PREL *In* AGARD, Effects of Adverse Weather on Aerodynamics

12 p Dec. 1991 In FRENCH
Copyright Avail: NTIS HC/MF A13; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A three dimensional method for calculating the concentration coefficients of water droplets, its general principles, as well as the details of the calculating computer programs that were used, are described. The applications are presented for locating probes on the Airbus 340 and ATR 72 airplanes, mainly showing the effect of the drop diameter on the measured concentration.
Author

N92-21699# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abt. Antriebsintegration.
EXTENSION OF A THREE DIMENSIONAL EULER-CODE FOR THE INVESTIGATION OF THE FLOW FIELD AROUND BYPASS ENGINES WITH FAN AND CORE JET Thesis - Technische Univ.
RALF RUDNIK Nov. 1990 113 p In GERMAN; ENGLISH summary
(DLR-FB-91-13; ISSN-0171-1342; ETN-92-90732) Avail: NTIS HC/MF A06; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 37.50 DM

An existing finite volume scheme for the discretization of the three dimensional Euler equations is extended by including the core jet flow field. The modifications are described, with special regard to grid generation and the numerical algorithm. Flow calculations of a typical high bypass engine are performed for takeoff and cruise conditions, under consideration of real operational jet parameters. Several variations of the jet pressure and temperature ratio are presented. The influence of numerical parameters on the solution in the region of the jet flow is analyzed by varying the coefficient of the artificial dissipation and the grid density.
ESA

N92-21730# Pratt and Whitney Aircraft, West Palm Beach, FL.
METAL-METAL BONDLINE NDE METHODS Final Report, 1 Oct. 1989 - 28 Feb. 1991
B. A. WESTON and L. D. PERCIVAL Dec. 1991 17 p
(Contract F33615-89-C-5616)
(AD-A244429; WL-TR-91-4135) Avail: NTIS HC/MF A03 CSCL 13/5

Advanced gas turbine engine concepts are continually striving towards higher thrust to weight ratios. Two methods of achieving this goal are higher compression ratios and weight reduction through use of less material, lighter material, or a combination of the two. Development of integrally bladed rotors (IBR) is a relatively new manufacturing technique that would eliminate the need for the heavier construction of the dovetail area. Integrally bladed rotors require reliable metal to metal bonding (MMB) techniques and the ability to have the bond plane adequately inspected for defects that could reduce bond strength capabilities. The purpose of this program was the validation and refinement of an ultrasonic inspection method for examination of metal-to-metal bonds (MMB) that are representative of those encountered in bonded gas turbine components such as integrally-bladed rotors. The methodology was to be optimized for detection of typical defect conditions such as blown grains and microcracking. To assist in the development of this method, the metal-to-metal (MTM) simulation program, which was developed at Iowa State University, was to provide theoretical guidelines for method optimization.
GRA

N92-21741# Rolls-Royce Ltd., Derby (England).
APPLICATION OF FINITE ELEMENT METHODS TO FRACTURE MECHANICS
A. C. PICKARD and M. J. WALSH 1 Jul. 1990 15 p Presented at the 1st International Conference on Computer-Aided Assessment and Control of Localised Damage, Portsmouth, England, 26-28 Jun. 1990
(PNR-90770; ETN-92-90761) Copyright Avail: NTIS HC/MF A03

The application of three dimensional Finite Element (FE) modeling to the calculation of stress intensity factors is considered. Recommended methods of solution are discussed and reference is made to the need to attain quality standards and consistency of solution through the use of NAFEMS guidelines. For many situations, solutions from standard geometries are inappropriate since they fail to model the component geometry and load distribution accurately. An example of modeling cracks in an aeroengine component feature is given. Recent work has considered the stress intensity around coalescing coplanar fatigue cracks in bend specimens. Finite element models of the specimens used and the methods of analysis are discussed. Microstructurally short cracks were modeled assuming locally nonisotropic material properties and the FE modeling and method of analysis are discussed.
ESA

N92-21828# National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
PROGRESS REPORT ON ANALYSIS OF DIFFERENTIAL ATTENUATION RADAR DATA OBTAINED DURING WISP-91
B. E. MARTNER, R. A. KROPFLI, L. E. ASH, and J. B. SNIDER Oct. 1991 49 p
(PB92-133800; NOAA-TM-ERL-WPL-215) Avail: NTIS HC/MF A03 CSCL 17/9

Liquid water attenuates radar signals more strongly at shorter wavelengths that at longer ones. In theory, the differential attenuation at two wavelengths offers a new method for obtaining range resolved measurements of cloud liquid water content by remote sensing. A relatively inexpensive dual wavelength system was assembled from existing X band (3.2 cm) and K(a)-band (0.87 cm) radars and operated during the 1991 Winter Icing and Storms Project to experimentally test this technique. Analysis of the data is in early stages. The differential attenuation theory is described, along with experimental procedures and instrumentation, data collection, data processing, and one preliminary case study. The detailed case study of a cloud that produced very light drizzle prompted development of automated editing refinements to the original processing algorithm to remove complications from ground clutter, non-Rayleigh scattering, receiver saturation, and other factors. The overall study had potential applications to aircraft icing (safety).
Author

N92-21953# Naval Postgraduate School, Monterey, CA. Dept. of Aeronautics and Astronautics.
THE AERODYNAMICS OF SHIP SUPERSTRUCTURES
J. V. HEALEY *In* AGARD, Aircraft Ship Operations 14 p Nov. 1991
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After 70 years of naval aviation, a belated understanding of the aerodynamics of ships is slowly emerging. The lack of understanding, and undoubtedly other reasons, has led to superstructure configurations that are unsuited to adjacent helicopter flight. This has resulted in severely limited safe operating envelopes, danger to pilots and ship personnel and blade strikes that occasionally result in the complete loss of a helicopter. The air flows around ships abound with recirculating zones, bounded by shear layers that emanate from the sharp edges of the superstructures. These zones vary enormously in size in an intermittent manner, giving rise to flows with extreme velocity gradients and turbulence intensity levels that are too high to be measured with hot wire anemometers. This complicates the situation because, at the present time, a data base for simulation can be established only via measurement. The essential ingredients for the aerodynamic design of new ships are proposed and some suggestions for the improvement of the aerodynamics of existing ships are made. Correcting an aerodynamically poor ship is no substitute for the incorporation of aerodynamics into the ship design process.
Author

N92-21954# Naval Air Test Center, Patuxent River, MD. Rotary Wing Aircraft Test Directorate.
SHIP AIRWAKE MEASUREMENT AND MODELING OPTIONS FOR ROTORCRAFT APPLICATIONS
DEAN CARICO, BILL REDDY, and CHARLES DIMARZIO

(Northeastern Univ., Boston, MA.) *In* AGARD, Aircraft Ship Operations 24 p Nov. 1991
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Ship airwake is important in defining rotorcraft ship operational limitations and in predicting those limitations using analysis and simulation. Accurate real time ship airwake models are required to support pilot shipboard landing training in aviation training devices. Increased emphasis must be placed on obtaining quantitative full scale airwake data and in quantitatively evaluating ship airwake simulation models. Quantitative ship airwake data measurement equipment ranges from hand held mechanical sensors, to propeller anemometers mounted on a mast, to possible laser velocimeter and other options in the near future. Wind tunnel and computational fluid dynamics options are also possible candidates for ship airwake data generation. It is important to compare the different techniques for obtaining ship airwake data and evaluate the utility and strengths and weaknesses of each technique. Many activities in the U.S. and in other countries are involved in rotorcraft shipboard landing flight test, analysis, and simulation. Author

N92-21955# Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain).
MEASUREMENT OF THE FLOW DISTRIBUTION OVER THE FLIGHT DECK OF AN AIRCRAFT CARRIER
M. MULERO and F. GOMEZ PORTABELLA *In* AGARD, Aircraft Ship Operations 12 p Nov. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A study was conducted on the general configuration of the air flow over the flight deck of a Spanish aircraft carrier. The level was determined of fluctuations of the wind vector in certain points of the deck where operations of VSTOL planes and helicopters take place. It was decided to study the possibility of making wind tunnel testing over a reduced scale model of the ship and later take some limited data over the actual ship. Preliminary tests to assess the validity of the simulation of the main flow features in the wind tunnel were performed over a simple square cube and they showed a systematic constancy in the shape of the cavity and the wake as a function of the Reynolds numbers studied. Tests were then performed on a reduced scale model of the ship and data were gathered by means of hot film probes and by photographing wool tufts attached to the surface of the model. Results show separation past the leading edge of the ramp, which produces vortices that trail along and over the deck to distances that depend on the direction of the approach wind. Limited data of local velocities and direction in the horizontal plane were obtained over the real ship, which show the highly disturbed flow. Author

N92-22028# National Research Council of Canada, Ottawa (Ontario). Inst. for Aerospace Research.
EVALUATION AND QUALIFICATION OF DIFFUSION BRAZE REPAIR TECHNIQUES FOR SUPERALLOY GAS TURBINE COMPONENTS
P. STOUTE, D. MANENTE (Vac-Aero International, Oakville, Ontario), and J.-P. IMMARIGEON 9 Sep. 1991 34 p Presented at the Symposium on Industrial Application of Gas Turbines, Banff, AB, 16-18 Oct. 1991
(NRC-LTR-ST-1839; CTN-92-60410) Avail: NTIS HC/MF A03

The development of diffusion braze repair (DBR) techniques for service damaged engine nozzle guide vanes (NGVs) made from cobalt and nickel-base superalloys is discussed. A description of the work performed for qualification of the repair techniques for aero engine applications is also provided. This qualification work included bench testing of material test coupons as well as accelerated endurance testing of repaired aero engine parts under simulated service conditions in a burner rig. It was shown that it is possible to closely simulate NGV operating conditions in the laboratory. Thermal fatigue damage typical of service was produced in both new and repaired components. By comparing the response of new and repaired parts to rig testing in terms of crack initiation and growth, it was possible to assess repair durability expediently and at minimal cost. Cracking generally initiated sooner in the repaired NGVs than in new components for leading edge/outer shroud cracks. Although test components incurred severe stress through rig testing, many of the repaired areas looked structurally sound after testing. The results indicated that DBR of cobalt base components is a viable alternative to component replacement. CISTI

N92-22029# National Research Council of Canada, Ottawa (Ontario). Inst. for Aerospace Research.
INSPECTION OF AIRCRAFT ENGINE COMPONENTS USING AUTOMATED EDDY CURRENT AND PATTERN RECOGNITION TECHNIQUES
A. FAHR, C. E. CHAPMAN, A. PELLETIER, and D. R. HAY (Tektrend International, Inc., Montreal, Quebec) 28 Jun. 1991 20 p
(NRC-LTR-ST-1834; CTN-92-60411) Avail: NTIS HC/MF A03

A fully automated inspection and decision making system, which utilizes a standard eddy current (EC) instrument, an automated XYZ table, and an advanced pattern recognition software package, was developed and integrated. The system was used to inspect fastener bolt holes in aircraft engine rotating parts and the preliminary inspection results on a J 85 CAN 40 compressor disc are presented in this report. The effectiveness of pattern recognition in determining defective bolt holes was compared with the conventional visual analysis of EC signals by an experienced operator. The results were verified by pry opening of all the bolt holes and examination under a scanning electron microscope. The use of pattern recognition analysis provided significant improvement in the sensitivity, reliability and speed of inspection. It was possible to indicate the presence of service-induced fatigue cracks as small as 0.05 mm in the bolt holes of a compressor disc in real-time. The correlations between the EC signal amplitude and phase angle with the crack size indicate that both the amplitude and phase information are required to increase the detectability for small cracks. Pattern recognition uses these and other optimal features of the EC signal for improved detection results. CISTI

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GEOSCIENCES

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

A92-29726
CARCINOGENIC HYDROCARBONS EMISSION WITH GAS-TURBINE ENGINES EXHAUST GASES
IU. KNYSH IN: CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991. Nanjing, People's Republic of China, Nanjing Aeronautical Institute, 1991, p. 169-176. refs

Results are presented from an experimental study of carcinogenic benzapyrene emissions in gas turbine exhaust gases. Despite the wide range of characterisics among the engines tested, emission maximum levels are uniformly observed in the low power regime, while minimum levels typify full-power operation. An investigation of fuel diffusive combustion processes showed that the greatest concentration of benzapyrene occurs in the initial section of the flame, where fuel pyrolysis occurs under conditions of oxygen deficit. O.C.

A92-32052
AIRBORNE TESTS OF FLUX MEASUREMENT BY THE RELAXED EDDY ACCUMULATION TECHNIQUE
J. I. MACPHERSON (National Research Council of Canada, Flight Research Laboratory, Ottawa) and R. L. DESJARDINS (Agriculture Canada, Land Resource Research Centre, Ottawa) IN: Symposium

on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 6-11. refs
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The application aboard aircraft of the relaxed eddy accumulation (REA) method for fast-response analysis of airborne pollutants is investigated. Computer simulations performed on data collected by atmospheric research aircraft are described. The critical parameters involved in this application of the REA are addressed. C.D.

A92-32073* National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
OBSERVATION AND COMPARISON OF RAINFALL MEASURED AT A HIGH SAMPLE RATE
W. E. MELSON, JR. (NASA, Wallops Flight Center, Wallops Island, VA) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. 195-198. refs
Copyright

Two NASA programs, the Effects of Heavy Rain on Aerodynamics and the Tropical Rainfall Measuring Mission, require accurate high-frequency rainfall measurements. A weight-measuring rain gauge was developed to collect rain data and configured to operate at a high sample rate. The design of the gauge and preliminary test are briefly described. Frequency distributions of rainfall rates determined at five observation sites in the U.S. and at one in Australia are presented. C.D.

A92-32129* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
RETRIEVAL OF TOTAL PRECIPITABLE WATER OVER HIGH LATITUDE REGIONS USING RADIOMETRIC MEASUREMENTS NEAR 90 AND 183 GHZ
J. R. WANG, W. C. BONCYK, L. R. DOD (NASA, Goddard Space Flight Center, Greenbelt, MD), and A. K. SHARMA (ST Systems Corp., Lanham, MD) IN: Symposium on Meteorological Observations and Instrumentations, 7th, New Orleans, LA, Jan. 14-18, 1991, Preprints. Boston, MA, American Meteorological Society, 1991, p. J79-J84. refs
Copyright

The functional dependence of brightness temperature, at frequencies near 183 and 90 GHz, on total precipitable water in the range less than 0.5 g/cm is examined by means of radiative transfer calculations of a number of observed temperature and relative humidity profiles over both ocean and land surfaces. A wide range of land and sea surface reflectivities is assumed in the calculations. Both sensitivity and precision of total precipitable water estimates are derived from these calculations. The estimated values in the Southern Hemisphere showed a gradual decrease toward the polar region, as expected. Radiative transfer calculations were made with a number of radiosonde data sets for a wide range of surface reflectivity and temperature. The calculated results are used to estimate total precipitable water from the airborne radiometric measurements over Alaska. Reflectivities at both 92 and 193 GHz are found to be mostly in the range of 0.2-0.4. High reflectivity is attributed to scattering by the snow particles on the ground. P.D.

N92-20245# Midwest Research Inst., Golden, CO.
RECENT RESULTS FROM DATA ANALYSIS OF DYNAMIC STALL ON WIND TURBINE BLADES
C. P. BUTTERFIELD, D. SIMMS, and S. HUYER (Colorado Univ., Boulder.) Jan. 1992 14 p Presented at the International Energy Agency (IEA) Experts Meeting on Wind Turbine Aerodynamics, Stuttgart (Germany), 3-4 Dec. 1991
(Contract DE-AC02-83CH-10093)
(DE92-001200; NREL/TP-257-4654; CONF-911287-1) Avail: NTIS HC/MF A03

Wind turbines are subjected to dynamic loading from a variety of different sources. Wind shear and turbulence cause time-varying inflow that results in unsteady airloads. Tower shadow, upwind turbine wakes, and yaw angles also introduce unsteady inflow to wind turbine rotors. Wind turbine designers must predict these loads accurately in order to adequately design blades, hubs, and the remaining support structure to achieve a 30-year life. Structural analysts have not been able to predict mean or dynamic loads accurately enough to predict the fatigue life of major wind turbine components with confidence. Part of the problem is due to uncertainty in the stochastic wind environments as mentioned earlier. Another important part of the problem is the lack of basic knowledge of rotary wing airfoil stall performance. There is mounting evidence that dynamic stall may be related to dynamic loads that are greater than predictions. This paper describes some results of investigations of unsteady aerodynamic loads measured on a wind turbine blade. The objective of the investigation is to understand the steady and unsteady stall behavior of wind turbine blades. DOE

N92-20574# Rolls-Royce Ltd., Derby (England).
THE ENVIRONMENTAL IMPACT OF COMMERCIAL AVIATION: THE EVOLUTION OF EXHAUST EMISSIONS LEGISLATION AND CONTROL TECHNOLOGY
G. PILKINGTON and A. B. WASSELL 14 Apr. 1991 8 p
(PNR-90847; ETN-92-90797) Copyright Avail: NTIS HC/MF A02

Interest in the environmental impact of turbine powered aircraft was kindled in the early 1960s by the black smoke trails emanating from engines that also emitted the characteristic high noise levels of high velocity exhaust jets. The introduction of more powerful engines, jet mixing, and combustors with leaner primary zones occurred in parallel with the development of the first environmental legislation towards the end of the decade. The 1970s were characterized by the introduction of the high ratio engines with low noise levels and invisible exhausts. Attention was then turned to the invisible exhaust emissions and initial estimates were made of their effect on the environment. This activity resulted in international guidelines for both noise and emissions by 1981. All commercial aircraft engines currently being produced now meet these standards and discussions have started to see whether these standards are still appropriate for the start of the next century or whether more stringent standards should be considered. ESA

N92-20928# Rolls-Royce Ltd., Derby (England).
THE ENVIRONMENTAL CHALLENGES FOR THE NEXT SUPERSONIC AIRCRAFT
M. J. T. SMITH 9 Nov. 1990 6 p Presented at the Japan Society for Aeronautical and Space Sciences 28th Aircraft Symposium, Tokyo, Japan, 7-9 Nov. 1990
(PNR-90782; ETN-92-90768) Copyright Avail: NTIS HC/MF A02

Most people would accept that there will, one day, be a Second-generation Supersonic Transport (SST). At the same time, in an era of heightening environmental awareness, one can assume that there will be progressively more stringent restrictions on both exhaust emissions and noise. Indeed, because aircraft deliver all their pollutants directly to the upper atmosphere, they may come under a far more powerful microscope than land based consumers of fossil fuels. At the same time, noise, although a pollutant with far less effect in human well being, will always be a political stalking horse and, in the case of the SST, there is the added issue of the sonic boom. Hence, the next SST will be faced with more and bigger environmental hurdles than aroused the 'green' interest in the Concorde 20 years ago. Designers will have to anticipate the stringency of environmental legislation to ensure that their new SST can fly alongside subsonic contemporaries without any operational and, therefore, commercial disadvantages. The environmental regulatory situation and ways in which targets may be met are discussed. Special attention is given to exhaust emission and noise restrictions. ESA

N92-21040# Sandia National Labs., Albuquerque, NM.
THE STATUS OF THE US VAWT PROGRAM
H. M. DODD, D. E. BERG, T. D. ASHWILL, H. J. SUTHERLAND, and L. L. SCHLUTER 1991 20 p Presented at the Canadian

Wind Energy Association (CWEA) Meeting, Montreal (Canada), 4 Nov. 1991
(Contract DE-AC04-76DP-00789)
(DE92-002931; SAND-91-2386C; CONF-9111131-1) Avail: NTIS HC/MF A03

Vertical axis wind turbine (VAWT) technology in the United States started in the early 1970s directly from the original work in Canada. The close, and very productive relationships among laboratories, universities and industry have continued since that time. This paper briefly discusses the significant technical progress and rather dramatic programmatic changes that have occurred in the past 18 to 24 months on the U.S. side of the border. DOE

N92-21546*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
HIGH ALTITUDE SOLAR POWER PLATFORM
M. D. BAILEY and M. V. BOWER (Alabama Univ., Huntsville.) Apr. 1992 91 p
(NASA-TM-103578; NAS 1.15:103578) Avail: NTIS HC/MF A05 CSCL 10/2

Solar power is a preeminent alternative to conventional aircraft propulsion. With the continued advances in solar cells, fuel cells, and composite materials technology, the solar powered airplane is no longer a simple curiosity constrained to flights of several feet in altitude or minutes of duration. A high altitude solar powered platform (HASPP) has several potential missions, including communications and agriculture. In remote areas, a HASPP could be used as a communication link. In large farming areas, a HASPP could perform remote sensing of crops. The impact of HASPP in continuous flight for one year on agricultural monitoring mission is presented. This mission provides farmers with near real-time data twice daily from an altitude which allows excellant resolution on water conditions, crop diseases, and insect infestation. Accurate, timely data will enable farmers to increase their yield and efficiency. A design for HASPP for the foregoing mission is presented. In the design power derived from solar cells covering the wings is used for propulsion, avionics, and sensors. Excess power produced midday will be stored in fuel cells for use at night to maintain altitude and course. Author

N92-21743# Rolls-Royce Ltd., Derby (England).
ENVIRONMENTALLY SOUND
M. J. T. SMITH and K. GODDARD 1 Oct. 1990 14 p Presented at the 3rd Annual Conference in Techno-Economic Issues, London, England, 31 Aug. 1990
(PNR-90776; ETN-92-90764) Copyright Avail: NTIS HC/MF A03

Developments made in stage 2 aircraft since 1989 are reviewed. In brief, the events are as follows: the first stage 2 aircraft to be reengined with a stage 3 Rolls-Royce Tay has flown; the first order for stage 3 Tay engines to replace stage 2 Pratt and Whitney JT8Ds in the Boeing 727 has been secured; Europe has decided on its future policy in the phase out of the stage 2 fleet; airports around the world have progressively tightened their stranglehold in stage 2 operations; it has become clear that simple hushkits are only marginal stop gap methods of hiding from tommorrow's environmental problems; concern about atmospheric pollution has cast another shadow over the old engines now powering the stage 2 fleet; Rolls-Royce is re-examined the development of a large Tay engine directed at the re-engining market. ESA

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MATHEMATICAL AND COMPUTER SCIENCES

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

A92-29037
REACHING CONDITIONS IN VARIABLE STRUCTURE SYSTEMS FOR OUTPUT FEEDBACK CONTROL
SUBBARAO V. YALLAPRAGADA and BONNIE S. HECK (Georgia Institute of Technology, Atlanta) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 32-36. Research supported by Georgia Institute of Technology. refs
Copyright

The issues surrounding the reaching conditions in variable structure systems with output feedback control are investigated. The control law is formulated so that static output feedback can be applied to variable structure systems as opposed to state feedback or estimated state feedback. The control law is chosen to ensure that the reaching conditions are satisfied. The control structure is such that certain parameters directly affect the time to reach the sliding surface. Several procedures are devised to select these parameters so that not only the reaching conditions can be satisfied with flexibility, but the time to reach the sliding surface can also be adjusted. Numerical examples are given. I.E.

A92-29052
MODEL-REFERENCE ADAPTIVE CONTROL FOR SYSTEMS WITH D MATRICES
JAKE GLOWER and DON CARPENTER (GE Aircraft Engines, Cincinnati, OH) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 165, 166.
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A model-reference adaptive control law based on Liapunov design techniques is presented for systems with D matrices. By controlling both the states and the outputs, perfect model-following and good output performance can be obtained. An example based on the GE16 engine is presented to illustrate the design. I.E.

A92-29066
LINEAR SYSTEMS WITH OUTPUT CONSTRAINTS - THE THEORY AND APPLICATION OF MAXIMAL OUTPUT ADMISSIBLE SETS
ELMER G. GILBERT and KOK T. TAN (Michigan, University, Ann Arbor) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 351-359. refs
Copyright

An initial state of an unforced linear system is output admissible with respect to a constraint set Y if the resulting output function satisfies a pointwise-in-time condition. The set of all such initial states is the maximal output admissible set, O(infinity). The properties of O(infinity) and its characterization are investigated. In the discrete-time case it is generally possible to represent O(infinity), or a close approximation of it, by a finite number of functional inequalities. Practical algorithms for generating the functions are described. O(infinity) has important applications in the analysis and design of closed loop systems with state and control constraints. An example is given. I.E.

A92-29101
DESIGN OF COMPENSATORS FOR LINEAR PARAMETER-VARYING FEEDBACK SYSTEMS BY THE GAIN SCHEDULING TECHNIQUE
S. M. SHAHRUZ (Berkeley Engineering Research Institute, CA) and G. LANGARI (California, University, Berkeley) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 641, 642. refs
Copyright
Design of compensators for linear multi-input-output feedback systems whose dynamics depend on a time-varying parameter is studied. Algorithms for designing compensators based on the gain scheduling technique are proposed. Compensators are designed so that certain design criteria are satisfied. The rate of change of the time-varying parameter so that the gain-scheduled feedback system remains stable is determined. I.E.

A92-29132
ON THE NYQUIST ENVELOPE OF AN INTERVAL PLANT FAMILY
C. V. HOLLOT (Massachusetts, University, Amherst) and R. TEMPO (CNR, CENS; Torino, Politecnico, Turin, Italy) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 861-864. Research supported by CNR. refs
(Contract NSF ECS-86-12948)
Copyright
The envelope of the Nyquist plots generated by an interval plant family is studied, and it is shown that this boundary is not always contained in the Nyquist plots of the Kharitonov plants. With this motivation, a sufficient condition for an envelope point to be contained in the Nyquist plot of a Kharitonov plant is given and it is used to generate large and critical portions of the Nyquist envelope as well as to create a framework for developing new extreme point results for interval feedback systems. This framework is useful in computing the phase margin and the maximal peaking in the sensitivity and complementary sensitivity functions and in stating a robust version of the circle criterion. I.E.

A92-29134
THE IMPLICIT FUNCTION THEOREM AND ROBUST ROOT LOCUS
SCOTT W. TENTO (Boeing Co., Seattle, WA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 869, 870. refs
Copyright
The application of the implicit function theorem to control theory is discussed. A definition of robust root locus is given, and sample computations are made. A compact representation of n-dimensional root locus is given. Similar analyses can be applied to problems throughout control theory. I.E.

A92-29155
A HIERARCHICAL DATA STRUCTURE AND NEW CAPABILITIES OF THE ROBUST-CONTROL TOOLBOX
R. Y. CHIANG and M. G. SAFONOV (Southern California, University, Los Angeles, CA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 1. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 984-989. refs
Copyright
The Robust-Control Toolbox is a collection of M-files which extend the capability of PC/PRO-MATLAB to do modern multivariable robust control system design. A description is presented of the basic functions with practical examples, and recent developments of the toolbox are introduced. These include the new MU-Synthesis tool with demonstrations, and most of all, a new hierarchical data structure which permits data describing systems and collections of systems to be incorporated in, and extracted from a single MATLAB variable called a TREE. This data structure facilitates user interaction with many MATLAB functions which operate on systems. I.E.

A92-29177
LOOP SHAPING IN MIXED H2 AND H-INFINITY OPTIMAL CONTROL
HSI-HAN YEH, SIVA S. BANDA, ANDREW G. SPARKS, and D. B. RIDGELY (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 2. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 1165-1170. refs
Copyright
Mixed H2 and H-infinity optimal control law design by shaping of the loop transfer function to meet engineering goals is considered. The development is closely analogous to the linear quadratic Gaussian with loop-transfer recovery procedure for H2 optimal control law design, with an additional constraint on the H-infinity norm of a certain disturbance transfer function matrix. To facilitate the numerical computation of the controller, the main results of mixed H2 and H-infinity optimization are modified by assuming that the design weights are interdependent and that the disturbance inputs are uncorrelated. The condition that forms the basis for loop-transfer recovery, under which the dynamic compensator recovers the properties of the state feedback, static gain controller, is derived. I.E.

A92-29189
THE GENERALIZED NORMAL FORMS AND METHOD OF RESONANCE CONTROL OF NONLINEAR DYNAMICAL SYSTEMS
MARK A. PINSKY (Nevada, University, Reno) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 2. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 1285-1290. refs
Copyright
The generalized normal forms (GNFs) method which allows normal forms to be found for the broad class of dynamical systems not considered by earlier techniques is presented. The proposed method is feasible for the dynamical systems with non-smooth and discontinuous nonlinearity. The GNFs method overcomes the lack of computability of earlier techniques. It is based on a simple iterative procedure which leads to an effective computer algorithm. The method has been implemented in computer software, providing a convenient tool for both qualitative and numerical analysis. The GNFs method is applied to design a resonance stabilization feedback control for a critical nonlinear system. The method of resonance control here developed allows one to find an efficient stabilization feedback and to estimate the basin of attractor. I.E.

A92-29237
LYAPUNOV EXPONENTS FOR SYSTEMS DESCRIBED BY DIFFERENTIAL EQUATIONS WITH DISCONTINUOUS RIGHT-HAND SIDES
STUART F. BOCKMAN (Hughes Aircraft Co., El Segundo, CA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 2. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 1673-1678. refs
Copyright
A discussion is presented of the numerical computation of Liapunov exponents for systems described by ordinary differential equations with discontinuous right-hand sides. Known methods for computing Liapunov exponents are extended to such systems by using jump conditions for the variational equation and treating sliding behavior explicitly. A computer program that computes Liapunov exponents for linear plants controlled by bang-bang control according to a linear switching law is briefly described. Examples include one involving the stabilization of the longitudinal dynamics of a helicopter. I.E.

A92-29248 National Aeronautics and Space Administration, Washington, DC.
A SYSTEM IDENTIFICATION MODEL FOR ADAPTIVE NONLINEAR CONTROL
DENNIS J. LINSE and ROBERT F. STENGEL (Princeton University, NJ) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 2. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 1752-1757. Research supported by FAA. refs
(Contract NGL-31-001-252; DAAL03-89-K-0092)
Copyright

A system identification model that combines generalized-spline function approximation with a nonlinear control system is described. The complete control system contains three main elements: a nonlinear-inverse-dynamic control law that depends on a comprehensive model of the plant, a state estimator whose outputs drive the control law, and a function approximation scheme that models the system dynamics. The system-identification task, which combines an extended Kalman filter with a function approximator modeled as an artificial neural network, is considered. The results of an application of the identification techniques to a nonlinear transport aircraft model are presented. I.E.

A92-29280
FREQUENCY RESPONSE SPECIFICATIONS AND SENSITIVITY FUNCTIONS IN QUANTITATIVE FEEDBACK THEORY
DAVID F. THOMPSON and OSITA D. I. NWOKAH (Purdue University, West Lafayette, IN) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 2. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2015-2020.
(Contract F49620-88-C-0053)
Copyright

Traditional QFT (quantitative feedback theory) design criteria are contrasted with a relaxed, sensitivity-based formulation for single input single output (SISO) feedback systems. The advantage of the latter is a greater degree of mathematical commonality with alternative frequency domain methods, thus laying the groundwork for future benchmark studies in control design. The methodology is demonstrated by application to a lateral autopilot design problem for the C-135 aircraft, both to the traditional QFT design specifications as well as to the relaxed sensitivity based criterion. I.E.

A92-29291
A NEW APPROACH TO THE REAL-TIME SIMULATION OF CONTROL SYSTEMS WITH DISCONTINUITIES
K. C. LIN (Central Florida, University, Orlando, FL) and R. M. HOWE (Michigan, University, Ann Arbor) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 2. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2122-2127. refs
Copyright

Control systems consisting of a subsystem with discontinuities often cause problems in digital simulation. An approach which replaces the subsystems with a function table is suggested. The dynamic equations of the control subsystem with discontinuities are integrated off-line over a time interval which will be used as the step-size for the on-line integration of the whole control system. This off-line integration uses a sufficiently small step size and the necessary algorithm to handle the discontinuities of the subsystem. The process is repeated for a matrix of initial conditions and inputs. In the on-line real-time simulation, table lookup and linear interpolation are used to update the subsystem with discontinuities while the rest of the control system is integrated with conventional real-time algorithms. I.E.

A92-29313
PARAMETER IDENTIFICATION OF COMPRESSOR DYNAMICS DURING CLOSED-LOOP OPERATION
J. PADUANO, L. VALAVANI, and A. H. EPSTEIN (MIT, Cambridge, MA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2379-2385. Research supported by USAF and U.S. Navy. refs
Copyright

By combining various extensions to the basic instrumental variable approach, a scheme for estimating parameters in an unstable system in closed-loop operation was developed. This scheme was successfully applied to a model for the distributed dynamics of an axial compressor. Thus, the usefulness of the procedure and the validity of the model were both verified experimentally. I.E.

A92-29315
COMPRESSOR MODELING AND ACTIVE CONTROL OF STALL/SURGE
L. P. HARRIS and H. A. SPANG, III (GE Research and Development Center, Schenectady, NY) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2392-2397. refs
Copyright

The Moore-Greitzer formulation for compressor dynamics is extended to symmetric-flow compressor map shapes other than the cubic map treated by Moore and Greitzer. Two families of curves, the odd-polynomial and even-polynomial families, are defined that provide a wide range of shapes in the stable-flow regime, and the amplitudes of flow asymmetry in steady rotating stall are calculated for members of both families. Also detailed is a control strategy based on sensing of asymmetric axial flow components and the rate of change of mean flow. It is shown that controlled bleed of high pressure air based on such measurements can be used to suppress both stall and surge oscillations. I.E.

A92-29316* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A LYAPUNOV BASED NONLINEAR CONTROL SCHEME FOR STABILIZING A BASIC COMPRESSION SYSTEM USING A CLOSE-COUPLED CONTROL VALVE
J. S. SIMON and L. VALAVANI (MIT, Cambridge, MA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2398-2406. refs
(Contract NAG3-770)
Copyright

The use of a closed-loop control to allow surge-free operation of a compression system beyond its uncontrolled surge line is addressed. In contrast to previous analyses which used a linearized model, the approach described directly addresses the nonlinear nature of the compressor characteristic using a Liapunov-based control law design formulation. The proposed approach is fairly generic and should be of interest for gas turbine engines as well as other applications. I.E.

A92-29324
ACTIVE VIBRATION CONTROL USING FIXED ORDER DYNAMIC COMPENSATION WITH FREQUENCY SHAPED COST FUNCTIONALS
J. V. R. PRASAD, ANTHONY J. CALISE, and EDWARD V. BYRNS, JR. (Georgia Institute of Technology, Atlanta) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2461-2466. refs
Copyright

An approach for the design of controllers for active suppression of helicopter vibration is presented. The approach is a result of combining recent developments in the design of fixed-order dynamic compensators with the frequency shaped cost functional approach. A robust compensator which provides loop shaping at the plant input is used in conjunction with frequency shaped cost functionals in order to arrive at a controller for vibration reduction. The effectiveness of this technique is demonstrated by a detailed case study for the design of an active vibration controller. I.E.

A92-29326
DYNAMIC STABILITY OF ELASTIC VEHICLES WITH UNSTEADY AERODYNAMIC FORCE MODELING
SHILU CHEN, HENGYUAN YAN, XIUFANG HUO, and FUMING HUAN (Northwestern Polytechnical University, Xian, People's Republic of China) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2475, 2476.
Copyright
The stability problem of an elastic vehicle is studied with the effect of unsteady aerodynamic forces considered. Longitudinal equations for disturbance motions with the action of unsteady aerodynamic force are derived. A method of analysis for the effect of aeroelasticity on the stability of an elastic vehicle by using a simplified mathematical model of unsteady aerodynamic forces is proposed. I.E.

A92-29327
ON AUTOMATIC CONTROL OF AEROELASTIC VEHICLES
I. STIHARU-ALEXE (Polytechnical Institute, Bucharest, Romania) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 2477, 2478. refs
Copyright
An analytical approach for second-order aircraft dynamics in which the stationary aeroelastic effects are considered is examined. The system is developed by extending the rigid-body derivatives with the aeroelastic stability and command derivatives due to four elastic nodes, a twelve-order steady-state model being obtained for the perturbed decoupled motion. To simplify the computational burden simple low-order models are developed. The goal is to adequately solve the essential tradeoffs of feedback focused on eigenstructure assignment. I.E.

A92-29368
ROBUST OPTIMAL CONTROL WITH A WORST CASE TIME DOMAIN PERFORMANCE CRITERION
MARC STEINBERG and M. B. SUBRAHMANYAM (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 3024-3029. refs
A method of designing controllers by optimizing a worst case time domain performance index is described. This method directly maximizes a finite time ratio of weighted exogenous input energy to weighted energy error for the worst possible combination of commanded inputs, disturbances, and sensor noise. Robust performance can also be achieved by including the worst possible degradation of the performance index due to parameter variations and uncertainty. Extensions to nonlinear and time-varying problems are possible, and neither the plant or the controller is required to be stable or minimum phase. In addition, this method synthesizes the worst possible case to verify it is a real possibility, and not just an idiosyncrasy of the mathematical design model. I.E.

A92-29374
A GENERAL NONLINEAR DYNAMICAL ANALYSIS OF A SECOND-ORDER, ONE-DIMENSIONAL, THEORETICAL COMPRESSION SYSTEM MODEL
S. M. OLIVA and C. N. NETT (Georgia Institute of Technology, Atlanta) IN: 1991 American Control Conference, 10th, Boston, MA, June 26-28, 1991, Proceedings. Vol. 3. Piscataway, NJ, Institute of Electrical and Electronics Engineers, 1991, p. 3158-3165. Research supported by U.S. Navy, NSF, FAPESP, et al. refs
Copyright
A nonlinear dynamical analysis of a second-order, one-dimensional, theoretical compression system model is presented. As in previous analyses of this type, a nondimensional speed parameter is regarded as a variable system parameter. However, in contrast to previous analyses of this type, the nondimensional compressor and throttle characteristics embedded within the model are also regarded as variable system parameters. This results in an explicit characterization of the way in which the nonlinear dynamical behavior exhibited by the model depends on these characteristics. In applications this characterization provides guidelines for specifying unmeasurable details of these characteristics in such a way as to ensure that the nonlinear dynamical behavior exhibited by the model corresponds to that observed in the underlying physical compression system. I.E.

A92-30130
INVESTIGATION OF EXTREMAL FIELD BEHAVIOR FOR TWO-DIMENSIONAL LINEAR PROBLEMS IN FLIGHT MECHANICS [ISSLEDOVANIE ZAKONOMERNOSTEI POLIA EKSTREMALEI DVUMERNYKH LINEINYKH ZADACH MEKHANIKI POLETA]
L. P. FEDOROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 1, 1990, p. 36-48. In Russian. refs
Copyright
The characteristics of the extremal field for the simplest class of variational problems in flight mechanics, where the problems contain two differential bounds with a control variable entering linearly into them, are investigated using methods developed by Illarionov and Pashintsev (1971, 1973, 1974). The well-known solution methods including the Miele method, the Ostoslavskii-Lebedev method, and the Pontriagin maximum principle are compared. Particular attention is given to special control portions of the extremals. I.S.

A92-30311
ROBUSTNESS OF CONTROL SYSTEMS WITH NONLINEAR PARAMETRIC CORRECTION FOR CERTAIN TYPES OF PERTURBATIONS [ROBASTNOST' SISTEM UPRAVLENIIA S NELINEINOI PARAMETRICHESKOI KORREKTSIEI K NEKOTORYM VIDAM VOZMUSHCHENII]
I. N. KRUTOVA and V. IU. RUTKOVSKII (Institut Problem Upravleniia, Moscow, Russia) Avtomatika i Telemekhanika (ISSN 0005-2310), Sept. 1991, p. 145-159. In Russian. refs
Copyright
An analysis is made of the robustness of a control system with nonlinear parametric correction (based on an adaptive system structure with a reference model) for inaccuracy of the mathematical description of the system dynamics and parametric and coordinate perturbations. The efficiency of the correction proposed here is demonstrated using a system for the control of the pitching motion of a flight vehicle as an example. V.L.

A92-31430
RULE BASED IDENTIFIER FOR UNKNOWN SYSTEMS
H. WANG (Brunel University, Uxbridge, England) and A. H. JONES (Salford, University, England) IEE Proceedings, Part D - Control Theory and Applications (ISSN 0143-7054), vol. 138, Sept. 1991, p. 500-506. refs
Copyright
The paper deals with the problem of rule based identification for unknown systems. Several rules have been established which give a desirable estimate for the time delay, minimum structure order and unknown parameters, by using only one open-loop step response test. These rules actually adjust the poles and zeros of the proposed linear model to make its response as close as possible to that of the original open-loop system. It has also been shown that this method can be directly used to identify the unknown parameters of MIMO systems. Finally, this rule based identifier is applied to three real experimental systems: a jet engine speed control system (SISO), a temperature process control system (SISO) and a coupled electric drive control system (MIMO). For all the systems, desirable identification results have been obtained. Author

N92-20590 Electronique Serge Dassault, Saint Cloud (France).
SPACE SOFTWARE IS FIRST OF ALL SOFTWARE [LE LOGICIEL SPATIAL EST D'ABORD DU LOGICIEL]
PHILIPPE LORIER and BRUNO MEHU *In* CNES, The Management of Large Software Projects in the Space Industry p

23-32 Jun. 1991 In FRENCH; ENGLISH summary Previously announced in IAA as A91-47752
Copyright Avail: CEPADUES-Editions, 111 Rue Nicolas-Vauquelin, 31100 Toulouse, France

The use of software tools and methods in avionics and space applications is discussed. Similarities between the software used in these two domains is pointed out. Experience gained with software carried on the SPOT 2 and 3 satellites and on Helios, is described. Experience gained with calculation software on Mirage F1, Mirage 2000, and Rafale fighters is summarized. Software specifications, software validation tests, and configuration management are discussed in view of the experience gained in both the avionic and space software systems. ESA

N92-20905 Tel-Aviv Univ. (Israel). Dept. of Computer Science.
TIMING ANALYSIS OF PARALLEL ALGORITHMS ON A MIMD MULTIPROCESSOR M.S. Thesis
BARACK SHOHAM Feb. 1990 45 p
(ITN-92-85153) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

Two parallel processing applications were implemented on a shared memory MIMD (Multiple Instruction Multiple Data Stream) machine. In studying the speedup achievable through using multiple processors to solve CFD (charge flow device) problems, especially the computation of aerodynamic flow around complex bodies, a finite difference solution of a 2-D boundary problem was considered, with appropriate domain partition. The implementation of single grid and multigrid solutions on shared memory and shared bus (nonvector) MIMD multiprocessors was examined. When each processor was assigned a single horizontal line, processing time of the single grid solution increased nearly linearly with the number of grid points in the slice; the dependence was nonlinear for the multigrid solution, owing to the change in the number of processors utilized in different levels of the scheme. The second application involved the speedup achievable through using multiprocessors for solving Toeplitz systems, using a modified Levinson algorithm related to signal processing and very large scale integration. Local processing was used in this application, to facilitate parallel computing. When each processor was assigned a single entry in the solution vector, the processing time increased nonlinearly with the size of the matrix, owing to the global data transmission. Both applications were implemented on an MIMD machine, using the MMX (Multiprocessor Multitasking eXecutive), which is an experimental shared memory multiprocessor operating system. ISA

N92-21392# BBN Systems and Technologies Corp., Cambridge, MA.
SIMNET PLAN VIEW DISPLAY USER MANUAL
Jun. 1991 25 p
(Contract MDA972-89-C-0060; MDA972-89-C-0061)
(AD-A244617; BBN-7618) Avail: NTIS HC/MF A03 CSCL 05/2

This Simulation Network (SIMNET) project user manual describes the use of the Plan View Display (PVD) Workstation of the SIMNET hardware and software training system for vehicle crew training and operational training. The objective of the SIMNET program is to develop large-scale networking of military simulators for such vehicles as tanks and fixed-wing and rotary-wing aircraft. By utilizing a network of low-cost, full-crew simulators, each supported by its own set of microprocessors, the Army can conduct platoon-, company-, and battalion-level exercises incorporating all of the tactical, logistic, administrative, and communication elements that are critical to actual field operations. This technology will permit regular and intensive practice of team combat skills. A SIMNET simulator models the performance of the actual vehicle in mobility, fire control, and communication. A simulator contains crew stations, each of which has a set of controls comparable to those in the actual vehicle. The simulator's visual display system ensures that each crew member sees a depiction of the battlefield terrain as it would be seen from his vision blocks in the actual combat vehicle. SIMNET offers the crew member the opportunity to behave as he would in a real vehicle, succeeding or failing in assigned missions as he would in a battlefield exercise. SIMNET provides components for recording exercise data and for reviewing an exercise via a plan view (bird's-eye view) of the battlefield. GRA

N92-21847# Rolls-Royce Ltd., Derby (England).
THE PROPOSED REVISION TO RTCA DO178A AND ITS INFLUENCE ON SYSTEM DESIGN
C. D. JACK 1 Nov. 1990 7 p
(PNR-90821; ETN-92-90785) Copyright Avail: NTIS HC/MF A02

The RTCA document DO-178A entitled 'Software considerations in airborne systems and equipment certification' is introduced. Its importance in the avionics field is explained and some of the changes currently proposed and their possible impact on airborne systems and their certification are explained. Particular consideration is given to high-integrity systems, although the proposed changes could have effects on less critical systems. ESA

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PHYSICS

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

A92-28682
NUMERICAL COMPARISON OF EXPERIMENTALLY MEASURED ULTRASOUND THROUGH A MULTILAYERED SPECIMEN
JOHN M. SULLIVAN, JR., REINHOLD LUDWIG, YIPING GENG, and VINOD K. NAIR (Worcester Polytechnic Institute, MA) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 1359-1366. Research supported by U.S. Army. refs
Copyright

The present analytical strategy for the assessment of bondline integrity by means of ultrasound NDE employs analytical, numerical, and experimental investigations in a concerted and mutually complementary fashion. While experimental results can distinguish the presence of total disbonds, partial disbond testing is conducted on a continuous basis. Numerical simulations are shown to be in close agreement with experimental results. The transparent view of elastic wave propagation in a material that is afforded by the simulation mode is expected to help in the development of a successful experimental facility predicated on the present methodology. O.C.

A92-28720
A TECHNIQUE FOR QUANTITATIVELY MEASURING MICROSTRUCTURALLY INDUCED ULTRASONIC NOISE
F. J. MARGETAN, T. A. GRAY, and R. B. THOMPSON (Iowa State University of Science and Technology, Ames) IN: Review of progress in quantitative nondestructive evaluation; Proceedings of the 17th Annual Review, La Jolla, CA, July 15-20, 1990. Vol. 10B. New York, Plenum Press, 1991, p. 1721-1728. refs
(Contract W-7405-ENG-82)
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A method for quantifying backscattered grain noise amplitudes in pulse/echo inspections is presented. The technique employs positional averaging to extract the rms grain noise as a function of time, or equivalently, as a function of depth in the specimen. This technique has been demonstrated for focussed transducer inspections of titanium alloys. A simple grain noise model that assumes incoherent single scattering by the individual metal grains is presented as a first step toward the development of a comprehensive theory. R.E.P.

A92-30143
REDUCING THE BACKGROUND NOISE LEVEL IN THE TEST SECTION OF A WIND TUNNEL FOR TRANSONIC FLOW VELOCITIES [SNIZHENIE UROVNIA FONOVOGO SHUMA V RABOCHEI CHASTI AERODINAMICHESKOI TRUBY PRI TRANSZVUKOVYKH SKOROSTIAKH POTOKA]
A. G. EREZA, V. G. MIKELADZE, A. G. MUNIN, E. P. STOLIAROV, R. D. FILIPPOVA, and A. N. SHLIAGUN TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 2, 1990, p. 10-19. In Russian. refs
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The paper reports the results of an experimental study of the background noise in the test section of a wind tunnel with perforated walls. The principal sources of the noise at transonic flow velocities are identified. Some methods for reducing the level of the background noise are discussed, and their efficiency evaluated. V.L.

A92-30205
INVESTIGATION OF THE EFFECT OF AN ULTRASONIC ACOUSTIC FIELD ON BOUNDARY LAYER SEPARATION ON AN AIRFOIL [ISSLEDOVANIE VLIIANIIA UL'TRAZVUKOVOGO AKUSTICHESKOGO POLIA NA OTRYV POGRANICHNOGO SLOIA NA PROFILE]
S. V. ZHIGULEV and A. V. FEDOROV TsAGI, Uchenye Zapiski (ISSN 0321-3439), vol. 21, no. 6, 1990, p. 58-66. In Russian. refs
Copyright
The paper presents results of theoretical and experimental studies on the effects of an ultrasonic field in the 40-70 kHz range on laminar flow separation in the vicinity of the leading edge of a supercritical wing profile at angles of attack of 7.3-7.7 deg. The experiment was conducted in a low-noise subsonic wind tunnel at flow velocities of 33-71 m/s, corresponding to Reynolds numbers of 0.9 x 10 exp 6 to 1.9 x 10 exp 6. In the absence of the acoustic field a global separation occurs which occupies 20 percent of the airfoil chord. When an acoustic field is applied, the dimensions of the separation zone change substantially, and, when the ultrasonic-field intensity exceeds a certain threshold value, global separation is eliminated altogether, so that the thickness of the shear layer changes by an order of magnitude. This effect has a marked hysteretic and resonant character. L.M.

A92-30318
ACOUSTIC EMISSION DURING CHANGES IN THE AERODYNAMIC LOAD ON THE SURFACE OF A FAN BLADE [AKUSTICHESKOE IZLUCHENIE PRI IMPUL'SNOM IZMENENII AERODINAMICHESKOI NAGRUZKI NA POVERKHNOSTI LOPASTI VENTILIATORA]
S. G. CHUKHLANTSEV (AN SSSR, Akusticheskii Institut, Moscow, USSR) Akusticheskii Zhurnal (ISSN 0320-7919), vol. 37, Sept.-Oct. 1991, p. 1019-1025. In Russian. refs
Copyright
The directional characteristics and acoustic parameters of a source resulting from the aerodynamic interaction between a fan blade and a bluff body located at the exit of the air flow are investigated analytically and experimentally. The results of the study suggest that the theoretical relations obtained for other cases of fan rotation in the field of inhomogeneous flow remain valid for the case considered here. It is shown, in particular, that by changing the number of blades and obstacle location, it is possible to reduce the radiation in the axial direction since most of the radiation in this direction is generated by a force harmonic with a number equal to the number of blades. V.L.

A92-32502
ANALYTICAL STUDY ON PLATE EDGE NOISE. I - TRAILING EDGE NOISE CAUSED BY VORTICITY WAVES
KOJI TAKAHASHI and SHOJIRO KAJI Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016), vol. 56, Sept. 1990, p. 2582-2589. In Japanese. refs
An analysis is performed on the trailing-edge noise which is one of the mechanisms of noise generation in flow machines. An acoustic field is treated where a semiinfinite flat plate is placed parallel to the inviscid uniform flow with incident vorticity waves convected from the upstream direction. Applying the Wiener-Hopf technique, an exact solution is derived for the sound pressure which is proportional to the amplitude of the incident vorticity wave and does not restrict frequency or velocity. The calculated acoustic field exhibits general features of the sound-pressure level (SPL) in a cardioid pattern with the constant phase surface distorted by the main flow. The relationship between flow velocity and SPL is dependent on the fifth law at low Mach numbers. The results show that such dependence does not hold at higher Mach numbers at which the radiated noise level rises progressively as the flow velocity increases. Author

N92-20360 Pennsylvania State Univ., University Park.
NONLINEAR ACOUSTIC PROPAGATION OF SHOCK WAVES THROUGH THE ATMOSPHERE WITH MOLECULAR RELAXATION Ph.D. Thesis
JONGMIN KANG 1991 220 p
Avail: Univ. Microfilms Order No. DA9127350
A theory is developed for determining a detailed rise phase of weak shocks based on molecular relaxation. The principal hypothesis is that the molecular relaxation process is so fast that a frozen shock profile is achieved very quickly within a length scale of the atmospheric inhomogeneity. By the frozen profile assumption, the augmented Burger's equation and the relaxation equation are reduced to equations which can be solved by numerical integration. The central issue is what is the most dominant mechanism for rise phase of weak shocks. Molecular relaxation mechanism has been believed to be a predominant mechanism; however, there exists no complete theory and analysis. From the comparison of theoretical predictions with experimental shock profiles of sonic boom, it is found that molecular relaxation cannot sufficiently explain the finite rise time of sonic booms. The rise times of experimental data are larger than predictions by a factor of 2 to 5. Atmospheric turbulence may be a predominant mechanism for this normal thickening effect. However, present theory provides a lower bound to rise time and an upper bound to loudness. It is possible to modify existing programs for sonic boom propagation without much effort. Dissert. Abstr.

N92-20388# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de la Physique Generale.
BLADE-VORTEX NOISE ON A HELICOPTER MAIN ROTOR. STUDY OF THE STRONG TWO DIMENSIONAL INCOMPRESSIBLE INTERACTION [BRUIT D'INTERACTION PALE-TOURBILLON SUR UN ROTOR PRINCIPAL D'HELICOPTERE. ETUDE DE L'INTERACTION FORTE EN BIDIMENSIONNEL INCOMPRESSIBLE]
G. RAHIER Jan. 1991 40 p In FRENCH
(Contract DRET-89-001-118)
(ONERA-RT-96/5094-PY; ETN-92-90876) Avail: NTIS HC/MF A03
A parametric study of the strong interactions in incompressible two dimensions is described. The study allows for the elaboration of an air vortex model compatible with the calculations of such interactions and allows the effects of various parameters of the interaction to be elucidated. Parameters such as the position of the air vortex, its intensity, the dimensions of its viscous core, and its profile incidence are identified. The results obtained using the S2DI code are compared to other calculation results, especially those based on Navier-Stokes equations. It is concluded that rapid calculation of interaction noise with relatively correct prediction capacity can be carried out in most cases. ESA

N92-20428 Florida Atlantic Univ., Boca Raton.
A NUMERICAL STUDY OF FUSELAGE SCATTERING EFFECTS ON ROTOR NOISE Ph.D. Thesis
NOUREDDINE ATALLA 1991 236 p
Avail: Univ. Microfilms Order No. DA9134559
The effects are considered of scattering on the sound radiation from rotating sources. The study was carried out using a combined numerical implementation of ray acoustics and the paraxial ray

approximation. A detailed description of the theoretical background to these methods are presented, along with a description of their numerical implementation. Application of the method to classical problems is considered to prove the accuracy and the power of the approach. Application of the method to some typical problems involving scattering of noise from propellers and rotors is presented. It is found that for impulsive acoustic signatures, the scattering effects are important especially in the sideline direction from a helicopter fuselage. The effects of sharp edges on the steady loading noise from tilt-rotor configurations indicates that there is a new mechanism for generating impulsive acoustic signatures caused by scattering caused by sharp edges of the fuselage. The acoustic signature generated by this mechanism can appear very similar to other types of impulsive source generated by aerodynamic interactions on the blade and therefore must be important. This type of source can be eliminated if the fuselage has rounded edges. Flow effects on scattering problems were also considered. It is concluded that scattering effects cannot be ignored for highly directional rotating sources next to rigid scattering objects as is always the case for propellers and helicopter rotors.

Dissert. Abstr.

N92-20461# Rolls-Royce Ltd., Derby (England).
THE IMPACT OF AIRCRAFT NOISE CONTROL TECHNOLOGY
M. J. T. SMITH 7 May 1991 9 p Presented at the Canadian Aeronautics and Space Seminar, Montreal, Quebec, 7 May 1991
(PNR-90846; ETN-92-90796) Copyright Avail: NTIS HC/MF A02

Reductions made in aircraft noise since the first generation jet aircraft are reviewed. The critical facts presently underpinning the airport noise situation are listed. The technologies which are responsible for the reduction in aircraft noise are reviewed and illustrated. Progress in noise control around airports is considered and future prospects concerning aircraft noise are discussed.

ESA

N92-20479*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ANNOYANCE CAUSED BY AIRCRAFT EN ROUTE NOISE
DAVID A. MCCURDY Mar. 1992 40 p
(NASA-TP-3165; L-16975; NAS 1.60:3165) Avail: NTIS HC/MF A03 CSCL 20/1

A laboratory experiment was conducted to quantify the annoyance response of people on the ground to enroute noise generated by aircraft at cruise conditions. The en route noises were ground level recordings of eight advanced turboprop aircraft flyovers and six conventional turbofan flyovers. The eight advanced turboprop enroute noises represented the NASA Propfan Test Assessment aircraft operating at different combinations of altitude, aircraft Mach number, and propeller tip speed. The conventional turbofan en route noises represented six different commercial airliners. The overall durations of the en route noises varied from approximately 40 to 160 sec. In the experiment, 32 subjects judged the annoyance of the en route noises as well as recordings of the takeoff and landing noises of each of 5 conventional turboprop and 5 conventional turbofan aircraft. Each of the noises was presented at three sound pressure levels to the subjects in an anechoic listening room. Analysis of the judgments found small differences in annoyance between three combinations of aircraft type and operation. Current tone and corrections did not significantly improve en route annoyance prediction. The optimum duration-correction magnitude for en route noise was approximately 1 dB per doubling of effective duration. Author

N92-21046# California Univ., Berkeley.
EXPERIMENTAL STUDIES OF COMPACT TOROIDS
1991 11 p
(Contract DE-FG03-87ER-53262)
(DE92-003469; DOE/ER-53262/T2) Avail: NTIS HC/MF A03

The Berkeley Compact Toroid Experiment (BCTX) device is a plasma device with a Marshall-gun generated, low aspect ratio toroidal plasma. The device is capable of producing spheromak-type discharges and may, with some modification, produce low-aspect ratio tokamak configurations. A unique aspect of this experimental device is its large lower hybrid (LH) heating system, which consists of two 450 MHz klystron tubes generating 20 megawatts each into a brambilla-type launching structure. Successful operation with one klystron at virtually full power (18 MW) has been accomplished with 110 microsecond pulse length. A second klystron is currently installed in its socket and magnet but has not been added to the RF drive system. This report describes current activities and accomplishments and describes the anticipated results of next year's activity. DOE

N92-21173*# McDonnell-Douglas Helicopter Co., Mesa, AZ.
BLADE-MOUNTED TRAILING EDGE FLAP CONTROL FOR BVI NOISE REDUCTION Final Report
A. A. HASSAN, B. D. CHARLES, H. TADGHIGHI, and L. N. SANKAR (Georgia Inst. of Tech., Atlanta.) Washington Feb. 1992 208 p
(Contract NAS1-19136)
(NASA-CR-4426; NAS 1.26:4426) Avail: NTIS HC/MF A10 CSCL 20/1

Numerical procedures based on the 2-D and 3-D full potential equations and the 2-D Navier-Stokes equations were developed to study the effects of leading and trailing edge flap motions on the aerodynamics of parallel airfoil-vortex interactions and on the aerodynamics and acoustics of the more general self-generated rotor blade vortex interactions (BVI). For subcritical interactions, the 2-D results indicate that the trailing edge flap can be used to alleviate the impulsive loads experienced by the airfoil. For supercritical interactions, the results show the necessity of using a leading edge flap, rather than a trailing edge flap, to alleviate the interaction. Results for various time dependent flap motions and their effect on the predicted temporal sectional loads, differential pressures, and the free vortex trajectories are presented. For the OLS model rotor, contours of a BVI noise metric were used to quantify the effects of the trailing edge flap on the size and directivity of the high/low intensity noise region(s). Average reductions in the BVI noise levels on the order of 5 dB with moderate power penalties on the order of 18 pct. for a four bladed rotor and 58 pct. for a two bladed rotor were obtained. Author

N92-21719# Aerospace Medical Research Labs., Brooks AFB, TX.
SONIC BOOMS PRODUCED BY US AIR FORCE AND US NAVY AIRCRAFT: MEASURED DATA Final Report, Jul. 1987 - Dec. 1990
R. A. LEE and J. M. DOWNING Jan. 1991 318 p
(Contract AF PROJ. 7231)
(AD-A244804; AL-TR-1991-0099) Avail: NTIS HC/MF A14 CSCL 20/1

A sonic measurement program was conducted at Edwards Air Force Base. Sonic boom signatures, produced by F-4, F-14, F-15, F-16, F-18, F-111, SR-71, and T-38 aircraft, were obtained under the flight track and at various lateral sites which were located up to 18 miles off-track. Thirteen monitors developed by Det 1 AL/BBE were used to collect full sonic boom waveforms, and nine modified dosimeters were used to collect supplemental peak overpressures and the C-weighted Sound Exposure Levels (CSEL) for 43 near steady supersonic flights of the above United States Air Force and United States Navy aircraft. This report describes the measured database (BOOMFILE) that contains sonic boom signatures and overpressures, aircraft tracking, and local weather data. These measured data highlight the major influences on sonic boom propagation and generation. The data from this study show that a constant offset of 26 from the peak overpressure expressed in dB gives a good estimate of the CSEL of a sonic boom. GRA

N92-21736# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de la Physique Generale.
PREDICTION OF HELICOPTER NOISE: ADAPTATION OF NOISE LOAD CALCULATIONS TO THE BLADE-VORTEX INTERACTION Summary Report [PREVISION DU BRUIT DES HELICOPTERES: ADAPTATION DU CALCUL DE BRUIT DE CHARGE A L'INTERACTION PALE-TOURBILLON. RAPPORT DE SYNTHESE]
P. SPIEGEL Jan. 1991 45 p In FRENCH
(Contract DRET-89-001-118)
(ONERA-RS-97/5094-PY; ETN-92-90872) Avail: NTIS HC/MF A03

The techniques used in predicting the noise produced by turbine motor helicopters are reviewed. Prediction of the noise produced by the interaction of the main rotor blades and the air vortex is given particular attention. The predictions are made based on pressure values generated by the DIPTEST simulation program. The quality of aerodynamic data required to carry out any acoustic calculations using the DIPTEST program, is defined. Smoothing of pressure coefficients allows a clean acoustic signal to be obtained, which faithfully reflects the physics involved in the phenomenon. ESA

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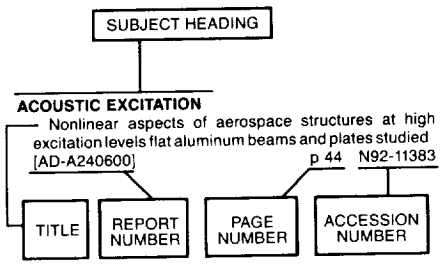
SOCIAL SCIENCES

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

N92-20629 Societe Anonyme de Telecommunications, Toulouse (France).
DATA PROCESSING ASPECTS OF THE HERMES FLIGHT CONTROL CENTER [LES ASPECTS DATA PROCESSING DANS LE CENTRE DE CONTROLE EN VOL HERMES]
FRANCOIS MARTIN-DUPONT *In* CNES, The Management of Large Software Projects in the Space Industry p 479-494 Jun. 1991 In FRENCH Previously announced in IAA as A91-47791
Copyright Avail: CEPADUES-Editions, 111 Rue Nicolas-Vauquelin, 31100 Toulouse, France

The overall content and goals of the Hermes project are reviewed. The specific data processing needs of each different section of the Hermes project are considered. Operational organization and preliminary architecture schemes are studied. Test strategy, validation, and qualification are discussed. Future applications of the approach to industrial organization and development planning are considered. ESA

Typical Subject Index Listing



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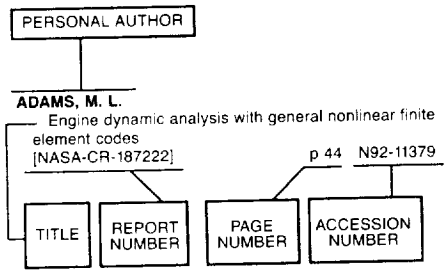

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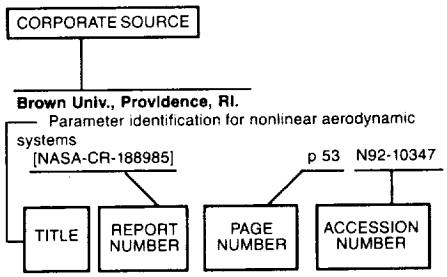

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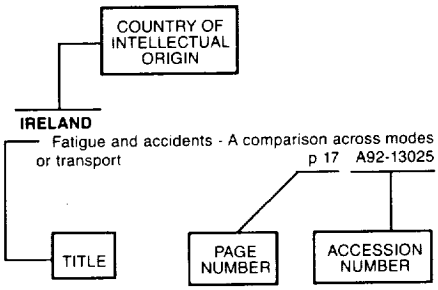

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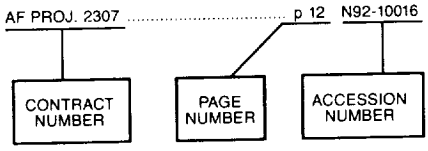

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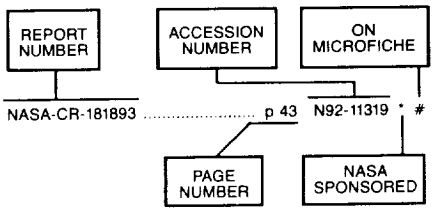

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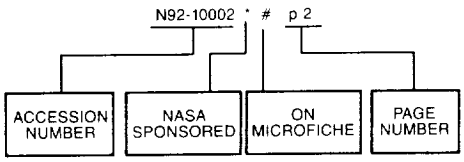

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