

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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ENGINEERING: A CONTINUING
BIBLIOGRAPHY WITH INDEXES
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NASA SP-7037 (299)
January 1994

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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

This issue of *Aeronautical Engineering — A Continuing Bibliography with Indexes* (NASA SP-7037) lists 244 reports, journal articles, and other documents recently announced in the NASA STI Database.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)

International Aerospace Abstracts (IAA) (A-10000 Series)

None for this issue

A93-54353 — A93-56544

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 1993 will be published in early 1994.

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

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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.	
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TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED

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ACCESSION NUMBER → N93-10098 *# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics. ← CORPORATE SOURCE

TITLE → NAVIER-STOKES DYNAMICS AND AEROELASTIC COMPUTATIONS FOR VORTICAL FLOWS, BUFFET AND AEROELASTIC APPLICATIONS Progress Report, 1 Oct. 1991 - 30 Sept. 1992

AUTHOR → OSAMA A. KANDIL Sep. 1992 38 p ← PUBLICATION DATE

CONTRACT NUMBER → (Contract NAG1-648)

REPORT NUMBER → (NASA-CR-190692; NAS 1.26:190692) Avail: CASI HC A03/MF A01 ← AVAILABILITY AND PRICE CODE

The accomplishments achieved during the period include conference and proceedings publications, journal papers, and abstracts which are either published, accepted for publication or under review. Conference presentations and NASA highlight publications are also included. Two of the conference proceedings publications are attached along with a Ph.D. dissertation abstract and table of contents. In the first publication, computational simulation of three-dimensional flows around a delta wing undergoing rock and roll-divergence motions is presented. In the second publication, the unsteady Euler equations and the Euler equations of rigid body motion, both written in the moving frame of reference, are sequentially solved to simulate the limit-cycle rock motion of slender delta wings. In the dissertation abstract, unsteady flows around rigid or flexible delta wings with and without oscillating leading-edge flaps are considered.

L.R.R.

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

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ACCESSION NUMBER → A93-12007 * National Aeronautics and Space Administration. ← CORPORATE SOURCE

Langley Research Center, Hampton, VA.

TITLE → NUMERICAL SIMULATIONS OF HIGH-SPEED FLOWS ABOUT WAVERIDERS WITH SHARP LEADING EDGES

AUTHORS → KEVIN D. JONES and F. C. DOUGHERTY (Colorado Univ., ← AUTHORS' AFFILIATION

JOURNAL TITLE → Boulder) Journal of Spacecraft and Rockets (ISSN 0022-4650) vol.

PUBLICATION DATE → 29, no. 5 Sept.-Oct. 1992 p. 661-667. Research supported by Univ. of Colorado and DLR refs

CONTRACT NUMBER → (Contract NAG1-880)

Copyright

A procedure is developed for the numerical simulation of stagnation-free inviscid supersonic and hypersonic flows about waveriders with sharp leading edges. The numerical approach involves the development of a specialized grid generator (named HYGRID), an algebraic solution-adaptive grid scheme, and a modified flow solving method. A comparison of the results obtained for several waverider geometries with exact solutions, other numerical solutions, and experimental results demonstrated the ability of the new procedure to produce stagnation-free Euler solutions about sharp-edged configurations and to describe the physics of the flow in these regions.

I.S.

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 299)

January 1994

01

AERONAUTICS (GENERAL)

A93-54601

**AIAA LIGHTER-THAN-AIR SYSTEMS TECHNOLOGY
CONFERENCE, 10TH, SCOTTSDALE, AZ, SEPT. 14-16, 1993,
TECHNICAL PAPERS**

Washington American Institute of Aeronautics and Astronautics
1993 110 p. For individual items see A93-54602 to A93-54615
Copyright

The papers presented in this volume are grouped under the following headings: airship applications for national defense, air vehicle characteristics, aerostat technology, propulsion system technology, developments and scientific applications, commercial support services and systems, airship design approaches, and airship operations. Specific topics discussed include airship applications of modern flight test techniques, a concept for automatic design of nonrigid tethered aerostats of small and medium volume, advanced technologies for enhancement of airships, and a mathematical model of the airship. AIAA

A93-54605#

**AIRSHIP: THE 'LOOK OUT' - A VERSATILE SURVEILLANCE
PLATFORM**

RICHARD G. DESIPIO (U.S. Navy, Naval Air Warfare Center, Warminster, PA) *In* AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 23-25.
(AIAA PAPER 93-4033)

A changing world has impacted our military's assessment of personnel and material to the degree of restructuring and defining new objectives and goals. Associated with these changes are Department of Defense technology conversion goals which are intended to transfer defense technology to the private sector. This is termed 'Defense conversion'. An airship's surveillance 'Look Out' capability intended to service Navy/Marine Corps operations is Defense converted to a City Aero Patrol concept for operation as a city police surveillance platform in the sky. Airships offer the ideal platform for surveillance operations. Whether functioning as a military or city police asset the need for a beyond line-of-sight 'Look Out' capability remains the same.

A93-54866

DESERT STORE

GUY NORRIS *Flight International* (ISSN 0015-3710) vol. 144, no. 4375 June 23, 1993 p. 49-52.
Copyright

The role of jet storage in ameliorating the problem of airline overcapacity is discussed. The dynamics of the jet storage business and the role of noise regulations in forcing some kinds of jet aircraft into storage are addressed. Future trends in jet storage are considered. AIAA

A93-54895

**THE CIVIL SCENE - THE AUTHORITIES RE-APPRAISAL OF
AGEING AIRCRAFT**

P. J. BASHFORD (British Aerospace /Commercial Aircraft/, Ltd., Airbus Div., Bristol, United Kingdom) *In* NDT for corrosion in aerospace structures; Proceedings of the Conference, London, United Kingdom, Feb. 12, 1992 London Royal Aeronautical Society 1992 p. 1.1-1.8. refs
Copyright

The work that has been done to date, both in the U.S. and Europe, to address the issue of older aircraft fleets is briefly reviewed. Particular attention is given to the problems of corrosion, its contribution to failure, and nondestructive inspection. It is noted that, although a significant proportion of inspections is done by time tested traditional methods, there is a growing pressure for automation. The question of human factors is also examined. Finally, directions of future work are outlined. AIAA

A93-55175

BEAR FACTS

MIKE GAINES *Flight International* (ISSN 0015-3710) vol. 144, no. 4381 Aug. 4, 1993 p. 26, 27.
Copyright

The first Westerner to fly with the Russian air force's long range aviation force here reports on the Tupolev Tu-95 Bear. The crew layout, the defensive suite, the toadstool navigation, the refueling facilities, and the crew escape procedure are described. AIAA

02

AERODYNAMICS

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

A93-54469

**COMPUTATION OF NONEQUILIBRIUM HYPERSONIC
FLOWFIELDS AROUND HEMISPHERE CYLINDERS**

ESWAR JOSYULA and JOSEPH S. SHANG (USAF, Wright Lab., Wright-Patterson AFB, OH) *Journal of Thermophysics and Heat Transfer* (ISSN 0887-8722) vol. 7, no. 4 Oct.-Dec. 1993 p. 668-679. AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992, AIAA Paper 92-2874. Previously cited in issue 20, p. 3469, Accession no. A92-47856 refs

A93-54477* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**CALCULATION OF REAL-GAS EFFECTS ON AIRFOIL
AERODYNAMIC CHARACTERISTICS**

CHUL PARK (NASA, Ames Research Center, Moffett Field, CA) and SEOKKWAN YOON (MCAT Inst., Moffett Field, CA) *Journal of Thermophysics and Heat Transfer* (ISSN 0887-8722) vol. 7, no. 4 Oct.-Dec. 1993 p. 727-729. Abridged. AIAA and ASME, Joint Thermophysics and Heat Transfer Conference, 5th, Seattle, WA, June 18-20, 1990, AIAA Paper 90-1712. Previously cited in

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issue 16, p. 2478, Accession no. A90-38414 refs
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A93-54560

ESTIMATION OF AERODYNAMIC CHARACTERISTICS FROM FLIGHT-TEST DATA. V - EFFECTS OF GUST AND ITS TIME LAG

OSAMU KOBAYASHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 41, no. 474 1993 p. 415-425. In JAPANESE refs

This paper mainly discusses about the physical relations between flight data, analysis methods and aerodynamic characteristics. This 5th report focuses the effects of gusts and time lags in flight data on the estimations, which use the equation error method and the perpendicular error method proposed by the 4th report. Gusts are essentially profitable for aerodynamic derivative estimations. If air data are precisely measured in strong gusts, multicollinearities diminish so that all aerodynamic derivatives are more exactly estimated. The time lag of a certain variable generates the virtual aerodynamic force in proportion to the time-derivative of its variable, and the estimation results include this virtual force component. As gusts are airflows moving along an airplane, the effects of their time lags on airdata and regression models should be noted.

A93-54581

CORRELATIVE BEHAVIOURS OF SHOCK/BOUNDARY LAYER INTERACTION INDUCED BY SHARP FIN AND SEMICONE

XUEYING DENG and JINHUA LIAO (Beijing Univ. of Aeronautics and Astronautics, China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 1-5. In CHINESE refs

An experimental correlation investigation of the shock wave/turbulent boundary layer interactions induced by sharp fins and semicones has been carried out. The correlated regime is limited in the interaction flow field upstream of inviscid shock wave at freestream Mach numbers of 1.79, 2.04, and 2.5 and unit Reynolds number of 2.4×10^6 /m. The correlative results of flow behaviors in that conical regime reveal that the slope of upstream influence line and the slope of separation line are dependent of the curvature of inviscid shock strength only and independent of the curvature of inviscid shock wave and Mach number of turbulent boundary layer. It is suggested that the inviscid shock strength is a dominant parameter for flow behaviors in conical interaction regime.

Author (revised)

A93-54583

AN INVERSE METHOD WITH REGULARITY CONDITION FOR TRANSONIC AIRFOIL DESIGN

ZIQIANG ZHU, ZHIXUN XIA, and LIYI WU (Beijing Univ., China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 12-19. In CHINESE refs

It is known from the Lighthill's exact solution of the incompressible inverse problem that in the inverse design problem the surface pressure distribution and the free stream speed can not both be prescribed independently. This implies the existence of a constraint (regularity condition) on the prescribed pressure distribution. The same constraint exists at compressible speeds. In this paper, a well-posed inverse design method for transonic airfoil is presented. In the method, the target pressure distribution contains a free parameter that is adjusted during the computation to satisfy the regularity condition derived in this paper. A few design results are presented in order to demonstrate the capability of the method.

Author (revised)

A93-54584

A NEW METHOD FOR RESOLVING TRANSONIC NOZZLE FLOWS USING ORTHOGONAL STREAM-LINES COORDINATE SYSTEM

HOUIE TU, QINAN ZHANG, and CHUNXUAN LI (Beijing Univ. of Aeronautics and Astronautics, China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 20-26. In CHINESE refs

For resolving the problems with curved boundaries or complex configurations, body-fitted coordinate systems are commonly used in computational fluid dynamics. As a body-fitted coordinate system, a stream-lines (surfaces) coordinate system possesses characteristics similar to the adaptive-grid techniques. When it is used for solving transonic or supersonic flow problems, rotated difference algorithm is not needed and C.F.L. condition can be satisfied easily. In the present paper, the governing equations for 2-D steady inviscid and irrotational flows based on the orthogonal stream-lines coordinate system are formulated. In addition, two first-integral formulations are deduced. A fast converging iterative procedure is developed for solving the nozzle problems with small radius of curvature on the nozzle wall at the throat, and large ratios of convergence and divergence. Nozzle flow fields are computed using the method developed in the present work and the distributions of flow parameters inside nozzles are given.

Author (revised)

A93-54586

THE EFFECTS OF REACTION RATE CONSTANTS AND CATALYTIC WALL ON THE HYPERSONIC FLOW FIELD OVER BLUNT BODIES

ZHIMING LIU and LIYI WU (Beijing Univ. of Aeronautics and Astronautics, China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 34-41. In CHINESE refs

The reaction rate constants and a catalytic wall involved in the numerical solution for the hypersonic viscous shock layer flow fields, over blunt bodies are analyzed. Sample rate constants and the deviation factor have been proposed to build the chemical reaction rate data library for the given chemical reaction system.

Author (revised)

A93-54587

DESIGN OF SHOCKLESS SUPERSONIC REGION IN THE AXISYMMETRIC TRANSONIC FLOW

YIJI QIAN (Beijing Univ. of Aeronautics and Astronautics, China) and H. SOBIECZKY (DLR, Oberpfaffenhofen, Germany) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 42-51. In CHINESE refs

A characteristic net in the supersonic bubble, which is originated from the transonic flow around a body of revolution, was constructed directly from a sonic line. A method developing a supersonic line from a sonic line is presented. A characteristic net in the irrotational axisymmetric flow is calculated. It was found that the net is impossible to spread over the symmetric axis. The calculation results of the present paper can be applied to the surface revision.

Author (revised)

A93-54588

AN EXPERIMENTAL INVESTIGATION ON LAMINAR BOUNDARY LAYER SEPARATION OVER A BACKWARD-FACING STEP

JINJUN WANG and QIXIANG LIAN (Beijing Univ., China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 52-56. In CHINESE refs

The differential LDA system has been used to measure the laminar boundary layer separation, reattachment, and redevelopment up to turbulent boundary layer over a backward-facing step. The distributions of mean velocity and turbulent intensity are obtained. It is found that the flow is transitional boundary layer at the reattachment position, which further developed until turbulent boundary layer was formed. In the turbulent boundary layer region, the distribution of mean velocity obeys the 'log-law' except the greater value of integral constant in comparison with that obtained in turbulent boundary layer over a flat plate.

A93-54589

THE EFFECT OF OUTBOARD LEADING-EDGE BLUNTNESS OF DOUBLE-DELTA WING ON ITS AERODYNAMIC CHARACTERISTICS

YANAN FENG, RIZHI LIU, and YUSHAN XING (Beijing Univ. of

Aeronautics and Astronautics, China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 57-62. In CHINESE refs

The vortex visualization and surface pressure distribution measurements for a 75 deg/60 deg double delta wing were carried out in a water tunnel and in a low speed wind tunnel of BUAA. The inboard wing of models is sharp-edged and the outboard wing has both sharp and round leading edge. The effect of outboard leading-edge bluntness of the double-delta wing and on its aerodynamical characteristics vortex patterns is studied. Experiment results indicate that the bursting of inboard wing vortex is delayed and the surface pressure distribution of the wing at downstream of leading-edge kink is changed for the blunted leading edge case. Author (revised)

A93-54594

THE FORMS OF UNSTEADY CONCENTRATED VORTEX-BREAKDOWN AND ITS REACTIONS TO DISTURBANCE

YANQIU CHENG, ZHIYONG LU, and CHUNHIAN LEE (Beijing Univ. of Aeronautics and Astronautics, China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 95-100. In CHINESE refs

The forced oscillation of leading-edge vortex-flap on delta-wing is used to suppress vortex breakdown. The flow visualizations of water channel experiments reveal that, under forced disturbances, there are two types of concentrated vortex-breakdowns, which in turn can be divided further into six patterns. The unsteady concentrated vortex-breakdown may involve a process of switching among several breakdown patterns. The effects of vortex-flap oscillations upon vortex breakdown are closely related to the sweep angles of the delta wing, which would be weakening as the sweep angles are increasing. For angles of attack less than 35 deg the oscillations of the vortex-flap can largely delay the vortex-breakdown for a delta wing with sweep angle of 50 deg. However, for sweep angle of 70 deg, it is found that the oscillations would become detrimental to the vortex-breakdown. The state of concentrated vortex is changed with vortex-flap oscillation, and vortex tends to be parallel to the leading-edge. Author (revised)

A93-54595

SECOND GENERATION LOW ORDER PANEL METHOD AND ITS APPLICATION FOR A CASE OF NACELLE

BINGYONG CHEN, MING ZENG, ZIQIANG ZHU, and BINGXUAN ZHANG (Beijing Univ., China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 101-108. In CHINESE refs

The basic theory of a second generation low order panel method is presented and computational results for a case of nacelle are shown. It is demonstrated that the present low order method gives comparable accuracy to the high order solutions. It is also shown that problems associated with some earlier low order, e.g., leakage in internal flows, do not appear in the present method. Meanwhile, the method has very low computing costs and thus is considered to be effective for complex configurations. Author (revised)

A93-54597

A METHOD FOR AERODYNAMIC CALCULATION BY PLACING LINEAR VARI-STRENGTH VORTEX PANELS ON AIRFOIL CONTOUR

ZHENYU WANG (Beijing Univ., China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 118-123. In CHINESE refs

Linear vari-strength vortex panels are placed on the contour of an airfoil. The system of linear equations determining the vortex strength is derived under specific boundary conditions. The appropriate control point location is found by cutting and trying. The system becomes overdetermined as zero vortex strength is set at the trailing edge, to satisfy the Kutta condition. A technique for solving the overdetermined system is given by utilizing the least-square method and the unique solution with minimum errors is obtained. The technique is simple and easy to use. A comparison

of the computation results with experimental data and an exact solution indicates that the technique is accurate and can be applied to engineering calculations and design. Author (revised)

A93-54598

THE BODY-FITTED COORDINATES GENERATION FOR MULTI-ELEMENT AIRFOILS

JIANFA CAO and YANQING CHEN (Beijing Univ., China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 124-131. In CHINESE refs

A method has been developed which generates the body-fitted coordinates of multi-element airfoils by using a grid patching technique. The body-fitted coordinates are numerically generated by solving the elliptic grid generations of Thompson, and the source terms suggested by Thomas are used to control the space and orthogonality near the grid boundary. This paper also discusses how to choose the region interfaces. This patched grid is used to calculate the potential flow around multi-element airfoils and the results are in good agreement with the independent methods. Author (revised)

A93-54599

TWO PROBLEMS APPLIED TO THE RHEOGRAPHICAL TRANSFORMATION OF AXISYMMETRIC FLOW

YIJI QIAN (Beijing Univ., China) and H. SOBIECZKY (DLR, Oberpfaffenhofen, Germany) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 132-139. In CHINESE refs

A relation between the partial derivatives of potential function and stream function of axisymmetric flow was derived. It is similar to that of 2-D flow and an extension of Molenbroek-Chaplygin's transformation. The formulation of the derivatives for axisymmetric flow was derived also. Although its form is different from that of 2-D flow, but it can be unified also. It is an extension of 2-D characteristic relation. Author (revised)

A93-54607#

AERODYNAMICS OF THE TCOM 71M AEROSTAT

S. BADESHA (TCOM L.P., Columbia, MD) and S. P. JONES In AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers, Washington American Institute of Aeronautics and Astronautics 1993 p. 36-42. refs (AIAA PAPER 93-4036) Copyright

This paper presents some of the aerodynamic characteristics of the 71-meter, the largest and most successful of the TCOM aerostats. Of unique design, the hull shape has been modified to provide an improved lift distribution and the stabilization system has been changed from cruciform to an inverted 'Y' configuration. Static wind tunnel data and dynamic coefficients based upon a theoretical model are presented. The latter has been used for stability studies, including nonlinear dynamic computer simulations and linear stability analyses. Some of these results are presented showing the aerostat to be statically and dynamically stable.

A93-54615#

AERODYNAMIC CHARACTERISTICS OF A SEMIBUOYANT STATION IN THE SHAPE OF A TORUS

TAKESHI TACHIBANA and HIROSHI TSUKAMOTO (Kyushu Inst. of Technology, Kitakyushu, Japan) In AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 100-104. refs (AIAA PAPER 93-4034) Copyright

The authors proposed a new design concept for Lighter-Than-Air stations for observation and communication missions. It is a semibuoyant station in the shape of a torus; some part of the lift force is provided by a thruster located in its central hole. The aerodynamic characteristics of the shape are discussed here. Numerical calculations were carried out for a conceptual prototype model of 44 m in diameter in a uniform flow of 10 m/s. The turbulent flow field around the present model was solved and the flow patterns and pressure distributions around the hull were

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obtained. The calculated results showed that the aerodynamic characteristics can be controlled well by auxiliary thrusters or by some flow direction changers so that the proposed semibuoyant station seems to be realistic.

Author (revised)

A93-54639

PREDICTION OF VISCOUS FLOWS IN ROTATING MACHINERY USING NAVIER-STOKES TECHNIQUES

ROGER L. DAVIS (United Technologies Research Center, East Hartford, CT) *In* Rotating machinery - Transport phenomena; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 419-440. Research supported by United Technologies Corp refs

Copyright

The application of two different Navier-Stokes numerical procedures for the prediction of steady two- and three-dimensional viscous flows in rotating machine blade passages is presented. The first procedure consists of an explicit, control volume, multiple-grid technique for the prediction of quasi-three-dimensional flows in axial or radial turbomachine cascades. Predicted results are compared with experimental data for a transonic fan section, a transonic turbine cascade, and a radial flow 'squirrel cage' fan cascade. These results demonstrate the capability of this quasi-three-dimensional Navier-Stokes technique to accurately predict complex blade passage flows with multiple shocks and flow separation as well as cascade performance. The second Navier-Stokes procedure presented consists of an implicit, finite difference approach for the prediction of three-dimensional flows in axial or centrifugal turbomachines. Comparisons between predicted results and experimental data are shown for viscous flow through a centrifugal impeller which demonstrate the ability of this technique to predict three-dimensional blade loading distributions. The results and discussions presented provide an example of how current two- and three-dimensional Navier-Stokes procedures can be used to compute a wide range of flow conditions in a variety of rotating machine blade passages.

A93-54640

TWO-DIMENSIONAL TRANSONIC FLOW AROUND VKI TURBINE CASCADE

J. H. BAEK, H. T. CHUNG (Pohang Inst. of Science and Technology, Republic of Korea), and K. KUWAHARA (Inst. of Space and Astronautical Science, Sagami-hara, Japan) *In* Rotating machinery - Transport phenomena; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 441-450. Research supported by Pohang Inst. of Science and Technology of Korea refs

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A fast and efficient cascade analysis code is developed for studies of two-dimensional transonic flows inside a turbine passage using two kinds of C-type grid system: one with its shape parallel to the main flow and the other of an arbitrary overall shape. The tested model is the VKI turbine cascade, which provides experimental data (Kioek et al. (1986)). The code is based on the LU-ADI factorization method developed by Obayashi and Kuwahara (1984). It is found that the numerical prediction for the grid system parallel to the main flow direction agrees better with the experimental results than the prediction for the arbitrary-shape grid system. The shock behavior on the suction surface near the trailing edge also depends on the grid system: the shock can be captured clearly if it is not crossed by a computational boundary.

AIAA

A93-54643

THREE-DIMENSIONAL FLOW ANALYSIS OF A FOUR-STAGE TRANSONIC AXIAL COMPRESSOR WITH INLET GUIDE VANES

XI-CHENG HUANG, WEI-MIN CHENG, and YAN-SHENG LI (Shanghai Inst. of Mechanical Engineering, China) *In* Rotating

machinery - Transport phenomena; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 481-489. refs

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Results from the 3D analysis of a multistage axial compressor with inlet guide vanes are compared with test data. The first part of our work presents a modified streamline curvature method for solving for the transonic flow field of S(2), the stream surface. The second part is concerned with the analysis of S(1), the stream sheet, by using the FEM with the converged parameter of the S(2) stream surface calculation. Numerical examples using the test data of the NASA TM X-3076 two-stage transonic axial fan and the design data for a four-stage transonic axial compressor with inlet guide vanes show that the results of the S(2) calculation correspond to the test data satisfactorily and that the S(1) calculation is effective as the relative Mach number is less than 1.2 and the circumferential Mach number is less than 0.85.

Author (revised)

A93-54646* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SPECTRAL ANALYSIS OF UNSTEADY SURFACE PRESSURE ON A PUSHER PROPELLER

SAEED FAROKHI (Kansas Univ., Lawrence) *In* Rotating machinery - Transport phenomena; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 665-680. refs

(Contract NAG1-867)

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A propeller of an advanced turboprop testbed aircraft in pusher configuration is instrumented with 22 miniature blade-mounted transducers (BMTs) at two radii. Upstream pylon wake interaction with the propeller is the source of a one-per-cycle excitation for the blades in flight. The time history of fluctuating pressure signals over 26 flight conditions is statistically analyzed in the frequency domain. The rms amplitude of fluctuating pressure signals measured by suction surface BMTs indicates a very strong presence of the fundamental frequency over most of the upper surface. The pylon wake pressure signature on the propeller trailing edge, i.e., x/c not less than 0.80, shows predominantly random turbulence; hence, the amplitude of the fundamental frequency wave is fairly small. The resurgence of a large amplitude fundamental harmonic with coherent pylon wake signature further downstream, say at 90 percent chord, is unexpected behavior. The appearance of a dominating second propeller shaft order in the spectra of the rms pressure in transonic flight conditions identifies the presence of a two-per-cycle excitation source in the azimuthal direction. This is due to the presence of a shock wave, as evidenced by the pressure-time history plots. Author (revised)

A93-54647

ROTOR/STATOR FLOW COUPLING IN TURBOMACHINES

Y.-T. LEE, C. W. JIANG, and T. BEIN (David Taylor Research Center, Bethesda, MD) *In* Rotating machinery - Transport phenomena; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 681-693. Research supported by U.S. Navy refs

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Successful turbomachine design requires detailed information about the flow characteristics in order to predict the performance of a candidate geometry. The designer needs information about the complex interaction between the blade rows when multistage blade rows are considered. A 3D steady potential-flow code for a single blade row has been developed, where integral equations were derived to model the solid surfaces and the inlet condition for both external and internal flows with rotating or nonrotating lifting blades. Global iterations for the surface-panel source

densities and the vortex strengths were used in conjunction with a Neumann iteration for solving the integral equations. Two numerical coupling procedures between the rotor and the stator are described. The phenomena of flow interaction between the rotor and the stator are studied, and two test cases are presented. The performance of a vaneaxial fan is predicted using this procedure, and the results indicate that the present numerical coupling procedure can be used by designers to select optimal blade shapes. Author (revised)

A93-54805

NONEQUILIBRIUM SHOCK LAYER RADIATION IN A SIMULATED TITAN ATMOSPHERE

D. BERSHDER and C. S. PARK (Stanford Univ., CA) /In Strong shock waves; Proceedings of the International Workshop, Chiba, Japan, July 18-20, 1991 Chiba, Japan Chiba University 1992 p. 23-39. refs

This work is a combined experimental and numerical study to assess the effect of nonequilibrium flow on the shock layer radiation surrounding the Huygens probe which will enter the atmosphere of the Saturnian Moon Titan at a speed somewhat under 6 km/sec in the year 2003. The radiation is especially enhanced due to the presence of a few percent of methane along with the preponderance of nitrogen. The laboratory experiment measured the radiation behind a hypervelocity shock penetrating a simulated Titan atmosphere, while the numerical studies, making use of a three-temperature model, utilized a modification of Chul Park's NEQAIR code to obtain radiation intensities. Agreement with experiment was good and verified that the nonequilibrium flow behavior produces nearly an order-of-magnitude increase in the shock-layer radiation - to the extent that the radiative heat transfer to the surface becomes comparable to that due to convection.

A93-54810

RESULTS ABOUT THE STRUCTURE OF THE SHOCK WAVE REFLECTION PROCESS FOR STRONG INCOMING SHOCK WAVES

BERND SCHMIDT and JUERGEN FUCHS (Karlsruhe Univ., Germany) /In Strong shock waves; Proceedings of the International Workshop, Chiba, Japan, July 18-20, 1991 Chiba, Japan Chiba University 1992 p. 125-137. Research supported by DFG refs

The aim of this investigation is to find out where the triple point of a Mach-type reflection comes into existence and how the trajectory of this point develops. The single shock traces were taken from photographs. Because of the low pressure (266.6 N/sq m = 2 Torr) the signals were very weak, but most of these could be transferred from the enlarged photograph onto a graph of suitable size. To get still visible traces of the waves on the negative, a special method of making the pattern of optically weak shock waves visible (the double exposure method) was used.

Author (revised)

A93-54815

NUMERICAL STUDIES OF MACH REFLECTION WITH AIR CHEMISTRY

A. HANAMITSU (Kawasaki Heavy Industries, Ltd., Kakamigahara, Japan) and M. NISHIDA (Kyushu Univ., Fukuoka, Japan) /In Strong shock waves; Proceedings of the International Workshop, Chiba, Japan, July 18-20, 1991 Chiba, Japan Chiba University 1992 p. 207-212. refs

A numerical simulation was performed for the chemical equilibrium flow ingested into an inlet placed in a hypersonic flow using TVD-MacCormack scheme. The calculations were carried out for a free stream Mach number 15 with atmospheric conditions at an altitude of 45 km. In the present work, we adopted the equivalent gamma and the simplified curve fits for the thermodynamic properties of equilibrium air. This made it possible to use the existing code for the perfect gas with little modification. From the results of computed axisymmetric inlet flows, it has been seen that the chemical equilibrium flow has a very complicated flow field in large ratios of an inlet radius to a duct wall thickness,

which was not observed in the perfect gas flow. In the two-dimensional inlet flow, this complicated flow field was not observed even in the chemical equilibrium flow.

A93-54816

CHEMICAL NONEQUILIBRIUM EFFECTS OF MACH REFLECTION

C. NEEDHAM (S-Cubed, Inc., Albuquerque, NM) /In Strong shock waves; Proceedings of the International Workshop, Chiba, Japan, July 18-20, 1991 Chiba, Japan Chiba University 1992 p. 213-220.

A computational code including 58 chemical reactions among up to 11 chemical species is used to demonstrate the importance of chemical nonequilibrium in Mach reflection. Quantitative differences between simulations of chemical equilibrium and chemical nonequilibrium cases are examined. It is shown, in particular, that chemical nonequilibrium becomes important when the relaxation distance is comparable to the dimensions of interest. Vibrational equilibrium is not important for these conditions. The numerical results are compared with the available experimental data, and the computational capability of the code is demonstrated. AIAA

A93-55014

STEADY-STATE SUPERSONIC FLOW OF A VIBRATIONALLY EXCITED GAS PAST A SLENDER BODY OF REVOLUTION AT A SMALL ANGLE OF ATTACK [OBTEKANIE TONKOGO TELA VRASHCHENIYA POD MALYM UGLOM ATAKI STATSIONARNYM SVERKHZVUKOVYM POTOKOM KOLEBATEL'NO-VOZBUZHDENNOGO GAZA]

A. N. BOGDANOV and V. A. KULIKOVSKIY PMTF - Prikladnaya Mekhanika i Tekhnicheskaya Fizika (ISSN 0869-5032) vol. 34, no. 3 May-June 1993 p. 11-20. In RUSSIAN refs Copyright

The problem of supersonic flow of a vibrationally excited gas past a slender body of revolution at a small angle of attack is solved analytically using a linear approximation. The solution makes it possible to calculate the transverse force acting on the body and the moment of this force relative to the body nose. It is found that the relaxation of the vibrational excitation changes the magnitude of the force and, in the case of sufficient initial nonequilibrium, even its sign. AIAA

A93-55015

AN AIRFOIL IN TRANSONIC FLOW IN THE PRESENCE OF WIND GUSTS AND WEAK SHOCK WAVES [PROFIL' V TRANSZVUKOVOM POTOKE PRI VOZDEJSTVII PORIVOV VETRA I SLABYKH UDARNYKH VOLN]

A. S. FONAREV PMTF - Prikladnaya Mekhanika i Tekhnicheskaya Fizika (ISSN 0869-5032) vol. 34, no. 3 May-June 1993 p. 20-27. In RUSSIAN refs Copyright

The paper is concerned with the problem of the interaction of unsteady perturbations (wind gusts and low-intensity shock waves) with an airfoil in transonic flow of an ideal gas. In particular, attention is given to the dynamics of compression shocks closing local supersonic regions; the effect of shock displacement on the unsteady aerodynamic characteristics is determined. The effect of problem nonlinearity associated with the transonic regime of motion is analyzed. Results of numerical calculations are presented for specific cases of aperiodic perturbations. AIAA

A93-55019* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DEVELOPMENT OF SEPARATION DUE TO INTERACTION BETWEEN A SHOCK WAVE AND A TURBULENT BOUNDARY LAYER PERTURBED BY RAREFACTION WAVES [RAZVITIE OTRYVA PRI VZAIMODEJSTVII SKACHKA UPLOTNENIYA S TURBULENTNYM POGRANICHNYM SLOEM, VOZMUSHCHENNYYM VOLNAMI RAZREZHENIYA]

A. A. ZHELTOVODOV (RAN, Inst. Teoreticheskoy i Prikladnoy Mekhaniki, Novosibirsk, Russia), E. H. KH. SHILEJN, and C. C. HORSTMAN (NASA, Ames Research Center, Moffett Field, CA)

02 AERODYNAMICS

PMTF - Prikladnaya Mekhanika i Tekhnicheskaya Fizika (ISSN 0869-5032) vol. 34, no. 3 May-June 1993 p. 58-68. In RUSSIAN refs
Copyright

The interaction of a turbulent boundary layer with rarefaction and shock waves in flows past inclined steps was investigated experimentally and theoretically. The experiments were carried out in supersonic wind tunnels with test sections of 0.6×0.6 m and 0.2×0.2 m, with adiabatic conditions on the surface model. Based on detailed measurements of pressure fields, velocity, and surface friction, combined with results of optical visualization and analysis of limiting flow lines, three characteristic flow regimes are identified. These are (1) nonseparated flow at small step angles, (2) formation of a local separation zone with a free separation point at moderate step angles, and (3) formation of a large-scale separated flow with a fixed separation point at sufficiently large step angles. The quantitative gasdynamic schemes and surface pressure distributions for these flow regimes are shown for Mach 2.85.

AIAA

A93-55026

DETERMINATION OF THE $N_2(+) + e$ RECOMBINATION RATE CONSTANT FROM BALLISTIC EXPERIMENTS [OPREDELENIE KONSTANTY SKOROSTI REKOMBINATSII $N_2/+ + e$ IZ BALLISTICHESKIKH EHKSPERIMENTOV]

N. N. PILYUGIN and A. V. PRONIN (Moskovskij Gosudarstvennyj Univ., Moscow, Russia) Teplofizika Vysokikh Temperatur (ISSN 0040-3644) vol. 31, no. 2 April 1993 p. 163-168. In RUSSIAN refs
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Methods of nonlinear regression analysis and results of microwave measurements of the electron concentration in the wake of a body moving at a hypersonic velocity in pure nitrogen are used to obtain the ambipolar Schmidt number, constants determining temperature distribution along the wake axis, initial wake diameter, and temperature dependence of the $N_2(+) + e$ dissociative recombination rate constant. Based on the constants and solutions obtained, calculations are made of temperature distributions, electron concentrations, and wake width increase. Good agreement is obtained between the numerical and experimental results.

AIAA

A93-55030

HYPERSONIC FLOW OF A GAS PAST WING WITH HEAT TRANSFER [OBTEKANIE KRYLA GIPERZVUKOVYM POTOKOM GAZA S PODVODOM TEPLA]

V. N. GOLUBKIN (TsAGI, Moscow, Russia) Teplofizika Vysokikh Temperatur (ISSN 0040-3644) vol. 31, no. 2 April 1993 p. 252-256. In RUSSIAN refs
Copyright

Hypersonic flow past a slender wing at angle of attack is analyzed in the approximation of a thin shock layer, with allowance made for heat transfer to the flow from both concentrated and distributed sources. The principal similarity parameters for the problem are determined. Analytical solutions are obtained for the characteristic cases of wings of small and large aspect ratios. Attention is given to the effect of heat release on the shape of the head shock, pressure distribution, and integral characteristics.

AIAA

A93-55142

INSTABILITY OF A SUPERSONIC VORTEX SHEET INSIDE A CIRCULAR DUCT

CHIEN-CHENG CHANG and CHIH-YU KUO (National Taiwan Univ., Taipei) Physics of Fluids A (ISSN 0899-8213) vol. 5, no. 9 Sept. 1993 p. 2217-2228. refs
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A theoretical study is carried out for investigating spatial instabilities of a supersonic vortex sheet inside a circular duct. The sheet is cylindrical in shape, separating the flow into an inner region and an outer one of uniform properties. It is found that there is one family of subsonic (Kelvin-Helmholtz) instability waves which are accompanied by two families of neutral modes. Two

families of supersonic instability waves can be identified to be associated with two other families of neutral modes. A mathematical analogy indicates that instability modes at high frequencies bear resemblance to those obtained by Tam and Hu (1989) for plane mixing layers inside a rectangular channel. Geometric effects of both the vortex sheet and the outer confinement are significant only at relatively low frequencies of disturbances. In addition, extensive parametric study reveals interesting features of the dependence of the instability waves on the density ratio, velocity ratio, radius ratio of the inner and outer regions, and 3D disturbances.

Author (revised)

A93-55146

RELAXATION OF DISCRETE ROTATIONAL ENERGY DISTRIBUTIONS USING A MONTE CARLO METHOD

IAIN D. BOYD (Cornell Univ., Ithaca, NY) Physics of Fluids A (ISSN 0899-8213) vol. 5, no. 9 Sept. 1993 p. 2278-2286. refs

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A new model is presented for simulating rotational energy relaxation in the direct simulation Monte Carlo method (DSMC) using discrete distributions. The method extends the phenomenological approach generally employed that simulates the distribution as a continuum. The discrete approach simulates the mechanics of relaxation for the rigid rotor model. The theory is developed and combined for use with an existing model for simulating the rate of rotational relaxation. A number of test problems are then considered. Each set of flow conditions is chosen because of the availability of experimental data. Some of the experimental measurements provide rotational energy distributions thus allowing detailed comparison with the numerical simulations. Generally, the comparisons are quite favorable, although it is indicated that more sophisticated models are required to simulate some of the detailed structure of the energy distributions observed experimentally.

A93-55351* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ANALYSIS OF HIGH REYNOLDS NUMBER INVISCID/VISCID INTERACTIONS IN CASCADES

M. BARNETT, J. M. VERDON, and T. C. AYER (United Technologies Research Center, East Hartford, CT) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 1969-1976. AIAA, SAE, ASME, and ASCE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992, AIAA Paper 92-3073. Previously cited in issue 20, p. 3471, Accession no. A92-48723 refs

(Contract NAS3-25425)

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A93-55352

COMPARISON OF CONFINED, COMPRESSIBLE, SPATIALLY DEVELOPING MIXING LAYERS WITH TEMPORAL MIXING LAYERS

LINDA SIGALLA HEDGES (Boeing Commercial Airplane Group, Seattle, WA) and D. S. EBERHARDT (Washington Univ., Seattle) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 1977-1983. refs

(Contract N00014-87-K-0174)

Copyright

The spatially developing mixing layer is investigated using both linear stability theory and numerical simulations. Temporal and spatial linear stability solutions are compared, and it is found that the temporal and spatial wave numbers are equal, the temporal frequency is a function of the spatial frequency, and the temporal and spatial growth rates have a one-to-one correspondence. Numerical simulations of the Euler equations are performed for the spatially developing mixing layer using a linear stability forcing function. Spatially developing simulations of the supersonic/supersonic and supersonic/subsonic acoustic instabilities and the Kelvin-Helmholtz instability are compared to temporally developing simulations and found to be in agreement.

A93-55353

DEVELOPING NUMERICAL TECHNIQUES FOR SOLVING LOW MACH NUMBER FLUID-ACOUSTIC PROBLEMS

VINCENT P. MANNO, SCOTT H. REITSMA (Tufts Univ., Medford, MA), and THOMAS F. TUREAUD (Charles Stark Draper Lab., Inc., Cambridge, MA) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 1984-1991. Research supported by Charles Stark Draper Lab., Inc. refs (Contract NSF CBT-91-0018P) Copyright

Numerical techniques applicable to the solution of low Mach number (M less than 0.1) fluid-acoustic problems are addressed. Conservation equations applicable to this regime are derived by applying four simplifying assumptions to the fully compressible form of the Navier-Stokes and energy equations: isentropic state changes, adiabatic flow, negligible density variation inertial terms, and Stokes' hypothesis. The resulting equations, termed acoustic compressible, are similar to the traditional pseudocompressible equations except for two distinctions. It is shown that the pseudocompressibility method can be used to recover temporal accuracy in incompressible problems as long as the characteristic time scales are sufficiently faster than bulk flow time scales. The simulation of acoustic wave propagation through a shear layer shows that temporal accuracy in the fluid-acoustic regime requires exact Mach number specification. Using the pseudocompressible equations in this problem introduces spatially dependent propagation speeds and inaccurate eigensystems. These discrepancies are of greatest concern at higher Mach numbers (M greater than 0.1), and they appear to be due to the neglect of the pressure convection term in the pseudocompressible formulation. Author (revised)

A93-55356

LOCALLY IMPLICIT TOTAL VARIATION DIMINISHING SCHEMES ON MIXED QUADRILATERAL-TRIANGULAR MESHES

C. J. HWANG and S. Y. YANG (National Cheng Kung Univ., Tainan, Taiwan) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 2008-2015. refs Copyright

Locally implicit total variation diminishing schemes on mixed quadrilateral-triangular static/dynamic meshes have been developed to study steady and unsteady flows, respectively. In a Cartesian coordinate system, the Euler equations are solved by using a cell-centered finite volume algorithm. For steady inviscid flows, the efficiency and accuracy of the present approach are confirmed by investigating the oblique shock reflection at a wall and transonic flow around an NACA 0012 airfoil. To treat unsteady flow problems with moving boundaries, a new dynamic mesh algorithm, which saves memory, is efficient, and maintains quality, is presented in this paper. For analyzing the unsteady transonic flow around an NACA 0012 airfoil that pitches harmonically about the quarter chord, a quadrilateral-triangular dynamic mesh system is used. The calculated instantaneous pressure distributions and lift and moment coefficients during a cycle of motion compare well with related numerical and experimental data.

A93-55357

DISCONTINUOUS GALERKIN FINITE ELEMENT METHOD FOR EULER AND NAVIER-STOKES EQUATIONS

SAN-YIH LIN and YAN-SHIN CHIN (National Cheng Kung Univ., Tainan, Taiwan) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 2016-2026. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993, AIAA Paper 93-0337. Previously cited in issue 07, p. 1075, Accession no. A93-23026 refs Copyright

A93-55359

ENHANCEMENT OF MIXING IN HIGH-SPEED HEATED JETS USING A COUNTERFLOWING NOZZLE

P. J. STRYKOWSKI (Minnesota Univ., Minneapolis), A. KROTHAPALLI, and D. WISHART (Florida Agricultural and

Mechanical Univ., Florida State Univ., Tallahassee) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 2033-2038. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992, AIAA Paper 92-3262. Previously cited in issue 20, p. 3473, Accession no. A92-48857 refs

(Contract N00014-92-J-1406)

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A93-55360

THREE-DIMENSIONAL SIMULATIONS OF COMPRESSIBLE MIXING LAYERS - VISUALIZATIONS AND STATISTICAL ANALYSIS

L. J. LEEP, J. C. DUTTON, and R. F. BURR (Illinois Univ., Urbana) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 2039-2046. Research supported by USAF refs Copyright

The effects of compressibility on the planar mixing layer are investigated by means of visualization and statistical analysis of the flowfield quantities computed using three-dimensional temporally evolving inviscid simulations. The levels of compressibility studied range from relative Mach numbers of $Mr = 0.2$ -2.4. The objectives of this research are to identify large-scale structures present in the mixing layer at different levels of compressibility as well as to examine the statistical description of the flowfield, in order to gain understanding of the physical entrainment and mixing processes. Three-dimensional simulation visualizations of both the passive scalar and pressure fields show the nature of the large-scale structure present in the planar mixing layer to change from nearly two-dimensional and spanwise at low compressibility to highly three-dimensional and oblique at increased compressibility. Statistical analysis of the flowfield quantities shows that the shear layer width, Reynolds shear stress, and transverse turbulence intensity decrease with increasing compressibility levels, whereas the stream-wise turbulence intensity remains nearly constant and the spanwise turbulence intensity increases. These statistics support the increasingly three-dimensional nature of the large-scale motion of the mixing layer with increasing Mr . Author (revised)

A93-55362

OSCILLATORY BLOWING - A TOOL TO DELAY BOUNDARY-LAYER SEPARATION

A. SEIFERT, T. BACHAR, D. KOSS, M. SHEPSHELOVICH, and I. WYGNANSKI (Tel Aviv Univ., Israel) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 2052-2060. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993, AIAA Paper 93-0440. Previously cited in issue 08, p. 1318, Accession no. A93-25529 Research supported by Ministry of Defence of Israel refs Copyright

A93-55364

THREE-DIMENSIONAL NAVIER-STOKES ANALYSIS OF TIP CLEARANCE FLOW IN LINEAR TURBINE CASCADES

JONG-SHANG LIU and RICCARDO BOZZOLA (Textron Lycoming, Turbine Engine Div., Stratford, CT) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 2068-2074. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993, AIAA Paper 93-0391. Previously cited in issue 07, p. 1076, Accession no. A93-23068 Research supported by Textron Lycoming refs Copyright

A93-55379

THREE-DIMENSIONAL SEPARATED FLOW OVER A PROLATE SPHEROID

WENHAU SU, BO TAO, and LI XU (Beijing Univ. of Aeronautics and Astronautics, China) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 2175, 2176. Research supported by NNSFC refs

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Three-dimensional separated flow over a prolate spheroid was

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investigated experimentally using flow visualization in a water channel at a speed of about 0.04 m/s by dye injection and laser sheet technique. The Reynolds number was about 1×10^4 ; the angle of attack varied from 0 to 70 deg. The discussion covers the mechanism of flow separation, the relationship between open separation and vortex flow, and topological structure of separated flows and their evolution with changing parameters. AIAA

A93-55380

REYNOLDS STRESS PROFILES IN THE NEAR WAKE OF AN OSCILLATING AIRFOIL

SEUNG O. PARK and BOO I. LEE (Korea Advanced Inst. of Science and Technology, Taejeon, Republic of Korea) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 2176-2178. Research supported by Korea Advanced Inst. of Science and Technology and Korea Science and Engineering Foundation refs Copyright

Unsteady wakes behind an airfoil oscillating in pitch about several mean incidences were investigated using an X-type hot wire in the near wake. The measurements reported here elucidate the link between the turbulent normal and shear stresses and the wake flow pattern represented by streakiness. Velocity and Reynolds stress data are presented for the wake immediately after the unsteady separation, the fully turbulent wake, and the Karman vortex street-type wake. AIAA

A93-55397

EFFECT OF BLADE LEANING ON THE DEVELOPMENT OF PASSAGE VORTICES AND LOSSES IN THE PASSAGE OF TURBINE CASCADE WITH A GREAT TURNING ANGLE

WANJIN HAN, CHUNQING TAN, HONG SHI, MECHUN ZHAO, and ZHONGQI WANG (Harbin Inst. of Technology, China) Journal of Engineering Thermophysics (ISSN 0253-231X) vol. 14, no. 2 May 1993 p. 146-150. In CHINESE refs

Five-hole spherical probes were used for detail measurements of aerodynamic parameters of a traditional blade cascade and a lean blade cascade, which were carried out in several transverse planes located ahead, in, and behind the cascade. The experimental results show that, in the traditional blade cascade, the growth and redistribution of energy losses depend on the evolution and development of passage vortices, and that, in the side of the obtuse angle between the lean blade pressure surface and the endwall, the passage vortex is weakened and controlled near the endwall, but in the side of acute angle the passage vortex is strengthened and develops to the midspan and the other side. Author (revised)

A93-55398

EXPERIMENTAL INVESTIGATION OF EFFECT OF PARTICLES ON BLADE PRESSURE DISTRIBUTION IN IMPULSE CASCADE FLOW

JINGHAI YI, CAIFEN MA, QING HAO, and ZHONG XU (Xian Jiaotong Univ., China) Journal of Engineering Thermophysics (ISSN 0253-231X) vol. 14, no. 2 May 1993 p. 159-162. In CHINESE refs

The blade pressure distribution of a gas-particle two-phase flow in an impulse cascade was investigated experimentally. Detailed measurements were made for two inlet velocities, 10.0, 22.0 m/s; two inlet angles of attack, -64 deg, -45 deg; and for four mass concentrations, 0.0, 1.1, 2.0, and 4.5 percent. The results indicate that the solid phase has significant effect on the blade pressure distribution of gas phase. With an increase inlet velocity and mass concentration, the effect of solid particles on the blade pressure distribution is increased. Also, the varying degrees of blade pressure depend on the inlet angle of attack. Author (revised)

A93-55400* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RECENT ADVANCES IN STEADY COMPRESSIBLE AERODYNAMIC SENSITIVITY ANALYSIS

ARTHUR C. TAYLOR, III (Old Dominion Univ., Norfolk, VA), PERRY A. NEWMAN (NASA, Langley Research Center, Hampton, VA), GENE J.-W. HOU (Old Dominion Univ., Norfolk, VA), and HENRY

E. JONES (U.S. Army, Aeroflightdynamics Directorate: NASA, Langley Research Center, Hampton, VA) Nov. 1992 20 p. Institute for Mathematics and Its Applications, Workshop on Flow Control, Univ. of Minnesota, Minneapolis, MN, Nov. 1992, Paper refs (Contract NAG1-1265)

Sensitivity analysis methods are classified as belonging to either of the two broad categories: the discrete (quasi-analytical) approach and the continuous approach. The two approaches differ by the order in which discretization and differentiation of the governing equations and boundary conditions is undertaken. The discussion focuses on the discrete approach. Basic equations are presented, and the major difficulties are reviewed in some detail, as are the proposed solutions. Recent research activity concerned with the continuous approach is also discussed. AIAA

A93-55411

MEASUREMENT OF TURBULENT BOUNDARY LAYER IN TRANSONIC FLOW

QI-LIN YUN and CHANG-AN ZHAO (China Aerodynamics Research and Development Center, Mianyang) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 2 May 1993 p. 79-84. Transl. of Acta Aeronautica et Astronautica Sinica, vol. 12, no. 11, Nov. 1991, p. A563-A567. Previously cited in issue 22, p. 3883, Accession no. A92-53010 refs Copyright

A93-55412

AN IMPROVED MULTIPLE LINE-VORTEX METHOD FOR SIMULATION OF SEPARATED VORTICES OF SLENDER WINGS

WEN-HAI GUO (Chinese Academy of Sciences, Inst. of Mechanics, Beijing, China), DING-DING XING, and FENG-GAN ZHUANG (Beijing Univ. of Aeronautics and Astronautics, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 2 May 1993 p. 85-89. Transl. of Acta Aeronautica et Astronautica Sinica, vol. 13, no. 1, Jan. 1992, p. A87-A90. Previously cited in issue 20, p. 3469, Accession no. A92-47694 refs Copyright

A93-55584

DESIGN PROBLEMS OF THREE-DIMENSIONAL CONTRACTIONS

YAO-XI SU, CHAO-QIANG LIN, and LIU HONG (Northwestern Polytechnical Univ., Xian, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 1 Feb. 1993 p. 25-31. Transl. of Northwestern Polytechnical Univ., Journal, vol. 9, July 1991, p. 245-252. Previously cited in issue 22, p. 3813, Accession no. A91-51612 refs Copyright

A93-55589

A NEW METHOD FOR PREDICTING THE END WALL BOUNDARY LAYERS AND THE BLADE FORCE DEFECTS INSIDE THE PASSAGE OF AXIAL COMPRESSOR CASCADES

HU WU, FU-QUN CHEN, SONG-LING LIU, and ZHI-TAO HUANG (Northwestern Polytechnical Univ., Xian, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 1 Feb. 1993 p. 59-69. Transl. of Acta Aeronautica et Astronautica Sinica, vol. 13, no. 1, Jan. 1992, p. A48-A56. Previously cited in issue 20, p. 3468, Accession no. A92-47691 refs Copyright

A93-55736 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DEVELOPMENT OF THE WAKE BEHIND A CIRCULAR CYLINDER IMPULSIVELY STARTED INTO ROTATORY AND RECTILINEAR MOTION

YEN-MING CHEN (NASA, Langley Research Center, Hampton, VA), YUH-ROUNG OU (ICASE, NASA, Langley Research Center, Hampton, VA), and ARNE J. PEARLSTEIN (Illinois Univ., Urbana) Journal of Fluid Mechanics (ISSN 0022-1120) vol. 253 Aug. 1993 p. 449-484. Previously announced in STAR as

N91-18063 Research supported by National Research Council refs
(Contract NAS1-18605; AF-AFOSR-89-0079; NSF MSM-84-51157; NSF CTS-90-17181; AF-AFOSR-90-0156; RTOP 505-90-52-01)
Copyright

The temporal development of a 2D viscous incompressible flow generated by a circular cylinder started impulsively into steady rotatory and rectilinear motion is studied by integration of a velocity/vorticity formulation of the governing equations, using an explicit finite-difference/pseudo-spectral technique and an implementation of the Biot-Savart law. Results are presented for a Reynolds number of 200 (based on the cylinder diameter $2a$ and the magnitude U of the rectilinear velocity) for several values of the angular/rectilinear speed ratio $\alpha = \omega(a)/U$ (where ω is the angular speed) up to 3.25. Several aspects of the kinematics and dynamics of the flow not considered earlier are discussed. For higher values of α , the results indicate that for $Re = 200$, vortex shedding does indeed occur for $\alpha = 3.25$. However, consecutive vortices shed by the body can be shed from the same side and be of the same sense, in contrast to the nonrotating case, in which mirror-image vortices of opposite sense are shed alternately on opposite sides of the body. The implications of the results are discussed in relation to the possibility of suppressing vortex shedding by open or closed-loop control of the rotation rate.

A93-56028
VIBRATION EXCITATION IN LAMINAR HYPERSONIC BOUNDARY LAYERS

U. BURGGRAF (DLR, Braunschweig, Germany) and R. GRUNDMANN (DLR, Goettingen, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 1 Feb. 1993 p. 33-44. refs
Copyright

The boundary layer equations of steady, 2-dimensional, laminar flow of a chemically reacting gas mixture according to the first order boundary layer theory, are extended to a flow model, that includes thermal non-equilibrium. The thermal state of the gas is characterized by a vibrational temperature for each molecular species and one translational temperature. The additional vibrational energy conservation equation for each molecular species is deduced. Electronic excitation so far, is not taken into account. A similarity and compressibility transformation yields quasi similar boundary layer profiles in the computational plane, which allow larger spacings in the streamwise direction. The governing equations are simplified to compute a binary gas mixture composed of the atomic and the molecular species. The computation of oxygen and nitrogen flows about a cone at hypersonic freestream velocities demonstrates the influence of the thermal non-equilibrium region on the flowfield.

A93-56030
ALGEBRAIC DETERMINATION OF THE SHOCK WAVE SHAPE IN AXISYMMETRIC FLOW OVER A CIRCULAR CYLINDER

O. W. TITOW Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 1 Feb. 1993 p. 52-56. refs
Copyright

Alternatively to the usual analytical and numerical methods a simple algebraic method is proposed to determine the shape and position of the detached shock wave by axisymmetric supersonic perfect gas flow over a circular cylinder. The method is based on the Taylor expansion for the solution constructed at the shock wave and on some theoretically exact relationships between the body curvature and normal velocity derivatives at the stagnation point. These relationships are valid for arbitrary blunt axisymmetric body. The results of selected numerical tests are checked by using the Bernoulli equation and compared with experimental data and other approximate solutions.

A93-56033
PRESSURE MEASUREMENTS AT SUPERSONIC SPEEDS ON THE RESEARCH CONFIGURATION ELAC I

W. LIMBERG and A. STROMBERG (Aachen, Rheinisch-Westfaelische Technische Hochschule, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 2 April 1993 p. 82-89. refs
(Contract DFG-SFB-253)
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Measurements of pressure distributions were carried out on the hypersonic research configuration ELAC I in wind-tunnel investigations. ELAC I has a delta-wing form composed of two semielliptical cross-sections on the upper and the lower side. One of the characteristic features of the configuration therefore are rounded leading edges. A 30-cm model was constructed and built, containing pressure taps in three cross-sections on the expansion and on the compression side. The experimental investigations were carried out for a freestream Mach number of 2. The angle of attack was varied in the limit prescribed by a reference flight trajectory. The paper documents the measured pressure distributions. The main purpose is to make the data obtained in the experiments available for comparisons with calculations.

Author (revised)

A93-56034
SUPERSONIC AND HYPERSONIC FLOW COMPUTATIONS FOR THE RESEARCH CONFIGURATION ELAC I AND COMPARISON TO EXPERIMENTAL DATA

D. HAENEL (Duisburg, Univ.-Gesamthochschule, Germany), A. HENZE, and E. KRAUSE (Aachen, Rheinisch-Westfaelische Technische Hochschule, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 2 April 1993 p. 90-98. refs
Copyright

The object of the present investigation is the numerical prediction of the stationary flow around a space plane. Computations of the 3D, laminar flow are carried out for a slender model configuration, called ELAC I. A space marching method, based on the time-dependent thin layer approximation of the Navier-Stokes equations has been developed, which enables efficient calculations of the flow field for a wide range of supersonic and hypersonic freestream conditions. The solution is obtained by marching in the main flow direction by determining the steady-state solution for each cross-section iteratively. Under the assumption of supersonic outer flow and attached boundary layers in the streamwise direction the complete viscous flow-field including the cross-flow separation can be computed. Compared to other solutions of the parabolized Navier-Stokes equations, no additional assumptions for imbedded streamwise subsonic regions are necessary. Starting conditions in an initial cross-section are calculated with the same method by assuming conical flow. Results are presented for flows with Mach numbers 2 and 8 and for several angles of attack.

Author (revised)

A93-56035
LOW-SPEED AERODYNAMICS OF THE HYPERSONIC RESEARCH CONFIGURATION ELAC I

F. DECKER, G. NEUWERTH, and R. STAUFENBIEL (Aachen, Rheinisch-Westfaelische Technische Hochschule, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 2 April 1993 p. 99-107. refs
(Contract DFG-SFB-253)
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Some low-speed characteristics of the generic hypersonic configuration ELAC I were experimentally investigated. The flow field around the configuration was visualized in a water-tunnel in order to understand basic physical flow phenomena. LDV-measurements in the region of the leading-edge vortices were performed to determine velocity profiles in spanwise and longitudinal direction. Low-speed wind-tunnel tests were carried out on a modular model of ELAC I. The upper surface has been investigated by means of surface oil-flow visualization. Six-component measurements have been performed for symmetrical and asymmetrical flow conditions.

A93-56036

FLOW COMPUTATION FOR THE HYPERSONIC CONFIGURATION ELAC I AT LOW SPEEDS AND LARGE INCIDENCE

C. A. MUELLER and J. BALLMANN (Aachen, Rheinisch-Westfaelische Technische Hochschule, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 2 April 1993 p. 108-115. refs

Copyright

A combination of a higher order panel method and a second order boundary layer calculation is used for the analysis of the flow around generic hypersonic configurations. A new approach to simulate the flow separating from smooth surfaces at low speeds and high incidence is presented. The essential elements of the method are discussed and the numerical technique is applied to the hypersonic configuration ELAC I. Some results and a comparison with experiments are presented.

A93-56037

EXPERIMENTAL INVESTIGATIONS OF HYPERSONIC SHOCK-BOUNDARY LAYER INTERACTION

A. HENCKELS, A. F. KREINS, and F. MAURER (DLR, Cologne, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 2 April 1993 p. 116-124. refs

(Contract DFG-SFB-253)

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The present investigation provides an experimental study of hypersonic shock wave boundary layer interaction on flat plate models. All test runs were performed in a hypersonic blow down facility of DLR Cologne at Mach number 6 and 8.7 under laminar boundary layer conditions. An impinging shock induces boundary layer separation and reattachment phenomena by generating longitudinal counterrotating vortices (Goertler vortices) on an uncurved flat plate in the downstream flow field. The existence of these vortices is demonstrated by interpretation of surface oil flow patterns and infrared thermovision, which indicates high local heat rates. A parametric study determined the effects of the impinging shock strength and the boundary layer thickness on the development of these vortices. In planes orthogonal to the mean flow direction the boundary layer is surveyed using a pitot rake. The downstream development of the Goertler vortices and the effect on the stability of the laminar boundary layer will be discussed.

A93-56038

COMPUTATION OF VISCOUS HYPERSONIC NON-EQUILIBRIUM BLUNT BODY FLOW

S. MUELLER, CH. DICKOPP, J. BALLMANN (Aachen, Rheinisch-Westfaelische Technische Hochschule, Germany), and R. JELTSCH (Zuerich, Eidgenoessische Technische Hochschule, Zurich, Switzerland) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 2 April 1993 p. 125-130. refs

(Contract DFG-SFB-253)

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The paper deals with a numerical integration scheme for the time-dependent Navier-Stokes equations in two spatial dimensions. The algorithm was used to calculate the flow past a blunt body flying at an altitude of about 35 km with a velocity between 2000 and 3000 m/s. Appropriate to the high temperatures in the shock layer the air was assumed to be a mixture of caloric imperfect gases. Finite rate chemical reactions were accounted for, whereas thermal equilibrium was assumed throughout. The air model is based on the five-component-model of Park (1985). A shock-capturing, explicit algorithm forms the basis of the code's method. Shock-capturing capability is achieved through a 1D ENO-Scheme, extended to two dimensions by means of dimensional splitting. Author (revised)

A93-56040

COMPUTATION OF HYPERSONIC HIGH-TEMPERATURE NOZZLE FLOW

U. FOX, W. RICK, and W. KOSCHEL (Aachen, Rheinisch-Westfaelische Technische Hochschule, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 2 April 1993 p. 139-148. refs

Copyright

A Finite-Element-procedure for the solution of the Euler equations utilizing unstructured grids with adaptive remeshing has been employed for the numerical simulation of thrust nozzle flowfields. The numerical scheme and the high temperature gas models required for the completion of the equation system are described. The gas models applied are thermally perfect gas, frozen in the combustion chamber, or a Bray-model based on a reaction kinetics calculation of the freezing line. Flowfield results and global performance values are presented in the case of a two-dimensional SERN nozzle for three operating points along an ascent trajectory and the deviations of the global values due to the gas model chosen are discussed.

A93-56212

ONERA CALCULATION MODEL OF DYNAMIC FLOW SEPARATION ON AN AIRFOIL SECTION [CYRKULACYJNY MODEL ONERA DYNAMICZNEGO ODERWANIA OPLYWU NA PROFILU]

JANUSZ NARKIEWICZ (Politechnika Warszawska, Warsaw, Poland), JACEK SYRYCZYNSKI (PZL Okęcie, Warsaw, Poland), and TOMASZ BARTLER (Inst. Lotnictwa, Warsaw, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 7-25. In POLISH refs

A method of determining nonstationary aerodynamic loading of airfoil sections using an ONERA phenomenological model is presented. The systematization of model coefficients and recording of the model as a function of circulation allows the aerodynamic hysteresis of loading to be obtained for optional values of airfoil section angles of attack. A comparison of the values obtained with calculations indicates a good agreement of lifting force coefficients with test results. The possibility of applying the model to helicopter blade loading calculations is also discussed.

Author (revised)

A93-56213

A NUMERICAL STUDY OF AERODYNAMIC WING DESIGN FOR SUPERCRITICAL CONDITIONS OF AN ADVANCED TRAINING AND MILITARY AIRCRAFT [NUMERYCZNE STUDIUM AERODYNAMICZNEGO PROJEKTOWANIA SKRZYDŁA NADKRYTYCZNEGO SAMOLOTU SZKOLNO-BOJOWEGO]

JERZY ZOLTAK, WOJCIECH KANIA, JAKUB ADYNOWSKI, TOMASZ BARTLER, and MALGORZATA ANTOSIEWICZ (Inst. Lotnictwa, Warsaw, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 26-40. In POLISH refs

A design study of a supercritical wing for an advanced training and military aircraft is introduced. The method of design is based on equivalent subcritical pressures. This method connects the 2D technology of supercritical design with the 3D method of subcritical wing design. The result of 2D design is an airfoil section which fulfills all supercritical requirements. The pressure distribution obtained at the design point determined for the airfoil section using the subcritical methods is a basis for design in 3D. The wing realized by the design process described here is a supercritical T-12 wing. On that wing a shock-free flow at the design point is realized and the residual requirements are all fulfilled. A comparison with a classical wing shows all the advantages resulting from the supercritical wing design. Author (revised)

A93-56214

NUMERICAL MINIMIZATION OF THE MOMENT COEFFICIENT OF A SUPERCRITICAL AIRFOIL SECTION [NUMERYCZNA MINIMALIZACJA WSPOLCZYNNIKA MOMENTU PROFILU NADKRYTYCZNEGO]

WIENCZYSLAW STALEWSKI, WOJCIECH KANIA, and TOMASZ BARTLER (Inst. Lotnictwa, Warsaw, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 41-49. In POLISH refs

A numerical modification process for selected supercritical airfoil sections is presented. The intention is to decrease the moment coefficient with as low as possible deterioration of other aerodynamic properties. Author (revised)

A93-56215

DETERMINATION OF THE TRANSONIC FLOW FIELD AROUND AN AIRFOIL SECTION FOR A GIVEN LIFT FORCE COEFFICIENT [WYZNACZANIE TRANSSONICZNEGO POLA PRZEPŁYWU WOKOL PROFILU DLA ZADANEGO WSPÓŁCZYNNIKA SIŁY NOSNEJ]

JERZY ZOLTAK (Inst. Lotnictwa, Warsaw, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 50-61. In POLISH refs

A method of modifying a calculation algorithm, realized in the TRANDES program, which directly determines the transonic flow around an airfoil section is given. The results of exemplary test calculations of the modified program version are discussed. They encompass the determination of the flow field for a given angle of attack and a given lift force coefficient, and the question of airfoil section design problem, all with the option of taking into account the weak effect of viscosity. Author (revised)

A93-56216

NUMERICAL STUDY OF SLIGHTLY COMPRESSIBLE NAVIER-STOKES SIMULATION OF BLADE-VORTEX INTERACTION

J. PIECHNA (Warsaw Technical Univ., Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 62-76. refs

The perturbation of a 2D viscous incompressible flow over a rotor blade due to the presence of a convected vortex is investigated numerically. The finite element method with a two-step integration scheme in time has been applied to solve simplified 2D unsteady Navier-Stokes equations. The influence of the initial vortex position with respect to the blade and influence of the blade thickness are investigated. The instantaneous velocity field and pressure distribution are presented. Author (revised)

A93-56219

INTERACTION OF COMPRESSIBLE VORTICES WITH A RIGID PLATE

J. R. PIECHNA (Warsaw Technical Univ., Poland) and G. E. A. MEIER (Max-Planck-Inst. fuer Stroemungsforschung, Goettingen, Germany) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 101-109. refs

This paper describes the numerical simulation of an unsteady flow field which is generated by the interaction of a vortex and a fixed rigid plate. The computed density distributions and variations of lift coefficient of vortex-plate interaction agree qualitatively with experimental data. The results show the significant influence of the initial position of the vortex with respect to the plate. Author (revised)

A93-56220

QUANTITATIVE KNUDSEN-NUMBER DEPENDENCES OF DENSITY DISTURBANCES IN FRONT OF OBSTRUCTIONS IN SUPERSONIC DIVERGENT FLOWS [ZALEZNOSCI ILOSCIOWE ZABURZEN GĘSTOSCI PRZED PRZESZKODAMI W NADDZWIĘKOWYCH STRUMIENIACH ROZBIEŻNYCH OD LICZBY KNUDSENA]

PAWEŁ TORECKI (Polish Academy of Sciences, Inst. of Fundamental Technological Research, Warsaw, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 110-121. In POLISH refs

A method and test results for density disturbances in front of bluff bodies placed in a divergent supersonic rarefied gas flow are presented. The use of a test stand in the form of a low-pressure jet tunnel is shown. Test results on the displacement of density disturbances on the flow symmetry axes are presented as generalized functions of Mach and Knudsen numbers. The method allows a comparison of the displacement of tested disturbances independently of the flow divergence ratio of flow and the number of degrees of freedom of the gases used. Author (revised)

A93-56327

FREE STREAMLINE-BOUNDARY LAYER ANALYSIS FOR SEPARATED FLOW OVER AN AIRFOIL

PIERO BASSANINI (Roma I, Univ., Rome, Italy) and ALAN ELCRAT (Wichita State Univ., KS) Zeitschrift fuer Angewandte Mathematik und Physik (ISSN 0044-2275) vol. 44, no. 4 July 1993 p. 695-706. Research supported by MURST refs (Contract CNR-92,00539,CT,01; AF-AFOSR-89-0323)

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We propose a model which combines boundary layer computations with a free streamline potential flow for obtaining pressure distributions on an airfoil section in steady flow near stall conditions. The model is conceptually simple and uses elements which can be computed rapidly and efficiently. The solution is essentially analytical and can be used naturally in the larger context of matching asymptotic expansions to get information about three dimensional flows.

A93-56402

THREE-DIMENSIONAL MESH EMBEDDING FOR THE NAVIER-STOKES EQUATIONS USING UPWIND CONTROL VOLUMES

B. L. LAPWORTH (Rolls-Royce, PLC, Derby, United Kingdom) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 17, no. 3 Aug. 15, 1993 p. 195-220. refs

Copyright

A numerical model for the compressible Navier-Stokes equations using local mesh embedding is presented. The model solves for 3D turbulent flow using an algebraic mixing length model of turbulence. The technique of control volume upwinding is used to produce a novel treatment, whereby the hanging nodes on the mesh interfaces are left with null control volumes. This yields an efficient discretization scheme which ensures second-order accuracy, flux conservation, and stability at the mesh interfaces, while retaining a simple interpolative treatment for the hanging nodes. The discrete flow equations are solved using the semiimplicit pressure correction method. The accuracy of the embedded mesh solver is demonstrated by modeling the 3D flow through a cascade of turbine vanes at design and off-design conditions. Mesh embedding gives a saving of 48 percent in the number of nodes. The embedded mesh solutions compare well with fine structured mesh solutions and experimental measurements. The capability of the embedded mesh solver to perform solution adaptive calculations is demonstrated using a 2D mid-height section of the cascade at the off-design flow conditions. Author (revised)

03

AIR TRANSPORTATION AND SAFETY

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

A93-54549

EVOLUTION OF THE SIIS-3 EJECTION SEAT INTO A REDUCED WEIGHT (RW) EJECTION SEAT

TERRY MERRIFIELD (Universal Propulsion Co., Inc., Phoenix, AZ) SAFE Journal vol. 23, no. 3 May-June 1993 p. 12-15.

Copyright

The first member of the family of SIIS-3 Ejection Seats was designed to meet or exceed the requirements of the U.S. Navy Specification MIL-S-18471D. Through extensive testing, the seat was certified in 1974 for service use in the A V-8A Harrier. During the certification/qualification test program, considerable component and subsystem testing was successfully conducted, resulting in the qualification of those items. This means that new derivatives of the SIIS-3 seat which feature a high degree of commonality require only minimal testing to demonstrate continued qualification status.

03 AIR TRANSPORTATION AND SAFETY

A93-54550

UNUSUAL ATTITUDES - HELICOPTERS AND INSTRUMENT FLIGHT

HILLMAN E. BEARDEN (FlightSafety International, Fort Worth, TX) SAFE Journal vol. 23, no. 3 May-June 1993 p. 30-33. Copyright

The hazards of pilots remaining under visual flight rules in dangerous weather conditions are discussed. Recommendations are made for reducing significantly the risk of accidents under these conditions. AIAA

A93-54604#

AIRSHIP/U.S. NAVAL VESSELS UHF COMMUNICATIONS RELAY DEMONSTRATION

ALAN S. VICTOR (U.S. Navy, Naval Air Warfare Center, Warminster, PA) In AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 17-22. refs (AIAA PAPER 93-4032)

The objective was to demonstrate Airship/Navy utility. The SENTINEL-1000 Westinghouse Airship performed as a communications and surveillance platform for this demonstration, with emphasis on the UHF beyond line of sight (BLOS) communications between two Over-the-Horizon (OTH) U.S. surface vessels. Connectivity between OTH Naval surface vessels was achieved with the Airship at 3,000 ft altitude and at various ranges from the U.S. Naval vessels. As another facet, on a not to interfere basis, a secondary objective was to illustrate Airship surveillance capability. A portable imaging system was employed. The impact to give the on scene commander (OSC) a 2- and 3-dimensional BLOS surveillance picture with communications connectivity will enhance the OSC decision making. All communications test plan objectives were achieved. Imaging tests were successful for direct line of sight transmissions. The stability exhibited by the Airship, along with its endurance to remain on station, particularly at one location, was especially noted by the test engineers.

A93-55414

A STUDY ON LOW LEVEL WINDSHEAR HAZARD INDEX

CHANG-JIANG JIN, HONG ZHANG, REN-BIAO ZHU, BIAO LUO, and WEI-BIN ZHOU (Beijing Univ. of Aeronautics and Astronautics, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 2 May 1993 p. 95-100. refs Copyright

One of the key problems of the design of airborne system of low level windshear detection, warning, and avoidance is the hazard assessment of low-level windshear (LLWS) to aircraft flight. This paper develops theoretically such a hazard index by energy height analysis that main risk is caused by the horizontal wind acceleration component $U\text{-dot}(wg)$ and vertical wind velocity component $W(wg)$. The quantitative and qualitative relationships between $U\text{-dot}(wg)$, $W(wg)$ and hazard index are studied in detail. It is also attempted to assess the hazard of LLWS to aircraft flight safety based only on the detectable windshear parameter $U\text{-dot}(wg)$. This provides the basis for the development of look-forward windshear detection sensors. Author (revised)

A93-56417

THE PROBABLE CAUSE

CARL W. VOGT (National Transportation Safety Board, Washington) Aerospace (UK) (ISSN 0305-0831) vol. 20, no. 8 Aug. 1993 p. 8-14. Copyright

The work of the U.S. National Transportation Safety Board which is aimed at finding the probable cause of civil aviation accidents and making recommendations to the safety regulator is described. Particular attention is given to survivable environments (the airport and the aircraft itself), the protection of children, passenger responsibilities, and improved cockpit automation. AIAA

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A93-55973

ACCURACY OF GPS-DERIVED ACCELERATION FROM MOVING PLATFORM TESTS

M. WEI (Calgary Univ., Canada), S. FERGUSON (Sander Geophysics, Ltd., Kanata, Canada), and K. P. SCHWARZ (Calgary Univ., Canada) In From Mars to Greenland: Charting gravity with space and airborne instruments - Fields, tides, methods, results New York Springer-Verlag 1992 p. 235-249. Research supported by Sander Geophysics, Ltd. and NSERC refs Copyright

In order to derive gravity from the output of an airborne gravimeter, precise position, velocity, and acceleration of the gravimeter platform are required from additional sensors. The major problem is to separate inertial and gravitational acceleration. To assess the capability of GPS phase and phase rate measurements for the determination of precise acceleration in a dynamic environment, tests on a moving platform were made. The platform motion is precisely controlled (i.e. independent control values for position and acceleration are available at all times). The paper briefly describes the test design and then focuses on investigating the accuracy of the acceleration determined from kinematic GPS measurements. Spectral techniques are used to analyze the acceleration in different dynamic environments. Processing methods are discussed at some length, because they affect the accuracy of the results in a major way. As expected, the accuracy is dependent on the averaging period. Standard errors of 1.0 and 0.4 mGal are achievable for moving averages of 1 and 2 minutes, respectively. Maximum values are about 2 and 1 mGal for the same periods. Author (revised)

A93-55974

MULTIPLE RECEIVER, ZERO-LENGTH BASELINE KINEMATIC GPS POSITIONING TECHNIQUES FOR AIRBORNE GRAVITY MEASUREMENT

M. F. PETERS, J. M. BROZENA (U.S. Navy, Naval Research Lab., Washington), and G. L. MADER (NOAA, Rockville, MD) In From Mars to Greenland: Charting gravity with space and airborne instruments - Fields, tides, methods, results New York Springer-Verlag 1992 p. 251-260. refs Copyright

Undetected and uncorrected cycle slips remain a major problem which must be overcome before kinematic GPS interferometric positioning can be routinely used in airborne geophysical investigations. This paper introduces a multiple GPS receiver arrangement technique in which several receivers are attached to one antenna or two closely spaced antennas on an aircraft or other survey vehicle. This technique makes it possible to easily detect and effectively correct cycle slips in GPS carrier phase data and to make the rapid calculations of the precise navigation solutions required for many geophysical research projects. A diagram of a GPS configuration for the experiment conducted to verify the technique is presented. AIAA

A93-55975* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

AIRBORNE GRAVIMETRY, ALTIMETRY, AND GPS NAVIGATION ERRORS

OSCAR L. COLOMBO (Maryland Univ.; NASA, Goddard Space Flight Center, Greenbelt) In From Mars to Greenland: Charting gravity with space and airborne instruments - Fields, tides, methods, results New York Springer-Verlag 1992 p. 261-271. refs (Contract NAG5-245) Copyright

Proper interpretation of airborne gravimetry and altimetry

requires good knowledge of aircraft trajectory. Recent advances in precise navigation with differential GPS have made it possible to measure gravity from the air with accuracies of a few milligals, and to obtain altimeter profiles of terrain or sea surface correct to one decimeter. These developments are opening otherwise inaccessible regions to detailed geophysical mapping. Navigation with GPS presents some problems that grow worse with increasing distance from a fixed receiver: the effect of errors in tropospheric refraction correction, GPS ephemerides, and the coordinates of the fixed receivers. Ionospheric refraction and orbit error complicate ambiguity resolution. Optimal navigation should treat all error sources as unknowns, together with the instantaneous vehicle position. To do so, fast and reliable numerical techniques are needed: efficient and stable Kalman filter-smoother algorithms, together with data compression and, sometimes, the use of simplified dynamics.

A93-55976* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

REQUIREMENTS FOR AIRBORNE VECTOR GRAVIMETRY

K. P. SCHWARZ (Calgary Univ., Canada), O. COLOMBO (NASA, Goddard Space Flight Center, Greenbelt, MD), G. HEIN (Muenchen, Univ. der Bundeswehr, Neubiberg, Germany), and E. T. KNICKMEYER (Nortech Surveys /Canada/, Inc., Calgary) *In From Mars to Greenland: Charting gravity with space and airborne instruments - Fields, tides, methods, results* New York Springer-Verlag 1992 p. 273-283. refs
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The objective of airborne vector gravimetry is the determination of the full gravity disturbance vector along the aircraft trajectory. The paper briefly outlines the concept of this method using a combination of inertial and GPS-satellite data. The accuracy requirements for users in geodesy and solid earth geophysics, oceanography and exploration geophysics are then specified. Using these requirements, accuracy specifications for the GPS subsystem and the INS subsystem are developed. The integration of the subsystems and the problems connected with it are briefly discussed and operational methods are indicated that might reduce some of the stringent accuracy requirements.

A93-55977

AIRBORNE VECTOR GRAVIMETRY WITH AN AIDED INERTIAL SURVEY SYSTEM

J. R. HUDDLE (Litton Industries, Guidance and Control Systems Div., Woodland Hills, CA) *In From Mars to Greenland: Charting gravity with space and airborne instruments - Fields, tides, methods, results* New York Springer-Verlag 1992 p. 285-300. refs
Copyright

This paper examines the role that different augmenting sensors such as GPS and a star tracker can play in airborne vector gravimetry, examines different system architectures that are potential candidates for obtaining measurement accuracies required by the geodesy and geophysics community, and derives a recommended architecture for an airborne vector gravimetry system. The system employs a novel four-mode gyro technology and a stellar sensor in a three-axis, angularly-isolated, local-level mechanization with controlled periodic rotation of the sensor assembly with respect to inertial space, thus minimizing the effects of inertial instrument error parameter instabilities on measurement performance. The system is also to be used in conjunction with GPS receivers operating in the differential carrier-phase tracking mode to minimize system velocity and position errors. AIAA

A93-56049

INTEGRATED DGPS/IMU SYSTEMS FOR AIRBORNE NAVIGATION IN POLAND

K. VORBRICH (Polish Academy of Sciences, Space Research Centre, Borowiec, Poland) *Artificial Satellites - Planetary Geodesy* (no. 18) (ISSN 0208-841X) vol. 28, no. 1 1993 p. 55-69. refs

Copyright

There exists in Poland an urgent need to improve the accuracy of radionavigation services for aviation. Some general information

is given to defend the opinion that the integrated satellite and inertial system DGPS/IMU is an alternative for Polish aviation. In the first part of the paper the state of aeronautical radionavigation in Poland is presented. In the second part a monographical description of both GPS and DGPS/IMU systems is given.

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A93-54551

ESTIMATION OF AERODYNAMIC CHARACTERISTICS FROM FLIGHT-TEST DATA. IV - PRINCIPAL COMPONENT ANALYSIS AND PERPENDICULAR ERROR METHOD

OSAMU KOBAYASHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 41, no. 472 1993 p. 265-274. In JAPANESE refs

It is shown how to apply principal components analysis (PCA) to multicollinearity problems and the equation error method. Also discussed is the perpendicular error (PE) method, one of the three main estimation methods under the concept of the in-flight wind tunnel test and corresponding to the maximum likelihood method under the concept of the response time history method. The PE method estimates the aerodynamic regression plane on which the perpendicular aerodynamic error variance between the data and the regression plane becomes minimal. PCA is a vital analysis technique for this PE method. Author (revised)

A93-54559

DIGITAL FLIGHT RECORDED DATA - A METHOD OF ESTIMATING DOWN DRAFT FROM DIGITAL FLIGHT RECORDED DATA

TSUNEHARU UEMURA and KANICHIRO KATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 41, no. 474 1993 p. 400-406. In JAPANESE

Some commercial jet liners are equipped with Aircraft Integrated Data System. The digital flight recorded data are obtained on the request of the pilot in command. Using the data, vertical wind can be estimated. Two methods are shown. One uses horizontal and vertical acceleration and fuel flow. The other uses pitch angle and angle of attack using vertical equation of motion.

A93-54590

VECTORIZING JET EFFECTS ON THE FLOW AND AERODYNAMIC BEHAVIORS OF FIGHTER MODEL

XUEYING DENG (Beijing Univ., China), ZHIWEI LIU, and ZUGENG ZHANG (Shenyang Aerodynamics Research Inst., China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 63-72. In CHINESE refs

A thrust vectoring/reversing technique is one of important technologies to develop next generation of fighters. The present experimental study is aimed at investigating the interaction between vectoring jet flow and main flow around an aircraft model. This interaction strongly depends on the nozzle/airframe configuration geometry. In the present configuration vectoring jet effects on the aerodynamic behavior of the wing can be divided into three types. The jet effects in the attached main flows of the wing are limited in the area near the nozzle exit. The jet effects in the stable leading edge vortex flows are weak and the vectoring jet effects can not increase the strength of the stable vortices. The jet effects in the bursted vortex flows can recover to the stable vortices due to reducing the adverse pressure gradient along the vortex axis and the pressure distribution on the wing can be improved. Author (revised)

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

A93-54596

A STUDY OF MILITARY AIRCRAFT AND ENGINE TACTICAL/TECHNICAL PERFORMANCE EVALUATION

YIKUN ZHU, JIAYUN WANG, and TING ZHANY (Beijing Univ., China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 109-117. In CHINESE refs

In this paper we will introduce the Aircraft/Engine Integrated Assessment System (AEAS) developed by Beijing University of Aeronautics and Astronautics and present some results of a military aircraft and engine (turbojet and turbofan) combination project based on AEAS. Especially some numerical optimal samples have also been discussed by applying the parameter optimization module of AEAS to select the aircraft/engine system design variables, including the aircraft thrust/weight ratio and wing loading for take off, wing configuration geometry parameters and engine cycle parameters with various constraints. The initial experience of employing AEAS has shown that the computation results are reasonable and the computation accuracy and required CPU time are appropriate for conceptual and preliminary design of the aircraft/engine system combination project. Author (revised)

A93-54603#

NATIONAL AIRBORNE SURVEILLANCE SYSTEM - AN ENGINEERING STUDENT STUDY

MAHLON C. SMITH (Michigan State Univ., East Lansing) In AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 7-16. refs (AIAA PAPER 93-4031) Copyright

This paper documents an LTA engineering design project by senior engineering students. The assignment was to propose a national boundary airborne surveillance and illegal entry interdiction system consisting of a number of lighter-than-air vehicles carrying radar, infrared sensors and heavier-than-air vehicles for detection and interception of illegally entering vehicles. Restriction was made to airborne and waterborne illegal entry. Each twenty five student competitive group had one project leader, two assistant project leaders and engineers assigned specific tasks. Details of pedagogical aspects of the study, student engineering and creativity, and some preliminary design results are given.

A93-54606#

AIRSHIP APPLICATIONS OF MODERN FLIGHT TEST TECHNIQUES

MICHAEL L. MCDANIEL (U.S. Navy, Naval Air Warfare Center, Patuxent River, MD) In AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 26-35. refs (AIAA PAPER 93-4035)

LTA flight test techniques, which have fallen behind contemporary HTA test methods, need modernization. One approach is to adapt the teachings of the U.S. Naval Test Pilot School (USNTPS) to meet LTA requirements. The USNTPS curriculum covers two main areas: test philosophy and test techniques. In the area of test philosophy, standard USNTPS practice is to emphasize thorough test planning, gradual buildup to high-risk test points, mission relation of test results, and the separation of satisfactory performance from specification compliance. Test techniques fall into two principal areas: performance and flying qualities. Most performance test techniques for airships can be easily adapted from USNTPS HTA test methods. Qualitative flying qualities may be tested using the Cooper-Harper HQR scale. Quantitative flying qualities may be determined with methods derived from HTA practice, although HTA techniques will require considerable modification for LTA applications. Without modernization of LTA flight test methods, the LTA community runs the risk of building airships that have inherent deficiencies, harming the entire LTA field in the long term. Author (revised)

A93-54610#

ADVANCED TECHNOLOGIES FOR ENHANCEMENT OF AIRSHIPS

WINFIELD H. ARATA, JR. (Airship Development Corp., Santa Maria, CA) In AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 55-65.

(AIAA PAPER 93-4040) Copyright

The abundance of new materials, processes, components, and systems incorporating advanced technologies offer the airship designer many choices to improve mission capabilities, with resulting economic benefits. This paper highlights many of these available advanced technologies. In turn, a specific application for these technologies is presented. It must be mentioned that utilization of advanced technologies is a never-ending process. Thus, the airship designer is permitted to continue to incorporate improvements and upgrade air vehicles in a sequential manner.

Author (revised)

A93-54612#

ZEPPELIN NT - A NEW CONCEPT IN AIRSHIP TECHNOLOGY, BASED ON RIGID AIRSHIP PRINCIPLES

KLAUS HAGENLOCHER (Luftschiffbau Zeppelin GmbH, Friedrichshafen, Germany) In AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 75-78.

(AIAA PAPER 93-4045) Copyright

The Zeppelin NT (ZNT) concept combines the advantages of both rigid and pressure (blimps) airships, allowing airships having a rigid internal structure to be built, but embodying substantial reductions in weight and production costs when compared with conventional rigid designs. The advantages of rigid airships may now be employed in the design of smaller airships. Due to the high level of maneuverability of the ZNT airship, especially during hover and at low speeds, it will be possible to apply mechanized ground handling techniques during takeoff and landing, thereby obviating the necessity for a large ground crew. The high maximum speed and robust construction of the ZNT design provides increased all-weather capability. The improvements in airship design provided by the innovative features of the ZNT will greatly enhance operational economy. The new load-carrying structure consists of a number of triangular frames which are interconnected at each apex of each frame by longerons and diagonal tensioning wires in a 'warren girder' space frame arrangement. The parameters governing the configuration are discussed together with the design of the primary structure and various examples of structural components of the LZ N07 airship. Author (revised)

A93-54613#

THE LARGEST FREIGHT AIRSHIP THAT CAN FIT IN MOFFETT HANGAR NO. 1

D. E. WOODWARD and F. M. DE PIOLENC (Association of Balloon and Airship Constructors, San Diego, CA) In AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 79-89. refs (AIAA PAPER 93-4046) Copyright

A rigid airship 160 ft in diameter and 975 ft overall length will fit the Moffett hangar no. 1 with adequate clearances. Such a hull, with a considerable length of parallel body, has an air volume of 14,600,000 cu ft. The airship is essentially a zeppelin, i.e., a structure of polygonal transverse frames united by longitudinal girders, containing gas cells and with an outer cover for streamlining and air-stream/weather protection. Optimum modern materials will be used. A stern propeller, recapturing wake momentum imparted by skin-friction drag, can achieve an apparent propulsive efficiency greater than 100 percent. The airship is powered by two gas turbines burning fuel gas of density equal to air, so that long flights can be made without induced drag and/or water-ballast recovery. Safety of this fuel-gas system is assured by containing the fuel bags within the helium cells. Design point specific fuel

consumption of 0.4 lb/bhp-hr is achieved without excessive turbine inlet temperature or use of a recuperator heat-exchanger. This airship's transport capability is 120 short tons at 100 knots for 6000 nautical miles, with 20 percent fuel reserves, flying no higher than 3000 ft MSL in ISA conditions. Author (revised)

A93-54614#

THE DEVELOPMENT PROGRESS OF THE U.S. ARMY'S SASS LITE, UNMANNED ROBOT AIRSHIP

JAMES H. BOSCHMA (Applied Research Associates, Inc., Huntsville, AL) /In AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 90-97.
(AIAA PAPER 93-4047) Copyright

This paper summarizes the Small Aerostat Surveillance System, Low Intensity Target Exploitation (SASS LITE) unmanned airship development effort. It reports on the current status and operations and discusses potential future applications. SASS LITE fills two voids in the UAV community: 1) It offers a reliable, noninterfering mobile airborne instrumentation platform, and 2) It offers a long endurance, stable platform ideal for detailed, high resolution survey of low intensity targets. The developmental funding history, details of acceptance by airspace managers for operations in close proximity to air traffic and ground personnel, the evolution of the electronic control systems, and the various sensor payloads are highlighted. Finally, the paper discusses emerging applications and demands.

A93-54650

FIGHTING FOR AIR

DOUGLAS BARRIE Flight International (ISSN 0015-3710) vol. 144, no. 4374 June 16, 1993 p. 83, 84, 86 (4 ff.).
Copyright

Progress in the Eurofighter 2000 program is discussed. Changes that have been made in the aircraft's configuration, equipment, and software and the role of the development bureaucracy in the changes are examined. The politics of the aircraft development is briefly addressed, including the debates about each participating nation's share of the costs. The cockpit design is described and a detailed diagram is presented of the aircraft's structure, electronics, fuel system power plant, undercarriage, and weapons, with each system shown and identified. AIAA

A93-54723

A NEW METHODOLOGY FOR HELICOPTER INTERNAL NOISE REDUCTION APPLICATION TO THE AS332 L2

M. DUSSAC (Eurocopter France, Marignane) /In The quiet helicopter; Proceedings of the Conference, London, United Kingdom, Mar. 17, 1992 London Royal Aeronautical Society 1992 p. 7.1-7.12. refs
Copyright

A strategy for optimization of sound-proofing treatment inside the helicopter cabin is developed. After reviewing the characteristics and the different origins of the acoustic field inside a helicopter and discussing the state of the art regarding the cabin acoustic insulation, the paper presents a three-step approach, based on the intensimetry technique, for combining weight saving and acoustic efficiency. The main problems of the technique are underlined, and solutions are recommended. As an example, the AS332 L2 MKII cabin treatment is examined. AIAA

A93-54724

EUROPEAN RESEARCH INTO HELICOPTER INTERNAL NOISE

K. H. HERON (Defence Research Agency, Aerospace Div., Farnborough, United Kingdom) /In The quiet helicopter; Proceedings of the Conference, London, United Kingdom, Mar. 17, 1992 London Royal Aeronautical Society 1992 p. 8.1-8.6. refs
Copyright

The paper presents the advanced statistical energy analysis (ASEA) method for theoretically predicting cabin noise levels, which is totally different from the statistical energy analysis developed in

the USA in the early 1960s. The ASEA approach is based on treating each plate as three subsystems and each beam as four subsystems, in order to properly accommodate the different wave types. Also described is a novel method for experimental path identification, a vital step to the understanding the mechanisms of internal noise generation. AIAA

A93-54838

POTENTIAL USE OF ALTERNATIVE FUELS IN AVIATION [MOEGLICHER EINSATZ ALTERNATIVER BRENNSTOFFE IN DER LUFTFAHRT]

RAINER WALTHER (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Germany) MTU Focus (ISSN 0935-8099) no. 2 1992 p. 35-41. In GERMAN refs
Copyright

The effects of using cryogenic fuel on the airframe and engine of modern aircraft is examined. Lightweight and reliable cryotanks need to be developed for the airframe and integrated optimally with it. Modifications to the engine combustor and to fuel system components such as pumps, pipes, and control valves need to be made. A heat exchanger is needed to vaporize and heat the fuel. Advanced low-pollution combustor concepts need to be realized. AIAA

A93-54867

RUSSIAN SURVIVOR

PAUL DUFFY Flight International (ISSN 0015-3710) vol. 144, no. 4375 June 23, 1993 p. 54, 55.
Copyright

The Russian program to develop the Tu-334 as a replacement for the Tu-134 is examined. Emphasis is given to design changes that will make the Tu-334 suitable for the Western market as well as those of Russian and the new CIS states. AIAA

A93-55415

OPTIMIZATION OF OLEO-PNEUMATIC SHOCK ABSORBER OF AIRCRAFT

LI LIU (Beijing Inst. of Technology, China), GUO-ZHU YANG, and QING-ZHI HE (Beijing Univ. of Aeronautics and Astronautics, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 2 May 1993 p. 101-107. refs
Copyright

The influence of the oleo-pneumatic shock absorber on aircraft response during both taxiing and landing impact is considered. For improving the dynamic response characteristics of the aircraft during taxiing, a model and method for optimization of shock absorber parameters are proposed, in which the mean square value of the heave acceleration of the aircraft during taxiing is taken as the objective function and the landing impact energy to be absorbed as the constraint conditions. As an example, the optimization of the main landing gear system is studied based on the model and method proposed above. Because the power-spectral density method is used in the analyses, the optimization procedure is easy and simple. Author (revised)

A93-55856* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STRUCTURAL-ACOUSTIC COUPLING IN AIRCRAFT FUSELAGE STRUCTURES

GOPAL P. MATHUR and MYLES A. SIMPSON (Douglas Aircraft Co., Long Beach, CA) /In International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 81-88. refs
(Contract NAS1-18037)
Copyright

Results of analytical and experimental investigations of structural-acoustic coupling phenomenon in an aircraft fuselage are described. The structural and acoustic cavity modes of DC-9 fuselage were determined using a finite element approach to vibration analysis. Predicted structural and acoustic dispersion curves were used to determine possible occurrences of structural-acoustic coupling for the fuselage. An aft section of DC-9

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

aircraft fuselage, housed in an anechoic chamber, was used for experimental investigations. The test fuselage was excited by a shaker and vibration response and interior sound field were measured using accelerometer and microphone arrays. The wavenumber-frequency structural and cavity response maps were generated from the measured data. Analysis and interpretation of the spatial plots and wavenumber maps provided the required information on modal characteristics, fuselage response and structural-acoustic coupling.

A93-55863

VIBRATION ISOLATION OF AVIATION POWER PLANTS TAKING INTO ACCOUNT REAL DYNAMIC CHARACTERISTICS OF ENGINE AND AIRCRAFT

V. S. BAKLANOV and V. M. VUL (A.N. Tupolev Aviation Science and Technical Complex, Moscow, Russia) /In International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 143-148. refs

Copyright

Results of studies of the dynamic compliance of various aircraft bodies and engines are generalized. Airframe acoustic response functions, calculated from the impedance test results in the frequency range 10-1000 Hz are also presented. An improved version of the D30-KU engine vibration isolating attachment on the TU-154M aircraft is examined as an example. AIAA

A93-56349

WEST POWERS EAST

HARRY HOPKINS Flight International (ISSN 0015-3710) vol. 144, no. 4384 Aug. 25, 1993 p. 32-37.

Copyright

Results of an evaluation of the Rolls-Royce-engined Tupolev Tu-204 at the Zhukovsky flight test center by a western pilot are reported. The discussion covers a brief history of the project, a description of the demonstrator cabin, the starting of the engines, pitch stability, and emergency descent. Brief descriptions of the systems configuration and of the fly-by-wire system are also included. AIAA

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A93-54391* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RESEARCH REQUIREMENTS FOR A REAL-TIME FLIGHT MEASUREMENTS AND DATA ANALYSIS SYSTEM FOR SUBSONIC TRANSPORT HIGH-LIFT RESEARCH

JULIA H. WHITEHEAD, FRANKLIN K. HARRIS (NASA, Langley Research Center, Hampton, VA), and CARROLL D. LYTLE (Lockheed Engineering and Sciences Co., Hampton, VA) /In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 635-647. refs

Copyright

A multiphased research program to obtain detailed flow characteristics on a multielement high-lift flap system is being conducted on the Transport Systems Research Vehicle (B737-100 aircraft) at NASA Langley Research Center. Upcoming flight tests have required the development of a highly capable and flexible flight measurement and data analysis instrumentation system. This instrumentation system will be more comprehensive than any of the systems used on previous high-lift flight experiment at NASA Langley. The system will provide the researcher near-real-time information for decision making needed to modify a flight test in order to further examine unexpected flow conditions. This paper

presents the research requirements and instrumentation design concept for an upcoming flight experiment for the subsonic transport high-lift research program. The flight experiment objectives, the measurement requirements, the data acquisition system, and the onboard data analysis and display capabilities are described. Author (revised)

A93-55294

IR SENSORS; PROCEEDINGS OF THE CONFERENCE, LONDON, UNITED KINGDOM, FEB. 18, 1992

London Royal Aeronautical Society 1992 53 p. For individual items see A93-55295 to A93-55299

(ISBN 1-85768-010-3) Copyright

Topics addressed include future trends in IR sensors, IR observer performance modeling, and displaying the night. Attention is also given to integration of an integrated helmet system for PAH 2 and passive IR surveillance based on the Sea Owl equipment for helicopter systems. AIAA

A93-55297

DISPLAYING THE NIGHT

C. T. BARTLETT (GEC Avionics, Ltd., Rochester, United Kingdom) /In IR sensors; Proceedings of the Conference, London, United Kingdom, Feb. 18, 1992 London Royal Aeronautical Society 1992 p. 3.1-3.14.

Copyright

The introduction of an electro-optic sensor based night vision system can substantially increase the effectiveness of ground attack aircraft and provide 24 hr operation. The key features of the system are the sensors and the displays. This paper addresses the development of the specialist displays required to complement the sensors. Flight trials in 1976 defined basic display parameters primarily that a display viewed head up was essential. The development of a wide FOV HUD leading to advanced holographic designs is described. The development of NVG to enhance the capabilities of the HUD/FLIR system is discussed leading to a description of a helmet-mounted display with the potential for display of images from multiple sources such as FLIR, NVG or synthetic symbology and scenes. Author (revised)

A93-55298

INTEGRATION OF AN INTEGRATED HELMET SYSTEM FOR PAH 2

H.-D. V. BOEHM and H. SCHREYER (Eurocopter Deutschland GmbH, Munich, Germany) /In IR sensors; Proceedings of the Conference, London, United Kingdom, Feb. 18, 1992 London Royal Aeronautical Society 1992 p. 4.1-4.12. refs

Copyright

A modern integrated helmet system (IHS) consists of a helmet shell, a Helmet Mounted Sight (HMS), two Image Intensifier Tubes (IIT) and two Cathode Ray Tubes (CRT) with an optical system including combiners to present the images binocular. Additional symbology can be superimposed to the CRT- or IIT-image. An IHS is a further development of a Helmet Mounted Display to cope with more demanding requirements regarding ergonomics and operability under adverse visual conditions. The HMS can steer a sensor platform with a thermal camera or an air-to-air missile system. The main helicopter requirements on such a system are: human factors; fit of helmet including optimized center of gravity and weight; optimized day, twilight and night optical modules; large exit pupil, good transmission of the optical path and a large adjustment range; good geometrical resolution/MTF with a large FOV; high focusing range of the IIT and a good SNR below 1 mLux; CRT automatic brightness and contrast control with a good readability on day time; flight symbology presentation for one or two eyes; good static and dynamic HMS-accuracy with a large Head Motion Box; NBC and laser protection compatibility. Author (revised)

A93-55299

PASSIVE IR SURVEILLANCE FOR HELICOPTER SYSTEMS - THE SEA OWL EQUIPMENT

A. C. PRIOR (GEC Sensors, Ltd., Basildon, United Kingdom) /In

IR sensors; Proceedings of the Conference, London, United Kingdom, Feb. 18, 1992 London Royal Aeronautical Society 1992 p. 5.1-5.11. Research supported by Ministry of Defence Procurement Executive and GEC Sensors, Ltd refs Copyright

A Sea Owl Passive Identification Device (PID), a steerable, stabilized IR sensor system for providing an exceptional stand-off viewing capability by night or day and in poor weather conditions, is described. The PID is based on dual field of view optics and advanced signal processing and is capable of providing both wide area detection, and a very long range target recognition, identification, and tracking capability. It may be integrated into a variety of helicopters, communicating with tactical information or weapons systems via the 1553B databus. The PID is based on an advanced equipment design concept that is characterized by high reliability, built-in-test equipment, and ease of maintenance.

AIAA

A93-55760* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

MULTIRATE AND EVENT-DRIVEN KALMAN FILTERS FOR HELICOPTER FLIGHT

BANAVAR SRIDHAR, PHILLIP SMITH, RAYMOND E. SUORSA (NASA, Ames Research Center, Moffett Field, CA), and BASSAM HUSSIAN (Sterling Federal Systems Group, Palo Alto, CA) IEEE Control Systems Magazine (ISSN 0272-1708) vol. 13, no. 4 Aug. 1993 p. 26-33. IEEE, Conference on Control Applications, 1st, Dayton, OH, Sept. 13-16, 1992 refs Copyright

A vision-based obstacle detection system that provides information about objects as a function of azimuth and elevation is discussed. The range map is computed using a sequence of images from a passive sensor, and an extended Kalman filter is used to estimate range to obstacles. The magnitude of the optical flow that provides measurements for each Kalman filter varies significantly over the image depending on the helicopter motion and object location. In a standard Kalman filter, the measurement update takes place at fixed intervals. It may be necessary to use a different measurement update rate in different parts of the image in order to maintain the same signal to noise ratio in the optical flow calculations. A range estimation scheme that accepts the measurement only under certain conditions is presented. The estimation results from the standard Kalman filter are compared with results from a multirate Kalman filter and an event-driven Kalman filter for a sequence of helicopter flight images.

A93-55972

AIRBORNE GRAVIMETRY FROM A LIGHT AIRCRAFT

R. E. BELL (Lamont-Doherty Geological Observatory, Palisades, NY), B. J. COAKLEY (Wisconsin Univ., Madison), D. D. BLANKENSHIP (Ohio State Univ., Columbus), S. M. HODGE (USGS, Water Resources Div., Tacoma, WA), and J. M. BROZENA (U.S. Navy, Naval Research Lab., Washington) In From Mars to Greenland: Charting gravity with space and airborne instruments - Fields, tides, methods, results New York Springer-Verlag 1992 p. 225-234. refs (Contract NSF DPP-91-00155) Copyright

Recent data collected from a Cessna 404 over water, and a ski-equipped Twin Otter over a grounded ice sheet, have demonstrated that airborne gravity can recover anomalies with wavelengths greater than about 5 km to accuracies of better than 3 mGal. The Cessna 404 was used over the Long Island Sound off the East Coast of the U.S., a region with extensive marine and land ground truth. The output from the Bell Aerospace BGM-3 was reduced with pseudorange GPS positioning from a Trimble 4000 CA-code receiver and with vertical positions and accelerations from a radar altimeter. The Twin Otter experiment was flown over the West Antarctic Rift system, where limited ground truth from surface gravity data exists that was collected in the early 1960s. The results from an overflight of a traverse gravity line indicate that, even in this remote location, airborne gravity can recover anomalies with accuracy adequate for geologic studies. The current

level of resolution and accuracy from airborne gravity is adequate for tectonic studies and deciphering the history of sedimentary basins, but it falls short of the high resolution required for detailed studies of intrusive features, hydrothermal deposits, and other small, yet important, geologic features. Author (revised)

A93-55978

CONTROLLING COMMON MODE STABILIZATION ERRORS IN AIRBORNE GRAVITY GRADIOMETRY

I. N. TZIAVOS (Salonika Univ., Greece), K. P. SCHWARZ (Calgary Univ., Canada), R. V. C. WONG (Western Atlas International, Inc., Western Geophysical Div., Houston, TX), and J. PANENKA (Canagrav Research, Ltd., Calgary, Canada) In From Mars to Greenland: Charting gravity with space and airborne instruments - Fields, tides, methods, results New York Springer-Verlag 1992 p. 301-310. refs Copyright

The precise measurement of second-order gravitational gradients is dependent on the isolation of the sensor package from rotations with respect to inertial space. To achieve this isolation in first approximation, a high quality inertial platform is employed to carry the sensor package. Imperfections in platform design and in gyros controlling the feedback loop cause initial tilt errors and platform drifts, and thus small time-dependent rotations with respect to inertial space. These rotations generate common mode errors in the gradiometer measurements. The control of these errors by GPS input is discussed in the paper. First, a state space approach to model the platform errors is outlined and the effect of these errors on the second-order gradients is derived. Then, the control of these errors by GPS coordinate updates is investigated in a simulation study. Results indicate that a GPS-controlled platform is an economical solution to the problem of common mode stabilization errors.

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.

A93-54450

NOVEL NOZZLE

GRAHAM WARWICK Flight International (ISSN 0015-3710) vol. 144, no. 4373 June 9, 1993 p. 77, 78. Copyright

Development-status evaluations are presented for several vectoring nozzle configurations for 20,000-30,000 lb thrust class military aircraft engines. These are the pitch/yaw balanced-beam nozzle (PYBBN), a 2D pitch-vectoring and thrust-reversing nozzle, a spherical convergent-flap nozzle, and a 2D multi-axis thrust vectoring and reversing nozzle. Attention is given to the PYBBN, which is to be flight-tested on the F-15 fighter's F100 engines. The critical component of the nozzle is a 'synchronization ring' controlling the convergent flaps; five actuators translate this nozzle to vary nozzle exit-area and rotate it to vector thrust. AIAA

A93-54467

NUMERICAL METHOD FOR SIMULATING FLUID-DYNAMIC AND HEAT-TRANSFER CHANGES IN JET-ENGINE INJECTOR FEED-ARM DUE TO FOULING

V. R. KATTA (Systems Research Labs., Inc., Dayton, OH) and W. M. ROQUEMORE (USAF, Wright Lab., Wright-Patterson AFB, OH) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722) vol. 7, no. 4 Oct.-Dec. 1993 p. 651-660. AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992, AIAA Paper 92-0768. Previously cited in issue 10, p. 1558, Accession no. A92-27108 Research supported by National

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Research Council refs
(Contract F33615-90-C-2033)
Copyright

A93-54556

THERMAL BARRIER DESIGN OF GAMMA-TiAl FUNCTIONALLY GRADIENT MATERIALS (FGMS) FOR SCRAMJET ENGINE APPLICATIONS

YUJI MATSUZAKI, JUNZO FUJIOKA, SHUICHI UEDA, and
YOSHIO WAKAMATSU Japan Society for Aeronautical and Space
Sciences, Journal (ISSN 0021-4663) vol. 41, no. 473 1993 p.
359-367. In JAPANESE refs

The work reported herein describes the results of analytical design using thermal-barrier-type Functionally Gradient Material (FGM) to insulate Scramjet cooling structures. The heat transfer coefficient of coolant side of the FGM (hl), representing the mass of the coolant required to cool the main structure, and the thermal resistance parameter (TRP) for equations governing the heat transfer at steady state were determined as the objective function and design variables, respectively. Using the function and variables, the heat transfer of the gas-FGM-coolant was numerically analyzed for a stabilized ZrO₂/gamma-TiAl FGM with a gamma-TiAl cooling structure. The effective thermal conductivity for the stabilized ZrO₂/gamma-TiAl FGM was calculated from the temperatures of the heated and cooled surfaces of the FGM, and from the enthalpy difference of the coolant at the inlet and outlet manifolds of the cooling structure, which was measured utilizing the Xe arc lamp heating test. Then the optimum TRP was found to be largely dependent upon the resistant temperatures of the high temperature and low temperature side materials of the FGM. In the cooling structure using ZrO₂/gamma-TiAl FGM with optimized TRPs, the mass of coolant required to maintain the gamma-TiAl cooling structure at temperatures below its resistant range was 35 percent of that of the cooling structure without FGM. Author (revised)

A93-54609#

A DIESEL POWERPLANT DEVELOPMENT PROGRAM FOR AIRSHIPS

R. MUNK (Westinghouse Airships, Inc., Baltimore, MD) In AIAA
Lighter-Than-Air Systems Technology Conference, 10th,
Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers
Washington American Institute of Aeronautics and Astronautics
1993 p. 49-54.

(AIAA PAPER 93-4038) Copyright

This paper explains the approach that Westinghouse Airships Inc. has taken in selecting an advanced technology 2 stroke diesel powerplant for consideration as a future enhancement for the Skyship and Sentinel series airships. It also outlines the current state of development of the selected Zoche diesel engine (currently running on the test bench in 4 cylinder form) and the further program that will bring the 8 cylinder variant to production readiness in the medium term. Finally, the paper addresses the dramatic advantages that this new propulsion engine should bring to the airship and the author's belief that this program could represent an opportunity for a major performance breakthrough for airships.

A93-54836

FUTURE AERO ENGINE DESIGN TRADE OFFS

DIETRICH ECKARDT (MTU Motoren- und Turbinen-Union
Muenchen GmbH, Munich, Germany) MTU Focus (ISSN
0935-8099) no. 2 1992 p. 11-21. refs

Copyright

The paper discussed the major aeroengine design trade-offs which will govern the future engine business for subsonic transports in the next decade. Particular attention is given to two approaches: a time- and cost-driven approach, used for a planned regional transport engine; and conceptual design trade-offs in the area of advanced new technologies, prevailing for the future generation of advanced ducted engines. AIAA

A93-54837

ALL-COMPOSITE FAN BLADE FOR ADVANCED DUCTED ENGINES

JOERG FRISCHBIER and SIEGFRIED SIKORSKI (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Germany) MTU Focus (ISSN 0935-8099) no. 2 1992 p. 22-29. Research supported by BMFT refs
Copyright

Supported by the Bundesministerium fuer Forschung und Technologie, a counterrotating integrated shrouded propfan is being investigated by MTU. This paper gives an overview of the development activities on fiber composite fan blades. Two types of composite blades have been designed: a full size blade (2.5 m fan diameter) and a scaled one expected to run in a test rig at DLR in Cologne. The blade construction for both types consists of an all-composite CFRP blade fitted into a metallic fork-shaped root. Several blades have been tested until now. Natural frequencies and mode shapes were determined by holographic methods, modal analysis, and vibration tests. The aeroelastic stability of the blades was analyzed with finite element methods including an aerodynamic routine for the calculation of unsteady loads in unstalled subsonic and supersonic flow. The fatigue strength of the composite/metal connection at the blade root and its fail safe behavior is being tested with CFRP/Ti specimens. To prove the bird strike potential of the blades, the bending strength of carbon/epoxy and APC2 (PEEK) at high strain rates was measured. Shooting tests of plasticine masses on composite plates were used to calibrate the 'DYNA3D' finite element bird strike analysis. Author (revised)

A93-54839

THE EUROJET EJ200 ENGINE

PAUL THEIMER (EUROJET Turbo GmbH, Munich, Germany) MTU Focus (ISSN 0935-8099) no. 1 1993 p. 5-10. Research supported by NATO

Copyright

A development status and design features account is presented for the EJ200 low-bypass turbofan that is to power the next-generation European Fighter Aircraft. Attention is given to the development schedule for the engine, the coordination of manufacturing responsibilities, and demonstrated levels of thrust, fuel consumption, and the service life of fracture-critical parts and hot-section parts. The thrust/weight value achieved is of the order of 10; the low and high-pressure spools use only a single turbine stage apiece. AIAA

A93-54841

COMBUSTOR DEVELOPMENT FOR ADVANCED HELICOPTER ENGINES

FRANZ JOOS, BURKHARD SIMON, BERNHARD GLAESER, and
STEFAN DONNERHACK (MTU Motoren- und Turbinen-Union
Muenchen GmbH, Munich, Germany) MTU Focus (ISSN
0935-8099) no. 1 1993 p. 26-33. Research supported by
BMFT refs

Copyright

An account is given of the design optimization and testing of a very short and compact reverse-flow annular combustor for a 1000 kW-category turboshaft engine applicable to helicopter propulsion. The combustor's development process employed a water-tank flow-simulation test rig and multidimensional flowfield models; realistic engine-environment measurements have been obtained for combustor temperature distributions, combustion efficiencies, flame stabilities, and material temperatures. Simulated cold-starts have exhibited easy ignition. AIAA

A93-54842

ADP - ENGINE CONCEPT OF THE FUTURE

ECKARD KRAFT and REINHARD NIEHUIS MTU Report (ISSN
0942-8267) no. 1 1993 p. 12-15.

An account is given of the design rationale and test performance to date of the technology demonstration hardware for the Advanced Ducted Propfan (ADP) commercial aircraft powerplant. The ADP, which employs a planetary gearbox to drive a reversible-flow wide-chord blade propfan, is a collaborative development effort between U.S. and German and Italian gas turbine manufacturers. Attention is given to the low-speed turbine driving the gearbox

and fan, which operates at exceptionally high loadings; configurational comparisons are drawn with a contrarotating ducted fan, ungeared engine alternative. AIAA

A93-54859

AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF SWIRLING FLOW ON THE PERFORMANCE OF NOZZLES

DA WU and XIAOHUI WU (Beijing Univ. of Aeronautics and Astronautics, China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 4 Oct. 1992 p. 85-90. In CHINESE refs

Swirl models designed to simulate the primary exhaust configuration of current high-bypass ratio engines and some test results of the effects of swirling flow on the performance of axisymmetric nozzle, 2D convergent-divergent nozzle, 2D wedge nozzle, and single expansion ramp nozzle, and on the flow pattern of a jet with a range of nozzle pressure ratio from 1.2 to 6.5 are presented. The test data indicate that the swirling flow at the nozzle entrance can enhance the intensity of the vortices existing in the jet plume and hence can increase the mixing zone between the plume and external stream and can decrease the central smooth-core flow, but the effect of swirl will be far much smaller for the axisymmetric nozzle. Test data also show that this swirling flow may adversely affect nozzle thrust coefficient and discharge coefficient, as swirl angle increases both thrust coefficient, and discharge coefficient will decrease for each configuration investigated, especially when the swirl angle surpasses a critical value. This critical value of swirl angle depends on nozzle types. Author (revised)

A93-54863

VECTORIZING THRUST AND TWO-DIMENSIONAL NOZZLE

ZHENYAN ZHAO and ZHAOFENG HU (Beijing Univ. of Aeronautics and Astronautics, China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 4 Oct. 1992 p. 133-146. In CHINESE refs

Vectoring thrust is a necessary measure in obtaining poststall maneuverability for the fourth generation fighter aircraft. A 2D nozzle is superior to other nozzles, such as a symmetrical nozzle, in performance of vectoring thrust control. In this paper, the development and status of the vectoring thrust and the 2D nozzle in the world, the construction and performance of the 2D nozzle, and the effect of the 2D nozzle in enhancing the lift-drag characteristics and the maneuverability of a fighter aircraft are described in detail. Improvements in the efficiency in air combat of an aircraft with vectored propulsion and the power needed in vectored propulsion control are also presented. Author (revised)

A93-55220

LOW-FREQUENCY COMBUSTION INSTABILITY MECHANISMS IN A SIDE-DUMP COMBUSTOR

J. M. SAMANIEGO, B. YIP, T. POINSOT, and S. CANDEL (Lab. d'Energetique Moleculaire et Macroscopique-Combustion, Chatenay-Malabry, France) Combustion and Flame (ISSN 0010-2180) vol. 94, no. 4 Sept. 1993 p. 363-380. Research supported by Aerospatiale refs

Copyright

A 2D two-inlet side-dump combustor fed with a mixture of air and propane is described, with emphasis on symmetric operating conditions with respect to the two inlets. Schlieren visualization, radical imaging with an intensified CCD camera, and simultaneous pressure, inlet velocity, and C2 emission light measurements are used to characterize the combustor behavior. The geometry of the flow field inside the combustion chamber with or without instability was symmetric with respect to the combustor centerline. For stable combustion, the flow field is characterized by the presence of two zones of intense heat release located on both sides of the jet impingement region. A conditional imaging technique is used to study two LF unstable modes. These instabilities are characterized by the excitation of the quarter-wave mode of the combustor and are associated with a complex evolution of the jets and the flame. AIAA

A93-55493

TURBOFAN PROPULSION SIMULATOR

Aerospace Engineering (ISSN 0736-2536) vol. 13, no. 8 Aug. 1993 p. 11-16.

Copyright

An ultrahigh-bypass turbofan propulsion simulator (UPS) has been built to evaluate candidate fan systems for current and future applications. The pneumatically powered, single-shaft, ducted-fan-engine model propulsion simulator is designed for testing various fan, outlet guide vane, inlet, nacelle, exhaust system, and acoustic treatment configurations associated with high-bypass-ratio, ducted-fan systems in either subsonic or transonic wind tunnels. The simulator can accommodate fans of a nominal 0.6-m tip diameter. A layout schematic of the UPS is given. AIAA

A93-55494

SMALL GAS TURBINES IN THE 21ST CENTURY

Aerospace Engineering (ISSN 0736-2536) vol. 13, no. 8 Aug. 1993 p. 17-20.

Copyright

The IHPTET (Integrated High-Performance Turbine Engine Technology) initiative is aimed at obtaining significant improvements in the performance and fuel economy of small gas-turbine engines. Technology goals of the initiative include a 40-percent reduction in specific fuel consumption, 120-percent increase in power-to-weight ratio, and a turbine-inlet temperature that is 800-1000 F higher. The discussion focuses on an engine output of about 1000 hp. Only five cycles are considered: the simple cycle, the regenerative-recuperative cycle, the nonconcentric simple cycle, the turbocompound cycle, and the Coleman cycle. AIAA

A93-55816

PRELIMINARY DESIGN OF EXPERIMENTAL SUB-SCALE SCRAMJET ENGINE

YUKIO YAMAOKA, KAZUYOSHI NINOMIYA, TAKUO KUWAHARA, NOBORU SHINOZAKI (Nissan Motor Co., Ltd., Aerospace Div., Kawagoe, Japan), YOSHIO WAKAMATSU, MASAYUKI NIINO, NOBUO CHINZEI, and GOROU MASUYA (National Aerospace Lab., Kakuda, Japan) In International Space Year in the Pacific basin; Proceedings of the 4th International Space Conference of Pacific-basin Societies, Kyoto, Japan, Nov. 17-20, 1991 San Diego, CA Univelt, Inc. 1992 p. 299-304. refs

(AAS PAPER 91-639) Copyright

In this paper the preliminary design of a water-cooled experimental subscale scramjet engine for the Ramjet Test Facility in NAL (National Aerospace Laboratory) is presented. This subscale engine will be submitted to a freejet firing test; this will be the first freejet firing test of a scramjet engine in Japan. The main objectives of this test are to investigate combustion properties in different engine configurations and to get data which can be compared with the results of CFD analysis. These data are very valuable to the next step in engines, regeneratively cooled engine and flight-type engine. The main purpose of this preliminary design is to define a practical engine concept. In this paper emphasis is placed on the engine thermal-structural design. Author (revised)

A93-55817

RESULTS OF SEA-LEVEL STATIC TESTS ON AIR TURBO RAMJET FOR A FUTURE SPACE PLANE

NOBUHIRO TANATSUGU, YOSHIHIRO NARUO (Inst. of Space and Astronautical Science, Sagami-hara, Japan), ITARU ROKUTANDA, TOMOAKI MIZUTANI, KAZUYUKI HIGASHINO, MASATO OGUMA, TAKESHI KASHIWAGI, and MASAKAZU OBATA (Ishikawajima-Harima Heavy Industries Co., Ltd., Tanashi, Japan) In International Space Year in the Pacific basin; Proceedings of the 4th International Space Conference of Pacific-basin Societies, Kyoto, Japan, Nov. 17-20, 1991 San Diego, CA Univelt, Inc. 1992 p. 305-315. refs

(AAS PAPER 91-640) Copyright

The Institute of Space and Astronautical Science (ISAS) has been engaged in the development study on the Air Turbo Ramjet (ATR) propulsion system since 1986. The ATR is one of the most

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preferable candidates for the propulsion system of a future space plane. Our ATR engine is a combined cycle air breathing propulsion system which consists of a turbojet and a fan-boosted ramjet using liquid hydrogen as a fuel. This engine system was named 'ATREX' after employing the expander cycle. ATREX is energized by thermal energy extracted regeneratively in both the precooler installed in air intake and the heat exchanger in combustion chamber. ATREX works in the flight condition from sea level static up to Mach 6 at 35 km altitude. ATREX employs the tip turbine configuration for compactness of turbo machinery. We are assessing the feasibility of the ATREX system by sea level static tests using the 1/4-scale model (ATREX-500) with fan inlet diameter of 300 mm and overall length of 2,210 mm. This paper presents results of ATREX-500 engine tests under the sea level static conditions.

Author (revised)

A93-55860

CONTROL OF SUPERSONIC THROUGHFLOW TURBOMACHINES DISCRETE FREQUENCY NOISE GENERATION BY AERODYNAMIC DETUNING

SANFORD FLEETER (Purdue Univ., West Lafayette, IN) *In* International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 113-120. refs

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Substantial improvements in supersonic and hypersonic flight vehicles can be obtained by utilizing supersonic throughflow fans and compressors. However, the environmental impact of such future propulsion systems must be considered, for example their noise generation. In this regard, progress in engine noise control is dependent on developing an increased fundamental understanding of turbomachinery noise generation and on novel methods for controlling this noise which do not impose performance penalties on the engine. In this paper, a mathematical is developed to analyze the effects of aerodynamic detuning on the discrete frequency noise generation of supersonic axial flow rotors, with the detuning achieved by alternating the circumferential spacing of adjacent rotor blades. This model is then applied to baseline uniformly spaced twelve bladed rotors and detuned configurations of these baseline rotors, with the effect of this aerodynamic detuning on the discrete frequency noise generation determined by considering the relative magnitudes of the gust generated unsteady aerodynamic lift. This study demonstrated that, dependent on the specific blade row and flow field geometry, alternate blade circumferential spacing aerodynamic detuning is a viable passive discrete frequency noise generation control technique for supersonic throughflow rotors.

A93-56348

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF FLOW THROUGH A TURBINE VANE CASCADE

T. VENKATAKRISHNAIAH, VIMALA NARAYANAN (Gas Turbine Research Establishment, Bangalore, India), and K. A. DAMODARAN (Indian Inst. of Technology, Madras, India) *Defence Science Journal* (ISSN 0011-748X) vol. 43, no. 1 Jan. 1993 p. 87-93. refs

Copyright

Present day military aero-gas turbines demand higher stage loadings for turbines so as to meet the growing need for higher thrust/power with lower fuel consumption. This calls for improved methods of blade element profiles. Details of a computer code developed for the design of blade elements for a prescribed distribution of surface velocity (Mach number) based on Stanitz's inverse methods are presented. Effect of boundary layer growth on the blade surface has also been incorporated in this code. Turbine vane was designed making use of this program and a four-bladed cascade was fabricated. It was tested in a blow down wind tunnel for different blowing pressures and stagger angles. Mach number distribution was determined from measured static pressure on the suction and pressure surfaces of the blade. Based on stream filament technique a computer code was developed to predict the characteristics of flow through a blade cascade. Results

of this study show reasonable agreement between experimentally obtained Mach number distribution and the initially prescribed as well as analytically predicted Mach number distributions.

Author (revised)

A93-56350

ENGINE FOR CHANGE

GRAHAM WARWICK *Flight International* (ISSN 0015-3710) vol. 144, no. 4384 Aug. 25, 1993 p. 39-43.

Copyright

The evolution of the design of Textron Lycoming's LF507 turbopan, an improved version of the ALF502, is briefly reviewed. The engine is a two-shaft turbopan, with a two-stage low-pressure turbine driving the fan and two-stage low-pressure compressor via a reduction gearbox. The LF507 addresses the ALF502's cost-of-ownership issues and solves its reliability problems. The way the manufacturer of the engine has changed its way of doing business in order to meet the regional airline market demands is described.

AIAA

08

AIRCRAFT STABILITY AND CONTROL

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

A93-54554

MINIMUM TIME TURN OF A HELICOPTER

TOSHIFUMI NEKOHASHI, SHIGERU SASAKI, and TOMOARI NAGASHIMA *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663) vol. 41, no. 472 1993 p. 293-299. *In JAPANESE* refs

Using a point mass approximation, two and three dimensional minimum time turn problems of a helicopter are formulated as the nonlinear optimal control problems. Optimum solutions are obtained numerically by SCGRA and MQA. The rotor is modeled as an ideal aerodynamic force generator which provides the thrust and the lift as well as control forces of the vehicle without any inertia effect. It is clarified that the minimum time turn performances of the helicopter are consistent with bangbang controls of the angle of attack of the rotor and the engine power and largely dependent on its autorotation capability. It is also revealed that for a rotary wing aircraft such as a helicopter, proper inclusions of the rotor induced power are essential for its maneuverability optimization.

A93-54857

WORST-CASE WIND MODELING AND ITS INFLUENCE ON CAPTURING OF AIRCRAFT PENETRATION TRAJECTORY

LIXING WANG and ZHAOFENG HU (Beijing Univ. of Aeronautics and Astronautics, China) *Beijing University of Aeronautics and Astronautics, Journal* (ISSN 1001-5965) no. 4 Oct. 1992 p. 68-75. *In CHINESE* refs

Based on a kind of nonlinear dynamic equations, the differential game solutions of quadratic payoff function are developed in order to construct the worst-case wind models containing non-linear factors. This model is especially useful for analyzing the disturbance sensitivity problem of aircraft during spatial maneuvering flight.

Author (revised)

A93-54969

EQUATIONS OF THE STEADY MOTION OF AIRCRAFT IN SPIN AND SPIRAL DIVE [URAVNENIYA USTANOVIVSHEGOSYA DVIZHENIYA SAMOLETA PRI SHTOPORE I SPIRAL'NOM SNIZHENII]

A. A. SHILOV (TsAGI, Zhukovskii, Russia) *Rossiyskaya Akademiya Nauk, Doklady* (ISSN 0869-5652) vol. 331, no. 1 July 1993 p. 49-52. *In RUSSIAN* refs

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A general solution is obtained in several equivalent forms for

the problem of the steady motion of aircraft in spin and spiral dive. The approach used here is based on vector analysis. The method for solving vector equations proposed here can also be used in other problems, such as that of determining the angles of attack and slip in steady spiral dive from airborne sensor data.

AIAA

A93-55590

A SIMULATION STUDY ON TAKE-OFF AND LANDING**DYNAMICS OF FLY-BY-WIRE CONTROL SYSTEM AIRCRAFT**

YA-CHANG FENG, GANG CHEN, and PEI-QIONG LI (Beijing Univ. of Aeronautics and Astronautics, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 1 Feb. 1993 p. 70-78. Transl. of Acta Aeronautica et Astronautica Sinica, vol. 12, June 1991, p. B252-B258. Previously cited in issue 22, p. 3821, Accession no. A91-52212 refs
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A93-55753

BOEING 777 HIGH LIFT CONTROL SYSTEM

JON REA (Boeing Commercial Airplane Group, Seattle, WA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985) vol. 8, no. 8 Aug. 1993 p. 15-21. IEEE, NAECON '93 - National Aerospace and Electronics Conference, Dayton, OH, May 24-28, 1993
Copyright

The Boeing 777 High Lift Control Systems (HLCS), a state-of-the-art microprocessor-based system that provides fly-by-wire control, protection, and built-in-test and maintenance access functions for the leading edge slats and trailing edge flaps drive and actuation systems, is discussed. This system is designed to take advantage of technologically proven concepts as well as judicious application of new concepts in response to market demands, airline customer input, and a thorough review of lessons learned from previous aircraft programs. The purpose of the HLCS, the wing high lift devices it controls, the HLCS components, its three modes of operation, automatic functions, and system failure protections are described. The use of the EASY5 engineering analysis program developed by the Boeing Company to model dynamic systems in both the time and frequency domains for modeling mechanical and hydraulic portions of the high lift system is discussed.

A93-56029

ESTIMATION OF AIRCRAFT INERTIA CHARACTERISTICS FROM BIFILAR PENDULUM TEST DATA

J. J. O. VAN HEMEL, J. A. MULDER (Delft Univ. of Technology, Netherlands), and K. O. PROSKAWETZ Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 1 Feb. 1993 p. 45-51. refs
Copyright

The inertial characteristics of the Dornier DO-128 research aircraft have been estimated using data from bifilar pendulum test oscillations. The bifilar pendulum rig and measurements system is described along with the mathematical model describing the response to arbitrary initial conditions. The method is found to be very promising, and new developments of it are discussed. AIAA

A93-56031

PREDEVELOPMENT OF A FLIGHT CONTROL SYSTEM FOR A SMALL CIVIL AIRCRAFT [VOR-ENTWICKLUNG EINER FLUGSTEUERUNG FUER EIN KLEINES VERKEHRSFLUGZEUG]

M. FISCHER (Deutsche Airbus GmbH, Hamburg, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 1 Feb. 1993 p. 57-64. In GERMAN refs
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The tradeoff study of different flight control systems for a civil aircraft with 80 to 130 seats resulted in significant advantages for the fly-by-wire technology. Compared to Airbus A320 and A330/A340 flight control systems the following innovations for the projected aircraft are implemented: (1) computer integration

and (2) a new rudder control concept. The feasibility of these innovations is shown by simulations and tests which were successful. To minimize risk for the 80- to 130-seater project the technology readiness shall be reached by further simulations and tests. Furthermore, some future flight control technologies, i.e. smart actuation, fly-by-light, and power-by-wire are being studied by Deutsche Airbus GmbH. Author (revised)

A93-56046

INVERSE SIMULATION: A TOOL FOR THE VALIDATION OF SIMULATION PROGRAMS - FIRST RESULTS

W. VON GRUENHAGEN (DLR, Inst. fuer Flugmechanik, Braunschweig, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 3 June 1993 p. 211-219. refs
Copyright

Inverse simulation is the technique to calculate the required control inputs to fly a predefined maneuver. This is useful in the design phase of a new flight vehicle. This technique has been recently developed for various applications. This note describes the use of inverse simulation as a tool for the improvement of simulation programs. An explicit model following control system is used for the validation procedure of these programs. Normally time histories are compared for this validation. The additional information of the required control inputs to match flight test and simulation data provides a useful tool to check the validity of the simulation program. The inverse simulation as described in this note is a suitable tool to evaluate the adequacy of models which shall be implemented in pilot-in-the-loop simulators. The quality of a model is demonstrated by the amplitude of the 'residual' controller outputs in the short and midterm responses, especially.

A93-56217

CONSIDERATION OF MASS ELEMENTS OF THE CONTROL SYSTEM IN A FLUTTER ANALYSIS [UWZGLEDNIANIE MAS ELEMENTOW UKLADU STEROWANIA W OBLICZENIACH FLATTERU]

WOJCIECH CHAJEC (Osrodek Badawczo-Rozwojowy Sprzetu Komunikacyjnego, Mielec, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 77-90. In POLISH refs

A method is presented which takes into account the mass elements of control system transmission. In order to minimize the input into existing programming, the method concentrates on calculating free structural vibrations based on known free vibrations of similar structures which differ in mass distribution. This method was developed before in order to calculate flutter based on test results of resonance measurements when the structure mass distribution is changing. Author (revised)

A93-56218

THE WHIRL-FLUTTER PROBLEM IN AIRCRAFT CONSTRUCTION [ZAGADNIENIA 'WHIRL-FLUTTER' W BUDOWIE SAMOLOTOW]

JANUSZ PIETRUSZKA (Osrodek Badawczo-Rozwojowy Sprzetu Komunikacyjnego, Mielec, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 91-100. In POLISH refs

A mathematical model of whirl-flutter analysis applied in calculations of the An-28 turboprop aircraft is presented. The phenomenon of whirl-flutter occurs at a certain flight velocity and is related to the loss of stability in the elastically supported engine and the propeller. Example results of calculations are presented. Author (revised)

RESEARCH AND SUPPORT FACILITIES (AIR)

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

A93-54389**AN UPDATED DATA ACQUISITION AND PROCESSING SYSTEM FOR TURBINE ENGINE TESTING**

P. E. MCCARTY and W. K. MORTON (Sverdrup Technology, Inc., Arnold AFB, TN) /*n* International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 599-615. refs

Copyright

The updated configuration, capabilities, and performance of the 5000-channel data system for the Aeropropulsion Systems Test Facility (ASTF) at the Arnold Engineering Development Center (AEDC) are presented. The system provides conditioning, recording, processing, and display of data for two simulated altitude test cells during testing of military and commercial aircraft turbine engine propulsion systems. Data are simultaneously processed for on-line, near-real-time analysis and archived for future off-line analysis. Extensive modifications incorporated since initial operations have significantly improved the system's reliability, performance, and overall test support capability. Descriptions of current operating modes, hardware/software architecture, communication networks, and operations and analysis displays are included.

A93-54395**INSTRUMENTATION AND DATA ACQUISITION SYSTEM FOR THE C.I.R.A. TRANSONIC PILOT TUNNEL**

F. FUSCO and F. NITTI (Italian Aerospace Research Center, Capua, Italy) /*n* International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 769-778. refs

Copyright

The C.I.R.A. Transonic Pilot Tunnel will be used to obtain information about tunnel flow quality parameters to allow optimization of the aerodynamic design of the High Reynolds Transonic Tunnel. The general design criterion, acceptance test program, acquisition chain for steady-state and dynamic measurements, and general layout of the pilot tunnel are described. AIAA

A93-54397* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DATA ACQUISITION FOR AEROELASTIC TESTING AT THE NASA LANGLEY TRANSONIC DYNAMICS FACILITY

ROBERT V. DOGGETT, JR., DAVID C. ROSSER, JR., and CHARLES S. BRYANT (NASA, Langley Research Center, Hampton, VA) /*n* International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 877-887.

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Aeroelasticity is defined and different types of aeroelastic tests are described. The instrumentation and data acquisition requirements dictated by the time varying characteristics of aeroelastic phenomena are pointed out. Instrumentation needs for various types of tests are discussed. The hardware components and operational features of the real-time, digital-computer-controlled data acquisition system used to support testing at the Langley Transonic Dynamics Facility, which includes a major wind-tunnel, a helicopter-model hover facility, and two model setup and calibration laboratories are described.

A93-54399* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

INSTRUMENTATION AND DATA ACQUISITION FOR FULL-SCALE AIRCRAFT CRASH TESTING

LISA E. JONES (NASA, Langley Research Center, Hampton, VA) and EDWIN L. FASANELLA (Lockheed Engineering and Sciences Co., Hampton, VA) /*n* International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 903-913. refs

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The Landing and Impact Dynamics Branch of the NASA Langley Research Center has been conducting full-scale aircraft crash tests since the 1970s. Using a pendulum method, aircraft are suspended by cables from a 240-ft high gantry and swung into the impact surface at various attitudes and velocities. Instrumentation for these tests include on-board high-speed cameras, strain gages, load cells, displacement transducers, and accelerometers. Transducers in the aircraft are hard-wired through a long umbilical cable to the data acquisition room. Up to 96 channels of data can be collected at a typical rate of 4000 samples per second. Data acquisition using an FM multiplexed analog system and a high-speed personal computer based digital system is described. Author (revised)

A93-54400* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NASA LANGLEY'S AIRCRAFT LANDING DYNAMICS FACILITY

PAMELA A. DAVIS (NASA, Langley Research Center, Hampton, VA) /*n* International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 915-947. refs

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The Aircraft Landing Dynamics Facility (ALDF) is a unique facility with the ability to test aircraft landing gear systems on actual runway surfaces at operational ground speeds and loading conditions. A brief historical overview of the original Landing Loads Track (LLT) is given, followed by a detailed description of the new ALDF systems and operational capabilities.

A93-54593**THE EXPERIMENTAL EVALUATION OF ANNULAR EJECTOR SYSTEM UNDER CONCURRENT MIXING AND DIFFUSION**

HUA ZHANG and YUNPEI LING (Beijing Univ. of Aeronautics and Astronautics, China) Beijing University of Aeronautics and Astronautics, Journal (ISSN 1001-5965) no. 1 Jan. 1993 p. 85-94. In CHINESE refs

An experimental study of the effect of concurrent mixing and diffusion and other parameters on performance of an annular ejector system and of the Induction Driven Wind Tunnel (IDT) is presented. The results show that the concurrent mixing and diffusion can do very well as the traditional mixing duct can do. The length scale of the system is considerably shortened under the concurrent mixing and diffusion, but this can only be used in such injection as periphic jet. The best angle of concurrent mixing and diffusion is about 6 deg which is comparable to that of a traditional diffuser. The area ratio and the pressure ratio affect the performance notably and oppositely, under the proper coordination of the two parameters, high performance of the IDT could be achieved. The effects of other parameters like jet Mach number and vortex generation on the performance are also presented. Author (revised)

A93-55841**HYPERSONIC VEHICLE RESEARCH BY USING A LARGE SHOCK TUNNEL**

KENICHI IGO (Tokyo Univ., Japan) /*n* International Space Year in the Pacific basin; Proceedings of the 4th International Space Conference of Pacific-basin Societies, Kyoto, Japan, Nov. 17-20, 1991 San Diego, CA Univelt, Inc. 1992 p. 677-688. refs (AAS PAPER 91-607) Copyright

This paper discusses hypersonic test facilities requirements for the 21st century. During reentry maximum Mach number will be

30 and unit Reynolds number will be 10×10^3 to $10 \times 10^7/\text{m}$. Total pressure will go up to 1-1000 MPa and total temperature will reach 1000-10,000 K. These demands exceed structural limits. Up to now, only shock tunnels can produce both the total enthalpy and pressure levels representative of flight beyond Mach 10. In the 21st century simulation of real gas effects will be given serious consideration. High total enthalpy of shock tunnel will make experiments of real gas effects easier than now. I recommend that we should construct a shock tunnel and simulate hypersonic flow to design a hypersonic vehicle. Author (revised)

A93-56032**EXPERIMENTAL STUDIES IN THE AACHEN HYPERSONIC SHOCK TUNNEL**

C. JESSEN, M. VETTER, and H. GROENIG (Aachen, Rheinisch-Westfaelische Technische Hochschule, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 2 April 1993 p. 73-81. refs (Contract DFG-SFB-253)

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Within the Sonderforschungsbereich 253 basic studies are performed on the hypersonic overall configuration ELAC-1 as well as on simpler detail-models. Besides the construction of the engine inlet and nozzle, theoretical and experimental studies over a Mach number range from 0 to 8 are of most interest. Since during the last five years the Aachen shock tunnel has proved suitable for generating hypersonic flows, experiments are performed at Mach numbers between 7 and 8 to evaluate pressure and heat flux distributions both around the overall configuration and simpler models. First results for the leeward side of the ELAC-1 configuration and a rearward facing step are presented. The measurement techniques play an important role, because the useful test time with nearly constant free stream properties amounts usually to a few milliseconds. Some unconventional techniques, especially for heat flux, skin friction and forces measurement are described.

A93-56222**THERMODYNAMIC ASPECTS OF MODEL TESTING IN CRYOGENIC WIND TUNNELS [TERMODYNAMICZNE ASPEKTY BADAN MODELOWYCH W TUNELACH KRYOGENICZNYCH]**

JAN GORSKI (Politechnika Rzeszowska, Rzeszow, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 132-133 1993 p. 136-145. In POLISH refs

The possibility of using gas mixtures in wind tunnel testing as applied to airplane aerodynamics and to flow stages of rotary flow machinery is analyzed. The present method, supported by examples, shows that with the proposed method the range and the efficiency of tests carried out in cryogenic wind tunnels as well as tests of flow stages of rotary compressors may be extended. As mixture components, besides inert gases, the ecologically safe Freons R22 (CHClF₂) and R142 (C₂H₃ClF₂) are used.

Author (revised)

A93-56278**CTS FOR A LOW SPEED WIND TUNNEL**

NORIO YAMASHITA (Japan Defense Agency, Technical Research and Development Inst., Tachikawa) In Space Sciences and Technology Conference, 35th, Nagaoka, Japan, Oct. 28-31, 1991, Proceedings Tokyo Japan Society for Astronautical and Space Sciences 1991 p. 149, 150. In JAPANESE

This report discusses the the design and functions of the Captive Trajectory System (CTS) for a low-speed wind tunnel in the Third Research Center Low Speed Wind Tunnel. The CTS was made experimentally to test and evaluate the aircraft external store separation characteristics and is characterized by the quantitative acquisition of store trajectory. Author (revised)

10

ASTRONAUTICS

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

A93-54368* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DEVELOPMENT OF A TETHERED SATELLITE FORCE TRANSDUCER

RAY D. RHEW (NASA, Langley Research Center, Hampton, VA) In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 287-297. refs Copyright

The SEDS (Small Expendable Deployer System)/Delta II is a demonstration flight of a tethered satellite deployer system. The satellite or end mass payload, which is deployed and tethered to the Delta II rocket, is instrumented to determine its dynamics during deployment. A three-component force transducer or strain-gage balance was developed to measure tether tension on the end-mass side of the tether. The transducer was designed to measure tensions up to 20N in each direction and resolve tensions as low as 0.002N. In addition, the transducer was required to withstand the shock, vibration, and temperature excursions of the mission. The development of the transducer from design to testing and integration is discussed.

A93-54409* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SPECTRAL MEASUREMENTS OF SHOCK LAYER RADIATION IN AN ARC-JET WIND TUNNEL

GIUSEPPE PALUMBO (Eloret Inst., Santa Clara, CA), ROGER CRAIG, and ARMANDO CARRASCO (NASA, Ames Research Center, Moffett Field, CA) In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 1087-1111. refs (Contract NCC2-653; NCC2-762)

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Measurements were made of the radiating gas cap of a blunt body in an NASA Ames 20 MW arcjet wind tunnel. The test gas was air. Spectra of the flux incident on a small aperture centered at the stagnation region were obtained. A helium-cooled MgF window transmitted flux into an evacuated collimating system that focused the aperture onto the entrance slit of a spectrometer. Data were obtained with films and by photomultipliers. The range covered was 120 nm to 1000 nm and the resolution was 0.05 nm to 0.5 nm. This paper presents preliminary results from the experiment. Representative spectral records from 200 nm to 1000 nm are shown. The spectra show the atomic lines from oxygen and nitrogen in the IR, as well as the molecular systems of NO, N₂, N₂(+), and CN. Copper, as a contaminant, and carbon are tentatively identified. Author (revised)

A93-54563* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

OPTIMAL TRAJECTORIES FOR HYPERSONIC LAUNCH VEHICLES

MARK D. ARDEMA, JEFFREY V. BOWLES, and THOMAS WHITTAKER (NASA, Ames Research Center, Moffett Field, CA) In Mechanics and control; Proceedings of the 4th Workshop on Control Mechanics, Univ. of Southern California, Los Angeles, CA, Jan. 21-23, 1991 Berlin and New York Springer-Verlag 1992 p. 18-28. refs

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In this paper, we derive a near-optimal guidance law for the

10 ASTRONAUTICS

ascent trajectory from Earth surface to Earth orbit of a hypersonic, dual-mode propulsion, lifting vehicle. Of interest are both the optimal flight path and the optimal operation of the propulsion system. The guidance law is developed from the energy-state approximation of the equations of motion. The performance objective is a weighted sum of fuel mass and volume, with the weighting factor selected to give minimum gross take-off weight for a specific payload mass and volume.

A93-54711

HOPE AND ITS THERMAL PROTECTION SYSTEMS

YOSHIKI MORINO (NASDA, Tsukuba Space Center, Japan) *In* International Symposium on Ultra-High Temperature Materials, Tajimi, Japan, Dec. 5, 6, 1991, Proceedings Tajimi, Japan New Energy and Industrial Technology Development Organization 1992 p. 22-36. *In* JAPANESE

HOPE (H-II Orbiting Plane) is an unmanned winged space vehicle which will be launched by the H-II rocket. HOPE will establish technologies for development of the space plane such as rendezvous and docking, deorbiting, reentry, automatic landing technologies, etc. One of the key technologies concerns the development of a lightweight airframe composed of a thermal protection system and heat resistant composite material. Efforts of R&D activities on the HOPE airframe have been concentrated on material development to withstand severe reentry thermal conditions. Polyimide-matrix composite materials and carbon/carbon materials are being studied for application to the main structure. Thermal protection systems being developed to protect the main structure from reentry heating environment include carbon/carbon systems, ceramic tile systems, and titanium multiwall systems. The development status of these candidate systems and materials is reported in this paper. Author (revised)

A93-54804* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

RESEARCH ACTIVITY AT THE SHOCK TUBE FACILITY AT NASA AMES

SURENDRA P. SHARMA (NASA, Ames Research Center, Moffett Field, CA) *In* Strong shock waves; Proceedings of the International Workshop, Chiba, Japan, July 18-20, 1991 Chiba, Japan Chiba University 1992 p. 1-21. refs

The general design and operating conditions of NASA Ames's electric arc drive shock tube facility are described, and the measurements conducted at the facility to support the development of a theoretical model of the effects of chemical nonequilibrium over a hypersonic vehicle are summarized. In particular, attention is given to the results of measurements at a shock velocity of 6.20 km/s in 1 Torr nitrogen and measurements at a shock velocity of 10.2 km/s in 0.1 Torr air. The discussion covers reaction rate measurement, the use of holographic interferometry, and measurements of vibrational populations using Raman scattering.

AIAA

A93-55034

EFFECT OF THE ATMOSPHERE DENSITY GRADIENT ON AERODYNAMIC STABILIZATION [VLIYANIE GRADIENTA PLOTNOSTI ATMOSFERY NA AERODINAMICHESKUYU STABILIZATSIYU]

V. V. BELETSKIY and V. L. KUSHPATOVA Moskovskiy Universitet, Vestnik, Seriya 1 - Matematika, Mekhanika (ISSN 0579-9368) no. 2 Mar.-Apr. 1993 p. 70-73. *In* RUSSIAN refs Copyright

One of the applications of tethered space system may include the deployment of an atmospheric probe, suspended on a long (100 km) tether from the main satellite, for studying the middle layers of the atmosphere and other experiments. The stability of such a system is investigated here for the case of aerodynamic stabilization. In particular, attention is given to the effect of the atmosphere density gradient on the stability of motion in the aerodynamic stabilization regime. The stability conditions are derived, and the regions of instability are defined. AIAA

A93-55825

GUIDANCE AND CONTROL OF HOPE (H-II ORBITING PLANE)

HITOSHI MINENO, TAKAHIRO SUZUKI, and YOSHISADA TAKIZAWA (NASDA, Tsukuba Space Center, Japan) *In* International Space Year in the Pacific basin; Proceedings of the 4th International Space Conference of Pacific-basin Societies, Kyoto, Japan, Nov. 17-20, 1991 San Diego, CA Univelt, Inc. 1992 p. 447-456. refs (AAS PAPER 91-653) Copyright

The National Space Development Agency of Japan (NASDA) has been studying HOPE. Guidance and control technology is one of the most critical technologies to realize HOPE. Studies on guidance and control of HOPE have been done focused on system design and management, navigation, guidance and control, and onboard equipment. The reference configuration and the algorithm of guidance and control system are almost fixed by navigation analyses. We show that the flight path of HOPE can be realized by guidance analyses. A trial model of GCC (Guidance Control Computer), GPSR (GPS Receiver) and MLS (Microwave Landing System) receiver are currently being developed. Several experiments are planned. The MLS flight experiment is explained by an example. Author (revised)

A93-56039

PERFORMANCE ANALYSIS OF A TURBOFAN AS A PART OF AN AIRBREATHING PROPULSION SYSTEM FOR SPACE SHUTTLES

D. A. STEINEBACH, W. KUEHL, and H. E. GALLUS (Aachen, Rheinisch-Westfaelische Technische Hochschule, Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X) vol. 17, no. 2 April 1993 p. 131-138. refs Copyright

This paper presents the results of the design and performance analysis of airbreathing engines for aerospace planes. The analysis is illustrated by introducing an exemplary twin-shaft turbofan engine with post-combustion and bypass-combustion. Some modules of the performance analysis algorithm such as inlet pressure recovery or real gas effects are also presented. The jet engine is designed in view of increasing temperatures at high flight Mach numbers. Hence, the engine design data are dependent on the characteristics of the available materials as well as on the trajectory of the aerospace plane. The results illustrate the strong influence of the real gas effects on the engine thrust particularly in the case of over-stoichiometric combustion of hydrogen. Turbofan engines offer the following advantages in comparison with equivalent turbojet engines: higher thrust performance in supersonic flight range and lower fuel consumption due to operation management of post-combustion and bypass-combustion.

11

CHEMISTRY AND MATERIALS

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

A93-54708

INTERNATIONAL SYMPOSIUM ON ULTRA-HIGH TEMPERATURE MATERIALS, TAJIMI, JAPAN, DEC. 5, 6, 1991, PROCEEDINGS

Tajimi, Japan New Energy and Industrial Technology Development Organization 1992 162 p. *In* Japanese and English. For individual items see A93-54709 to A93-54717

A93-54712

ULTRA-HIGH TEMPERATURE MATERIALS IN THE RESEARCH AND DEVELOPMENT OF SUPER/HYPERSONIC TRANSPORT PROPULSION SYSTEM

KANJI MURASHIMA (Engineering Research Association for

Super/Hyper-Sonic Transport Propulsion System, Japan) *In* International Symposium on Ultra-High Temperature Materials, Tajimi, Japan, Dec. 5, 6, 1991, Proceedings Tajimi, Japan New Energy and Industrial Technology Development Organization 1992 p. 37-45. *In* JAPANESE

In Japan, R&D is being promoted on advanced component and system technologies which will be required for the propulsion system used in the future hypersonic transport at flight speeds of up to Mach five. The necessity for new ultrahigh temperature materials in the engine is described. Author (revised)

A93-54728

STATUS OF R&D OF HIGH-PERFORMANCE MATERIALS FOR SEVERE ENVIRONMENTS (COMPOSITE MATERIALS)

AKIRA SAKAMOTO (Research and Development Inst. of Metals and Composites for Future Industries, Tokyo, Japan) *In* Basic technologies for future industries - High-performance materials for severe environments; Proceedings of the 2nd Symposium, Tokyo, Japan, Nov. 28, 29, 1991 Tokyo Japan Industrial Technology Association 1991 p. 11-16. *In* JAPANESE

The purpose of this project is to develop the basic technologies for advanced materials which can withstand the extremely severe environmental condition inherent to hypersonic aircraft and space planes. The material systems of composite materials under research are C/C composites and titanium-aluminide matrix composites. The goal of the C/C composites program is to develop high performance C/C composites for use at peak temperature of 2000 C. Research activities are being performed on several material systems of C/C composites using various carbon fibers as reinforcement, such as PAN-based and coal tar pitch-based and three kinds of petroleum pitch-based fibers. The program is divided into four categories: improvement of tensile and compressive properties for petroleum pitch-based carbon fibers, matrix precursors for inhibiting oxidation and yielding higher carbonization, fabrication process development of resin-char method and chemical vapor infiltration, and coating systems for oxidation protection.

A93-55032

KINETIC SCHEME SELECTION IN DESCRIBING DETONATION IN AN H₂-AIR MIXTURE BEHIND SHOCK WAVES [K VOPROSU O VYBORE KINETICHESKOJ SKHEMY PRI OPISANII DETONATSII V SMESI H₂ + VOZDUKH ZA UDARNYMI VOLNAMI]

N. G. DAUTOV and A. M. STARIK (Tsentrul'nyj Inst. Aviatcionnogo Motorostroeniya, Moscow, Russia) *Teplofizika Vysokikh Temperatur* (ISSN 0040-3644) vol. 31, no. 2 April 1993 p. 292-301. *In* RUSSIAN refs Copyright

A kinetic scheme is proposed for describing the formation of components affecting changes in ozone concentration in the stratosphere due to the combustion of a hydrogen-air mixture. The possibility of a reduction of the kinetic scheme in describing the combustion process in the wake of shock waves is analyzed. The results are compared with experimental data. AIAA

A93-55697

ANALYSIS OF JET FUEL THERMAL OXIDATION DEPOSITS BY SPECTRAL FLUOROMETRIC TECHNIQUE

JOHN L. BRICE (Alcor, Inc., San Antonio, TX) *Journal of Testing and Evaluation* (ISSN 0090-3973) vol. 21, no. 5 Sept. 1993 p. 422-437. Research supported by Alcor, Inc refs Copyright

The Jet Fuel Thermal Oxidation Test (JFTOT) is a widely used ASTM test procedure that evaluates the thermal stability of a fuel. It is evidenced by the fuel's resistance to undergo any chemical changes during increased thermal oxidative stress, until such time that a thermal breakpoint temperature is reached. A characteristic trace of the fuel is then deposited onto an aluminum test coupon and the fuel is rated on a pass/fail basis relative to industry standards. Current rating systems approved by the industry for evaluating these tube deposit formations often fail to generate repeatable rating results. The required visual inspection of these deposit areas produces considerable uncertainty among many

reviewers (due to a host of uncontrolled variables within the human observer). This paper will focus on the needs of the industry for an improved method of evaluating jet fuel thermal oxidation deposits using laser-induced spectral fluorometry (SF). A novel device for reading these tube deposit areas from the cylindrical surface of an aluminum test coupon will be described as well. The overall technique yields an array of objective criteria for the evaluation of heater tube deposit areas and shows great potential for the identification of individual jet fuels on the basis of their fluorescent profiles.

A93-55871

DAMPED ADVANCED COMPOSITE PARTS

DAVID J. BARRETT (U.S. Navy, Naval Air Development Center, Warminster, PA) and CHRISTOPHER A. ROTZ (Brigham Young Univ., Provo, UT) *In* International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 257-263. refs Copyright

A recently developed method of producing damped parts involves cocuring damping materials and advanced composites into hybrid structural forms. Besides offering an efficient method of construction, the cocuring of damping materials and composites provides new design opportunities. Thus, structural designs can be considered to take advantage of the orthotropic properties of advanced composites to increase the effectiveness of damping treatments. Laminated construction can also offer design options that can lead to improved structural performance. Finally, the flexibility of placing and arranging uncured materials prior to consolidation allows for the design and construction of new laminate architectures with improved stiffness, strength, and structural damping. AIAA

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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.

A93-54356* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN IMPROVED CALIBRATION TECHNIQUE FOR WIND TUNNEL MODEL ATTITUDE SENSORS

JOHN S. TRIPP, DOUGLAS T. WONG, TOM D. FINLEY, and PING TCHENG (NASA, Langley Research Center, Hampton, VA) *In* International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 89-102. refs Copyright

Aerodynamic wind tunnel tests at NASA Langley Research Center (LaRC) require accurate measurement of model attitude. Inertial accelerometer packages have been the primary sensor used to measure model attitude to an accuracy of ± 0.01 deg as required for aerodynamic research. The calibration parameters of the accelerometer package are currently obtained from a seven-point tumble test using a simplified empirical approximation. The inaccuracy due to the approximation exceeds the accuracy requirement as the misalignment angle between the package axis and the model body axis increases beyond 1.4 deg. This paper presents the exact solution derived from the coordinate transformation to eliminate inaccuracy caused by the approximation. In addition, a new calibration procedure is developed in which the data taken from the seven-point tumble test is fit to the exact solution by means of a least-squares estimation procedure.

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Validation tests indicate that the new calibration procedure provides ± 0.005 -deg accuracy over large package misalignments, which is not possible with the current procedure. Author (revised)

A93-54362

DEVELOPMENT OF A DYNAMIC PRESSURE RESPONSE CALIBRATOR

JOSEPH R. MALY and DAVID A. KIENHOLZ (CSA Engineering, Inc., Palo Alto, CA) /In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 185-201. refs

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In response to the need for an improved dynamic pressure response calibrator, a system has been developed for pressure levels ranging to 1.0 psi over the bandwidth of 2-2500 Hz. A prototype calibrator was built that is capable of achieving accurate and controlled pressure for several sensor configurations, including flush-mounted, rake, and tube-type. Controlled pressure can be provided, in sine or random waveform, to a reference transducer and a transducer under test. For the frequency bands of 2-150 Hz and 1600-2400 Hz, acoustic pressure levels of 1.0 psi rms can be attained. The application to acoustic-mechanical systems of a hybrid modeling technique known as admittance modeling is demonstrated. The technique combines test results with finite element analysis; here it is applied for a system with an acoustic pressure source driving various acoustic cavities.

Author (revised)

A93-54366

STATIC AND DYNAMIC ERRORS IN HEAT FLUX MEASUREMENTS

LASZLO I. KISS (Quebec Univ., Chicoutimi, Canada) /In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 255-270. refs

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Systematic errors occur during heat flux measurements due to the design and construction of the heat flux sensor. The presence of the sensor alters the original structure of the test article, often the sensor's additional thermal resistance distorts the temperature and flux field, and its thermal mass affects dynamic response. The response of heat flux sensors depends on the nature of the thermal interaction between the aerothermodynamic flowfield and the solid in which the sensor is installed. Static errors are presented in a dimensionless form for the case of convective flux conditions on the surface. The effect of the type of boundary condition and temperature levels are discussed. Characteristics of the transient response of flux sensors, like 'overshooting' under various conditions are analyzed by numerical simulation.

Author (revised)

A93-54369* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN IMPROVED METHOD FOR DETERMINING FORCE BALANCE CALIBRATION ACCURACY

ALICE T. FERRIS (NASA, Langley Research Center, Hampton, VA) /In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 321-335.

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The results of an improved statistical method used at Langley Research Center for determining and stating the accuracy of a force balance calibration are presented. The application of the method for initial loads, initial load determination, auxiliary loads, primary loads, and proof loads is described. The data analysis is briefly addressed. AIAA

A93-54372* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN OPTICAL FLAMEOUT DETECTION SYSTEM FOR NASA LANGLEY'S 8-FOOT HIGH TEMPERATURE TUNNEL

S. E. BORG, J. W. WEST (NASA, Langley Research Center,

Hampton, VA), R. M. LAWRENCE (Wyle Labs., Hampton, VA), S. E. HARPER, D. W. ALDERFER, and J. M. CONNELLY (NASA, Langley Research Center, Hampton, VA) /In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 371-378. refs

Copyright

A brief description is presented of an optical flameout detection system under development at NASA Langley's 8-Foot High Temperature Wind Tunnel. The system design, theory of operation, and performance are addressed. The system can respond quickly to sudden changes in combustor light intensity and is a reliable indicator of flame activity within the combustor. Deviations of the system could provide more detailed information on various aspects of the combustion process. AIAA

A93-54376

NEW DIGITAL CAPACITIVE MEASUREMENT SYSTEM FOR BLADE CLEARANCES

MARCEL MOENICH (Hytron GmbH, Ober-Ramstadt, Germany) and GILLES BAILLEUL (Philips Electronic Instruments, Norcross, GA) /In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 419-430. refs

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This paper presents a totally new concept for tip blade clearance evaluation in turbine engines. This system is able to detect exact 'measurands' even under high temperature and severe conditions like ionization. The system is based on a heavy duty probe head, a miniaturized thick-film hybrid electronic circuit and a signal processing unit for real time computing. The high frequency individual measurement values are digitally filtered and linearized in real time. The electronic is built in hybrid technology and therefore can be kept extremely small and robust, so that the system can be used on actual flights.

A93-54381

IMPROVED FLOW MEASUREMENT WITH SIMULTANEOUS PERIOD/FREQUENCY RECORDING

BOB G. MAHRENHOLZ (Sverdrup Technology, Inc., Arnold AFB, TN) /In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 481-488. refs

Copyright

Turbine flowmeters typically produce output pulses with the frequency of the pulse stream proportional to the flow rate. Measurement with a frequency counter provides an accurate indication of the average flow rate, but, because of the low frequencies involved, lengthy measurement periods are often required to obtain the desired accuracy. Measurement of the time period between one or more pulses can provide a more rapid readout of the flow rate but the result is subject to large precision errors due to pulse-to-pulse time variations. A new technique has been developed for determining flowmeter pulse rates that preserves both period and frequency information so the raw data may be optimally processed according to the need. This technique allows the same data stream to be long-term averaged for steady-state data points or converted into engineering units at a faster rate for real-time operational display.

A93-54392

UNCERTAINTY ASSESSMENTS FOR ENGINE THRUST DERIVED FROM TWO METHODS

M. F. MULLIGAN, G. B. MACKINTOSH, and J. W. BIRD (National Research Council of Canada, Inst. for Mechanical Engineering, Ottawa) /In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 677-688. refs

Copyright

An alternative simplified method for measuring jet engine gross thrust, referred to as the Real Time Thrust Sensor (RTTS), has

been investigated through a series of calibration and verification tests done in a sea level facility on a turbofan engine. The method, which utilized a set of calibration coefficients, computed gross thrust from pressure measurements made in the engine tailpipe. The coefficients, which relate the tailpipe pressures to the facility gross thrust measurements, were obtained during calibration test runs. This paper describes the results of an analysis that was done to estimate the uncertainty in the measurement of facility and RTTS engine gross thrust as part of an RTTS evaluation program. The estimates were based on specific defined measurement processes (DMPs), which describe the extent and duration of the experiment. Error estimates and influence coefficients (IC) for each elemental measurement are given. Results of the uncertainty assessment are summarized for measurements made at the intermediate rated power (IRP) setting or approximately 10,000 lb(f) thrust. In addition, recommendations are made for improving the assessment in areas where assumptions were made or where it was difficult to determine the errors of some elemental measurements. Author (revised)

A93-54398 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ICING RESEARCH TUNNEL ROTATING BAR CALIBRATION MEASUREMENT SYSTEM

THERESA L. GIBSON (NASA, Lewis Research Center, Cleveland, OH) and JOHN M. DEARMON (Sverdrup Technology, Inc., Brook Park, OH) / In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 889-902. Previously announced in STAR as N93-22598 refs (Contract RTOP 505-68-84) Copyright

In order to measure icing patterns across a test section of the Icing Research Tunnel, an automated rotating bar measurement system was developed at the NASA Lewis Research Center. In comparison with the previously used manual measurement system, this system provides a number of improvements: increased accuracy and repeatability, increased number of data points, reduced tunnel operating time, and improved documentation. The automated system uses a linear variable differential transformer (LVDT) to measure ice accretion. This instrument is driven along the bar by means of an intelligent stepper motor which also controls data recording. This paper describes the rotating bar calibration measurement system.

A93-54402 THERMAL EFFECTS TESTING AT THE NATIONAL SOLAR THERMAL TEST FACILITY

MARK E. RALPH, CHRISTOPHER P. CAMERON (Sandia National Labs., Albuquerque, NM), and CHERYL M. GHANBARI / In International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 961-973. refs (Contract DE-AC04-76DP-00789) Copyright

The National Solar Thermal Test Facility is operated by Sandia National Laboratories and located on Kirtland Air Force Base in Albuquerque, New Mexico. The permanent features of the facility include a heliostat field and associated receiver tower, two solar furnaces, two point-focus parabolic concentrators, and Engine Test Facility. The heliostat field contains 220 computer-controlled mirrors, which reflect concentrated solar energy to test stations on a 61-m tower. The field produces a peak flux density of 250 W/sq cm that is uniform over a 15-cm diameter with a total beam power of over 5 MWt. One solar furnace produces flux levels of 270 W/sq cm over and delivers a 6-mm diameter and total power of 16 kWt. A second furnace produces flux levels up to 1000 W/sq cm over a 4 cm diameter and total power of 60 kWt. Both furnaces include shutters and attenuators that can provide square or shaped pulses. The two 11-m diameter tracking parabolic point-focusing concentrators at the facility can each produce peak flux levels of 1500 W/sq cm over a 2.5-cm diameter and total

power of 75 kWt. High-speed shutters have been used to produce square pulses. Author (revised)

A93-54419 DEVELOPMENT OF COMPUTATIONAL SOLID MECHANICS AND ITS APPLICATION IN AEROSPACE ENGINEERING

YAONAN GONG (Beijing Univ. of Aeronautics and Astronautics, China) Computational Structural Mechanics and Applications (ISSN 1000-3401) vol. 10, no. 2 May 1993 p. 199-209, 218. In CHINESE refs

The foundations and background of the development of the computational solid mechanics (CSM) are discussed, taking the aerospace field as an example. The engineering benefits from the application of CSM are illustrated. In addition, some subjects that should be thoroughly investigated for the further development of CSM are discussed as well. Finally, the future perspective of the development of CSM is briefly examined.

A93-54540 OPTIMIZATION OF SANDWICH STRUCTURES WITH RESPECT TO LOCAL INSTABILITIES WITH MBB-LAGRANGE

W. DOBLER, P. ERL, and H. RAPP (MBB GmbH, Munich, Germany) / In Optimization of large structural systems; Proceedings of the NATO/DFG Advanced Study Institute, Berchtesgaden, Germany, Sept. 23-Oct. 4, 1991. Vol. 2 Dordrecht, Netherlands Kluwer Academic Publishers 1993 p. 951-972. refs Copyright

MBB-LAGRANGE is a powerful optimization code which allows the optimization of structures. To achieve the optimal design of a structure all special requirements must be fulfilled, i.e., constraints, e.g., stress, strains, or displacements have to be in a feasible range while the objective function, e.g., the structural weight reaches a minimum value. The results are strongly dependent on the optimization constraints which must be fulfilled. In this context local and global stability constraints may be essential for the design process. In the continuing development of MBB-LAGRANGE stability constraints are one of the major topics the MBB-LAGRANGE team is busy developing. One topic is the realization of local stability constraints of sandwich structures which are discussed in this paper. The theoretical background and the integration into the optimization code MBB-LAGRANGE are shown. An example of a helicopter sandwich structure demonstrates the influence of this constraint type in the design process while optimal results are found. These results satisfy all requirements: local stability, stress, and dynamic constraints. Author (revised)

A93-54544 OPTIMIZATION OF LARGE SCALE SYSTEMS IN ELASTICITY

E. SCHNACK and G. IANCU (Karlsruhe Univ., Germany) / In Optimization of large structural systems; Proceedings of the NATO/DFG Advanced Study Institute, Berchtesgaden, Germany, Sept. 23-Oct. 4, 1991. Vol. 2 Dordrecht, Netherlands Kluwer Academic Publishers 1993 p. 1073-1086. refs Copyright

Using the present procedure optimal stress designs have been computed in the last 13 years for 2D, axisymmetric and whole 3D structures. Constraints on the variation of the boundary are considered in form of linear equations. The sensitivity behavior for elastic structures can be predicted from the physical background which gives information about the influence of geometrical properties on the stress field at each point on a traction-free surface. In comparison with sensitivity methods, irregular boundaries can be avoided here by a priori introducing a smoothing operator. The iterative nongradient procedure is realized in 2D and 3D software packages which give the possibility, for example, to analyze practical mechanical engineering problems like rotor masts of helicopters or connecting rods treated as a 3D structure. Author (revised)

A93-54608# STRUCTURAL ANALYSIS OF THE LIGHT WEIGHT HARD NOSE OF THE 71M AEROSTAT

JOHN D. HUNT (TCOM L.P., Columbia, MD) / In AIAA

12 ENGINEERING

Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 43-48.

(AIAA PAPER 93-4037) Copyright

A new light weight hard nose structure has been developed for the 71 meter aerostat. This structure is much lighter and more efficient than the existing hard nose structure with battens. Advantages include reduced complexity, reduced cost, and simplified aerostat installation. This paper presents static and dynamic structural analysis which was performed to determine deflections, loads, and stresses under various survival and operational turbulent winds.

A93-54626

ROTATING MACHINERY - TRANSPORT PHENOMENA; PROCEEDINGS OF THE 3RD INTERNATIONAL SYMPOSIUM ON TRANSPORT PHENOMENA AND DYNAMICS OF ROTATING MACHINERY (ISROMAC-3), HONOLULU, HI, APR. 1-4, 1990

J. H. KIM, ED. (EPRI, Palo Alto, CA) and W.-J. YANG, ED. (Michigan Univ., Ann Arbor) Bristol, PA Hemisphere Publishing Corp. 1992 759 p. For individual items see A93-54627 to A93-54648 (ISBN 1-56032-147-4) Copyright

Topics discussed in these proceedings include turbine cooling heat transfer, rotating surfaces, curved ducts and rotating channels, flow in pumps, analytical and numerical methods, design and design methods, and multiphase flow and cavitation. Papers are presented on transient heat analysis of stator in air-cooled turbine generators, numerical evaluation of single central jet for turbine disk cooling, film condensation on a rotating cone, flows of a gas in an abruptly rotating cylinder, developing turbulent flow in a curved duct with strong secondary motion, effects of turn region treatments on pressure loss through sharp 180-deg bends, and examination of inlet surging in centrifugal pumps. Particular attention is given to the prediction of viscous flows in rotating machinery using Navier-Stokes techniques, two-dimensional transonic flow around VKI turbine cascade, the dynamic transfer matrix of a pump and its use in pumping system design, a fast CAE/CAD procedure for the optimum design of arbitrary impellers, particle dynamics and erosion in radial turbine guide vanes, sustained oscillations of pumped two-phase flow in a closed loop, and rotor/stator flow coupling in turbomachines. AIAA

A93-54633

HEAT TRANSFER IN A FIVE-PASS IRREGULAR CHANNEL WITH AND WITHOUT PIN-FINS

YUMING ZHANG, WEIZAO GU (Chinese Academy of Sciences, Inst. of Engineering Thermophysics, Beijing, China), and J. C. HAN (Texas A & M Univ., College Station) *In* Rotating machinery - Transport phenomena; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 121-128. Research supported by NNSFC refs Copyright

Heat transfer was studied in a five-pass irregular channel with and without pin-fins. The five-pass irregular channel included one diverging two trapezoid and two rectangular channels connected in series by four 180-deg bends. The flow Reynolds number was varied between 6,000 and 40,000. In the case of without pin-fins, heat transfer data in the second to the fifth-pass, due to the effect of 180-deg bends, are 10-100 percent higher than the corresponding straight-through tube results, depending upon the Reynolds number. For the case of with a single row of pin-fins, heat transfer augmentation in each of five-pass and 180-deg bends due to the effect of pin-fins is about 10-60 percent depending upon the passage geometry and Reynolds number. The effects of 180-deg bends and pin-fins on heat transfer enhancement diminish with increasing Reynolds number. Author (revised)

A93-54634

PREDICTION OF ROTATING DISC FLOW AND HEAT TRANSFER IN GAS TURBINE ENGINES

JOHN W. CHEW (Rolls-Royce, PLC, Derby, United Kingdom) *In* Rotating machinery - Transport phenomena; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 145-160. Research supported by Rolls-Royce, PLC refs Copyright

Motivated by the need to improve design techniques for aero engines considerable effort has been put into developing predictive techniques for rotating disc flow and heat transfer. Some notable advances have been made recently and these are reviewed here. The theoretical techniques employed include analytical solutions for laminar flow, momentum-integral methods for turbulent flow, and finite difference solutions of the Reynolds-averaged Navier-Stokes equations. Each of these methods is discussed and predictive capability is illustrated through comparisons with experimental data.

A93-54636

EFFECTS OF TURN REGION TREATMENTS ON PRESSURE LOSS THROUGH SHARP 180-DEGREE BENDS

C. W. PLEVICH and D. E. METZGER (Arizona State Univ., Tempe) *In* Rotating machinery - Transport phenomena; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 301-312. refs Copyright

An experimental study was conducted to evaluate the effect of geometric turn region inserts on pressure losses for flow through sharp 180-degree channel turns typical of internal cooling passages in gas turbine engine airfoils. The experiments were conducted in a rectangular cross-sectioned channel with 90-degree transverse rib roughening in both inlet and outlet legs, starting with completely smooth turn regions and progressing through various modifications including corner fillets, radial ribs, and turning vanes. The results show that modifications to the turn region geometry, particularly the inclusion of a single semi-circular turning vane, significantly reduce the pressure losses associated with coolant flows through sharp 180-degree turns and therefore can result in increased coolant flow for a given coolant supply pressure.

A93-54648

PERFORMANCE SIMULATION OF A COMBUSTION ENGINE CHARGED BY A VARIABLE GEOMETRY TURBOCHARGER. I - PREREQUIREMENTS, BOUNDARY CONDITIONS AND MODEL DEVELOPMENT. II - SIMULATION ALGORITHM, COMPUTED RESULTS

M. MALOBABIC, W. BUTTSCHARDT, and M. RAUTENBERG (Hannover, Univ., Hanover, Germany) *In* Rotating machinery - Transport phenomena; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 695-726. refs Copyright

The paper presents a theoretical derivation of the relationship between a variable geometry turbocharger and the combustion engine, using simplified boundary conditions and model restraints and taking into account the combustion process itself as well as the nonadiabatic operating conditions for the turbine and the compressor. The simulation algorithm is described, and the results computed using this algorithm are compared with measurements performed on a test engine in combination with a controllable turbocharger with adjustable turbine inlet guide vanes. In addition, the results of theoretical parameter studies are presented, which include the simulation of a given turbocharger with variable geometry in combination with different sized combustion engines and the simulation of different sized variable-geometry turbochargers in combination with a given combustion engine.

AIAA

A93-54649

THE USE OF BEAM-LIKE MODAL DATA FOR STIFFNESS PROFILE ESTIMATION BY THE EBS METHOD. I - JUSTIFICATION AND IMPLEMENTATION

T. A. VEST and M. S. DARLOW (Rensselaer Polytechnic Inst., Troy, NY) /In Rotating machinery dynamics New York American Society of Mechanical Engineers 1989 p. 51-56. refs Copyright

Thomas and Littlewood (1980) introduced a novel technique in which the effective stiffness profile of a freely suspended rotor could be estimated by applying the Euler-Bernoulli beam equation to the measured lateral vibration mode shapes. By determining the associated diameters from this profile and using them to replace the ones taken from sectional data in a computer model, significant improvements in the agreement of computed and measured nonrotating natural frequencies resulted. It is believed that the technique has great promise, but needs to be recast in a more generally applicable form. Here, the equivalent beam stiffness method is presented which is related to the previous technique but is based upon the more generally accepted Timoshenko beam theory which incorporates the effects of transverse, often called rotary, inertia and shear. Additional improvement is provided by using a piecewise continuous description of the mass and inertia properties, which are assumed correct, rather than the purely lumped-mass representation used previously. Although the process becomes much more involved numerically when these improvements are implemented, their inclusion is quantitatively justified and the procedure is shown to remain a readily programmed direct procedure. To demonstrate the superiority of the method, the extraction of the bending stiffness of a thick uniform shaft is used as a simple comparison. Author (revised)

A93-54651

ROTATING MACHINERY - DYNAMICS; PROCEEDINGS OF THE 3RD INTERNATIONAL SYMPOSIUM ON TRANSPORT PHENOMENA AND DYNAMICS OF ROTATING MACHINERY (ISROMAC-3), HONOLULU, HI, APR. 1-4, 1990

J. H. KIM, ED. (EPRI, Palo Alto, CA) and W.-J. YANG, ED. (Michigan Univ., Ann Arbor) Bristol, PA Hemisphere Publishing Corp. 1992 753 p. For individual items see A93-54652 to A93-54675 (ISBN 1-56032-147-4) Copyright

Topics addressed include rotordynamic software, blade loss dynamics of a magnetically supported rotor, flow visualization in a single simulated brush seal, an analytical investigation of a cryogenic journal bearing, vibration protection of aeration turbine gear motor, a simple procedure for assessing rotor stability, and stability of rotating cylindrical shells including nonlinear stiffening. Attention is also given to aeroelastic analysis of vertical axis wind turbines, an active chamber system for vibration control of rotating machinery, a computer system for multibearing rotor design, equations of motion of a flexible rotor with axially loose disc, and simulation research on the dynamic characteristics of a steam-injected gas turbine. AIAA

A93-54653

BLADE LOSS DYNAMICS OF A MAGNETICALLY SUPPORTED ROTOR

F. VIGGIANO and G. SCHWEITZER (Zuerich, Eidgenoessische Technische Hochschule, Zurich, Switzerland) /In Rotating machinery - Dynamics; Proceedings of the 3rd International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), Honolulu, HI, Apr. 1-4, 1990 Bristol, PA Hemisphere Publishing Corp. 1992 p. 53-68. refs Copyright

The equations for a rigid rotor in magnetic bearings are derived and examined for their response following a sudden unbalance created by a blade loss. The investigations concentrate on the maximum transient and steady-state response after unbalance. The analytical results are compared with experiments which were performed on a magnetic bearing test stand at our laboratory. A major result is that magnetic bearings are very well suited to cope with the loss of a rotor blade.

A93-54799

STUDY OF ARTIFICIAL AND NATURAL TURBULENCE IN ATMOSPHERIC BOUNDARY LAYER WITH A CW DOPPLER CO2 LIDAR

S. A. AKHMANOV (Moscow State Univ., Russia), A. P. GAL'TSEV (Inst. of Aircraft Equipment, Zhukovski, Russia), V. M. GORDIENKO (Moscow State Univ., Russia), L. A. KOSOVSKIY (Inst. of Aircraft Equipment, Zhukovski, Russia), N. N. KUROCHKIN (Moscow State Univ., Russia), G. A. POGOSOV (Inst. of Aircraft Equipment, Zhukovski, Russia), A. V. PRIEZZHEV (Moscow State Univ., Russia), and A. P. SHUSTOV (Inst. of Aircraft Equipment, Zhukovski, Russia) /In Laser radar VII: Advanced technology for applications; Proceedings of the Meeting, Los Angeles, CA, Jan. 23, 24, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 317-320. refs Copyright

An examination is conducted of the feasibility of using a Doppler lidar (DL) to detect artificially generated vortices, such as those due to aircraft drag-due-to-lift, and clearly distinguish them from natural gusts and turbulence on the basis of the C(V)-squared constant's magnitude. Both experimental and theoretical results are presented for DL performance; the intersection of the probing DL beam with the aircraft vortex generated a satisfactory Doppler signal whose S/N decreased with increasing distance to the passing aircraft. AIAA

A93-54840

PRESENCE AND FUTURE OF THE ELECTRO-CHEMICAL PROCESSES IN AERO-ENGINE PRODUCTION [STAND UND AUSSICHTEN DER ELEKTROCHEMISCHEN BEARBEITUNGSVERFAHREN IN DER FERTIGUNG VON FLUGTRIEBWERKEN]

PETER ADAM MTU Focus (ISSN 0935-8099) no. 1 1993 p. 15-19. In GERMAN Copyright

The paper reviews the state-of-the-art in applications of electrochemical machining (ECM) and electrochemical drilling (EC-drilling). It concerns nickel-base and titanium-base alloys as well. Recent development in titanium alloy based compressors in gas turbines for flight application make ECM more attractive again. EC-drilling processes remain on their firm place in yielding exclusively shaped holes, long but small diameter holes, inclined hole entrances and crack-free surfaces.

A93-54843

LASER AND SKILL ENHANCE RESULTS

PETER ADAM MTU Report (ISSN 0942-8267) no. 1 1993 p. 30, 31.

The laser-drilling method presently discussed for aircraft gas turbine air-cooled hot-section component fabrication is able to deliver beam pulses with power densities of $10 \exp 7$ W/cm² and duration. Such pulses are able to not only melt, but partially vaporize and eject the target material; material removal rates are of the order of 0.35 mm/sec. A turbine blade with a total of 142 laser-drilled holes underwent complete processing in only 21 min. Actual hole-drilling time was only 9.2 min. AIAA

A93-54894

NDT FOR CORROSION IN AEROSPACE STRUCTURES; PROCEEDINGS OF THE CONFERENCE, LONDON, UNITED KINGDOM, FEB. 12, 1992

London Royal Aeronautical Society 1992 58 p. For individual items see A93-54895 to A93-54900 (ISBN 0-903409-99-2) Copyright

The papers presented in this volume provide an overview of recent developments in nondestructive testing for corrosion in aerospace structures, with particular attention given to the effect of corrosion on fatigue initiation and damage protection. Specific topics discussed include the enhancement of conventional NDT method for corrosion detection in layered skins, inspection of aeronautical-structures using transient thermography, assessment of NDT reliability, and a review of NDT techniques. AIAA

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A93-54896

THE USE OF NON-DESTRUCTIVE TESTING TO DETECT AND MONITOR AIRCRAFT CORROSION IN SERVICE

M. WELBURN (RAF, Central Servicing Development Establishment, United Kingdom) /In NDT for corrosion in aerospace structures; Proceedings of the Conference, London, United Kingdom, Feb. 12, 1992 London Royal Aeronautical Society 1992 p. 3.1-3.4.

Copyright

The nondestructive testing methods that are commonly used by the testing operator to detect corrosion in an aircraft are reviewed. In particular, attention is given to visual inspection using remote video visual aids, penetrant flaw detection, magnetic particle inspection, eddy current flaw detection techniques, ultrasonic flaw detection, mechanical impedance analysis, radiography, and the use of a combination of techniques. The discussion also covers a general approach to the monitoring of defects and future trends in corrosion prevention and detection. AIAA

A93-54897

NDT FOR CORROSION IN AEROSPACE STRUCTURES - A REVIEW OF NDT TECHNIQUES

DAVID A. BRUCE (Defence Research Agency, Materials and Structures Dept., Farnborough, United Kingdom) /In NDT for corrosion in aerospace structures; Proceedings of the Conference, London, United Kingdom, Feb. 12, 1992 London Royal Aeronautical Society 1992 p. 4.1-4.13. refs

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The NDT techniques used for the detection of corrosion in aircraft structures are reviewed with emphasis on the capabilities of the available methods and their limitations in typical aircraft applications. The principal problems arising in corrosion detection are identified, with particular attention given to the particular needs of the aircraft industry. The nondestructive testing techniques discussed include X-ray and neutron radiography, ultrasonic thickness measurement, ultrasonic amplitude measurement, eddy current techniques, thermography, acoustic emission, and optical methods. Some future trends and requirements are summarized. AIAA

A93-54898

ENHANCEMENT OF CONVENTIONAL NDT METHODS FOR CORROSION DETECTION IN LAYERED SKINS

ROBERT A. SMITH (Defence Research Agency, Aerospace Div., Farnborough, United Kingdom) /In NDT for corrosion in aerospace structures; Proceedings of the Conference, London, United Kingdom, Feb. 12, 1992 London Royal Aeronautical Society 1992 p. 5.1-5.13. refs

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A VC10 lap-joint panel with suspected early corrosion was inspected using several nondestructive testing techniques, and the results obtained were compared with those of a destructive inspection of the panel. Conventional X-radiography failed to show any material loss due to corrosion. Penetrant-enhanced X-radiography produced good images of corrosion products, but its application is limited to areas where the penetrant can be injected. Eddy currents were able to detect material loss due to corrosion, but there were difficulties isolating this from the effects due to structural inhomogeneities. Ultrasonic methods using portable equipment were able to produce accurate two-dimensional maps of voids and disbonds between layers. Further improvements to the techniques examined are proposed. AIAA

A93-54899

THE INSPECTION OF AERONAUTICAL STRUCTURES USING TRANSIENT THERMOGRAPHY

CHRIS HOBBS (AEA Technology, Harwell Lab., Didcot, United Kingdom) /In NDT for corrosion in aerospace structures; Proceedings of the Conference, London, United Kingdom, Feb. 12, 1992 London Royal Aeronautical Society 1992 p. 6.1-6.10. Research supported by ESA and AEA Technology refs

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The principles of transient thermography and the equipment required are reviewed in relation to the inspection of aircraft for corrosion. Examples are presented to show how transient thermography can produce a single pictorial representation of the available information. The capability of the technique to detect corrosion is demonstrated with reference to a specific example of lap-joint inspection performed on an aircraft during scheduled maintenance. Plans for the use of the technique for the routine screening of large areas at high speed, thereby providing for more cost-effective NDT, are discussed. AIAA

A93-54900

ASSESSMENT OF NDT RELIABILITY

R. L. SMITH, C. WAITES, and R. MURGATROYD (AEA Technology, Harwell Lab., Didcot, United Kingdom) /In NDT for corrosion in aerospace structures; Proceedings of the Conference, London, United Kingdom, Feb. 12, 1992 London Royal Aeronautical Society 1992 p. 8.1-8.5. refs

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Recent incidents in the commercial aircraft industry have raised doubts over the reliability of NDT techniques to detect cracking and corrosion. While new technology generally improves sensitivity of detection techniques it is essential that they can be shown to have the appropriate detection reliability in actual use. This paper discusses the methods applied for assessing reliability and compares the approaches being adopted in the nuclear and aerospace industries.

A93-55018

PRESSURE FIELD AND DRAG OF A SINGLE CAVITY WITH ROUNDED AND SHARP EDGES [POLE DAVLENIJ I SOPROTVLENIE ODINOCHNOJ LUNKI S OSTRYMI I SKRUGLENNYMI KROMKAMI]

V. I. TEREKHOV, S. V. KALININA, and YU. M. MSHVIDOBADZE PMTF - Prikladnaya Mekhanika i Tekhnicheskaya Fizika (ISSN 0869-5032) vol. 34, no. 3 May-June 1993 p. 40-49. In RUSSIAN refs

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The paper is concerned with flow in cavities in the form of spherical segments, which are believed to increase heat transfer. In particular, experimental results are presented for single cavities of varying depth with sharp and rounded edges. Emphasis is placed on flow directly inside the cavity. Detailed results are presented on pressure fields and flow drag in the cavity; the structure of the flow is described with reference to visual observations. AIAA

A93-55295

FUTURE TRENDS IN IR SENSORS

H. M. LAMBERTON (Defence Research Agency, Electronics Div., Malvern, United Kingdom) /In IR sensors; Proceedings of the Conference, London, United Kingdom, Feb. 18, 1992 London Royal Aeronautical Society 1992 p. 1.1-1.5. refs

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New developments in IR detector physics and laser radar are discussed together with examples of research systems now being flown to illustrate technology which will be available for future avionic systems. It is concluded that future avionic systems will be based on large 2D arrays of cooled IR detectors, initially in the 3-5 microns band (PtSi, InSb, and CMT) and later in the 8-12 microns band. Various active and passive components of coherent laser systems based on eye safe CO₂ lasers will be combined into multisensor systems capable of performing multiple roles. AIAA

A93-55369

UNCERTAINTY ESTIMATES FOR PRESSURE SENSITIVE PAINT MEASUREMENTS

MIKLOS SAJBEN (McDonnell Douglas Aerospace, Saint Louis, MO) AIAA Journal (ISSN 0001-1452) vol. 31, no. 11 Nov. 1993 p. 2105-2110. Research supported by McDonnell Douglas Independent Research and Development Program refs

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A recently introduced surface pressure measurement technique

for aerodynamic applications uses pressure sensitive luminescent coatings. The primary measurable is luminescent light intensity, but the determination of pressure also requires the measurement of other variables, such as a reference light intensity and surface temperatures. Each of the primary measurables is associated with an error that contributes to the uncertainty of the pressure computed from all inputs. This paper investigates these contributions to the resultant uncertainty, both in fundamental terms and in terms of commonly used wind tunnel parameters. The uncertainty is sharply dependent on both freestream and local flow conditions, such that a simple global characterization of error magnitude does not seem to be practical. Spatial surface temperature variations and temperature differences between reference and run conditions may significantly affect the results.

A93-55459

LOCAL HEAT TRANSFER DISTRIBUTION IN A ROTATING SERPENTINE RIB-ROUGHENED FLOW PASSAGE

N. ZHANG, J. CHIOU, S. FANN, and W.-J. YANG (Michigan Univ., Ann Arbor) ASME, Transactions, Journal of Heat Transfer (ISSN 0022-1481) vol. 115, no. 3 Aug. 1993 p. 560-567. Research supported by EPRI refs
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Experiments are performed to determine the local heat transfer performance in a rotating serpentine passage with rib-roughened surfaces. The ribs are placed on the trailing and leading walls in a corresponding posited arrangement with an angle of attack of 90 deg. The rib height-to-hydraulic diameter ratio, $e/D(h)$, is 0.0787, and the rib pitch-to-height ratio, s/e , is 11. The throughflow Reynolds number is varied, typically at 23,000, 47,000, and 70,000 in the passage both at rest and in rotation. In the rotation cases, the rotation number is varied from 0.023 to 0.0594. Results for the rib-roughened serpentine passages are compared with those of smooth ones in the literature. Comparison is also made on results for the rib-roughened passages between the stationary and rotating cases. It is disclosed that a significant enhancement is achieved in the heat transfer in both the stationary and rotating cases resulting from an installation of the ribs. Both the rotation and Rayleigh numbers play important roles in the heat transfer performance on both the trailing and leading walls. Although the Reynolds number strongly influences the Nusselt numbers in the rib-roughened passage of both the stationary and rotating cases, $Nu(0)$ and Nu , respectively, it has little effect on their ratio $Nu/Nu(0)$.
Author (revised)

A93-55465

CONJUGATE MODELING OF HIGH-TEMPERATURE NOSECAP AND WING LEADING EDGE HEAT PIPES

Y. CAO and A. FAGHRI (Wright State Univ., Dayton, OH) ASME, Transactions, Journal of Heat Transfer (ISSN 0022-1481) vol. 115, no. 3 Aug. 1993 p. 819-822. ASME, Winter Annual Meeting, Anaheim, CA, Nov. 8-13, 1992 refs
Copyright

A generalized finite-difference computational methodology is developed to model the transient and steady-state behavior of high-temperature nosecap and leading edge heat pipes. The numerical simulation includes a consideration of capillary and sonic limits in the wick structures. The results demonstrate the validity of the proposed methodology. AIAA

A93-55585

THE CRACK INITIATION APPROACH FOR DURABILITY ANALYSIS

BIN-JUN FEI, WEN-TING LIU, and JUN-JIANG XIONG (Beijing Univ. of Aeronautics and Astronautics, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 1 Feb. 1993 p. 32-36. Transl. of Acta Aeronautica et Astronautica Sinica, vol. 13, no. 3, Mar. 1992, p. A182-A186. Previously cited in issue 20, p. 3570, Accession no. A92-47663 refs
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A93-55586

DYNAMIC ANALYSIS OF ANNULAR CASCADE STRUCTURES

JIN ZHANG (Beijing Univ. of Aeronautics and Astronautics, China), WEN-LIANG WANG (Fudan Univ., Shanghai, China), XIANG-JUN CHEN, and JUN ZANG (Wuxi Aeroengine Inst., China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 1 Feb. 1993 p. 37-41. Transl. of Acta Aeronautica et Astronautica Sinica, vol. 12, Sept. 1991, p. A474-A481. Previously cited in issue 10, p. 1629, Accession no. A92-27856 refs
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A93-55674* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EFFECT OF BOUNDARY CONDITIONS AND PANEL GEOMETRY ON THE RESPONSE OF LAMINATED PANELS SUBJECTED TO TRANSVERSE PRESSURE LOADS

DAWN C. JEGLEY (NASA, Langley Research Center, Hampton, VA) Jun. 1993 12 p. ASCE, ASME, and SES, Joint Conference, Charlottesville, VA, June 6-9, 1993, Paper refs

The behavior of thin laminated flat and curved panels subjected to transverse pressure and inplane loads is considered. The effects of panel geometry, boundary conditions and laminate stacking sequence on the response of panels subjected to transverse pressure loads up to 12.4 N/sq cm is presented. The response of thin laminated panels is evaluated analytically and selected results are compared with test data. A parametric study of the deformation and strain responses of panels with radius of curvature ranging from 20 to 305 cm is presented. The combination of inplane tensile and pressure loads is also considered.

Author (revised)

A93-55756

SURFACE EMITTING LASERS FOR AVIONICS APPLICATIONS

S. C. WANG, T. G. DZIURA, and Y. J. YANG (Lockheed Research Labs., Palo Alto, CA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985) vol. 8, no. 8 Aug. 1993 p. 39-43. IEEE, NAECON '93 - National Aerospace and Electronics Conference, Dayton, OH, May 24-28, 1993 Research supported by USAF and DARPA refs
Copyright

Vertical cavity surface emitting lasers offer many features that are suitable for applications in optical interconnect, optical data bus, optical backplane, and optical signal processing. The authors describe basic device structure and fabrication techniques of GaAs-based vertical cavity surface emitting lasers and discuss key laser performance characteristics such as emission wavelength, beam pattern, threshold current, power output, quantum efficiency, and modulation response that are important to these potential applications. Recent results on monolithic integration of the laser with an n-channel MESFET driver are described.

A93-55851* National Aeronautics and Space Administration, Washington, DC.

INTERNATIONAL CONGRESS ON RECENT DEVELOPMENTS IN AIR- AND STRUCTURE-BORNE SOUND AND VIBRATION, 2ND, AUBURN UNIV., AL, MAR. 4-6, 1992, PROCEEDINGS. VOLS. 1-3

MALCOLM J. CROCKER, ED. and P. K. RAJU, ED. (Auburn Univ., AL) Auburn, AL Auburn University 1992 p. Vol. 1, 634 p.; vol. 2, 492 p.; vol. 3, 652 p. For individual items see A93-55852 to A93-55928
Copyright

The papers presented in this volume cover a variety of topics, including sound intensity, structural intensity, modal analysis and synthesis, statistical energy analysis and energy methods, passive and active damping, and boundary element methods. Attention is also given to diagnostics and condition monitoring, material characterization and nondestructive evaluation, active noise and vibration control, sound radiation and scattering, and finite element analysis. AIAA

A93-55866

PASSIVE DAMPING TECHNOLOGY

ERIC M. AUSTIN and CONOR D. JOHNSON (CSA Engineering, Inc., Palo Alto, CA) In International Congress on Recent

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Developments in Air- and Structure-Borne Sound and Vibration, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 181-188. refs
Copyright

This paper presents a brief review of techniques for designed-in passive damping for noise and vibration control. Designed-in passive damping for structures is usually based on one of four damping technologies: viscoelastic materials, viscous fluids, magnetics, or passive piezoelectrics. These methods are discussed and compared. The technology of using viscoelastic materials for passive damping is discussed in more detail than the other methods since it is presently the most applicable for surface treatments for noise control. Testing and characterization of viscoelastic materials and design methods for passive damping are discussed. An example showing the benefits of a passive damping treatment for an acoustic problem is presented.

A93-55869

DAMPING IN AEROSPACE COMPOSITE MATERIALS

A. AGNENI, L. BALIS CREMA, and A. CASTELLANI (Roma I, Univ., Rome, Italy) /In International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 237-248. refs
(Contract CNR-CTB-90,01960,11)
Copyright

Experimental results are presented on specimens of carbon and Kevlar fibers in epoxy resin, materials used in many aerospace structures (control surfaces and wings in aircraft, large antennas in spacecraft, etc.). Some experimental methods of estimating damping ratios are first reviewed, either in the time domain or in the frequency domain. Some damping factor estimates from experimental tests are then shown; in order to evaluate the effects of the aerospace environment, damping factors have been obtained in a typical range of temperature, namely between +120 C and -120 C, and in the pressure range from room pressure to 10 exp -6 torr. Finally, a theoretical approach for predicting the bounds of the damping coefficients is shown, and prediction data are compared with experimental results.

A93-55874

HUMAN ENGINEERING ISSUES FOR DATA LINK SYSTEMS

VINCENT J. LEVRAEA and LYNN C. ROGERS (USAF, Wright-Patterson AFB, OH) /In International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 287-294. refs
Copyright

The purpose of this investigation was to develop candidate add-on damping treatments for the F-15 upper-outer wing skin. The upper-outer wing skin has experienced high cycle fatigue cracks caused by separated flow on the upper wing surface. The separated flow results during high load factor maneuvers and in turn, induces large vibratory loads on the upper wing skin and associated substructure. Damage accumulates due to the resonant vibration of local skin/stiffener modes. Two damping treatments resulted from the investigation. One was an external constrained-layer treatment and the other was an internal 'stand-off' treatment. Estimates of the life extension factors for the external and internal damping treatments were 5 and 34 respectively.

A93-55996

EFFECTS OF FOUNDATION EXCITATION ON MULTIPLE RUB INTERACTIONS IN TURBOMACHINERY

F. K. CHOY, J. PADOVAN, and W. QIAN (Akron Univ., OH) Journal of Sound and Vibration (ISSN 0022-460X) vol. 164, no. 2 June 22, 1993 p. 349-363. Research supported by Univ. of Akron refs
Copyright

The development of a comprehensive cost-effective approach to simulate the overall dynamics of a multilevel rotor-bearing-casing system undergoing extreme events is discussed, with special attention paid to the development of a numerical model for multiple

rub site interactions. The dynamics involved in a multiple rub event on a prototypical hardware configuration subject to parametric design variations is demonstrated. It is found that the shifting of an intermittent bouncing rub to a continuous rub will substantially decrease the maximum rub force at the rub sites. For a particular system configuration, multiple location rubs will tend to decrease the maximum rub force from that of a single rub site. The onset of multiple and single location rubs can be controlled by a variety of system parameters, such as blade/casing stiffness, rub site clearances, unbalance/base-motion excitations, and the stiffness/damping of the system. AIAA

A93-56331

THE EFFECT OF TEMPERATURE ON THE NATURAL FREQUENCIES AND ACOUSTICALLY INDUCED STRAINS IN CFRP PLATES

S. C. P. GALEA (Defence Science and Technology Organisation, Aeronautical Research Lab., Melbourne, Australia) and R. G. WHITE (Southampton Univ., United Kingdom) Journal of Sound and Vibration (ISSN 0022-460X) vol. 164, no. 3 July 8, 1993 p. 399-424. Research sponsored by Royal Aircraft Establishment of the United Kingdom refs
Copyright

The effects of temperature on the dynamic response of thin CFRP plates has been investigated by using the finite element method. Resonance frequencies of clamped CFRP plates were then measured, under various spatially varying temperature fields, and compared with results predicted by using a simple finite element model. An extensive experimental investigation of the effects of thermal/acoustic environments on acoustically induced strains in CFRP plates was undertaken. These experimentally determined strains were then compared with those predicted using a simple single-mode formula.

A93-56339

ON THE ANALYSIS OF AN IMPINGING JET ON GROUND EFFECTS

J. M. M. BARATA, D. F. G. DURAO, M. V. HEITOR (Lisbon Technical Univ., Portugal), and J. J. MCGUIRK (Loughborough Univ. of Technology, United Kingdom) Experiments in Fluids (ISSN 0723-4864) vol. 15, no. 2 1993 p. 117-129. Research supported by Ministry of Defence Procurement Executive refs
Copyright

Laser Doppler measurements and flow visualization are presented for a turbulent circular jet emerging into a low-velocity cross-stream and, then, impinging on a flat surface perpendicular to the jet-nozzle axis. The results, which have relevance to flows found beneath VSTOL aircraft in ground effect, show the presence of a complex 3D scarf vortex formed around the impinging jet. In zones where measurement data are not available, the flow details are numerically visualized using a solution of the finite difference form of the fully three-dimensional Reynolds-averaged Navier-Stokes equations incorporating the turbulence viscosity concept. The turbulent structure of the flow is affected by flow distortion at the impinging zone, which results in an unconventional behavior of the dimensionless structure parameters that determine the empirical constants in engineering models of turbulence. The relative magnitude of the terms involved in the transport equations for the turbulent stresses is quantified from the experimental data in order to assess the importance of these effects and show the extent to which the turbulent structure of the impingement zone is affected by extra rates of strain. Author (revised)

A93-56544

FATIGUE LIFE UNDER RANDOM LOAD HISTORY DERIVED FROM EXCEEDANCE CURVES USING DIFFERENT ALGORITHMS

RAGHU V. PRAKASH (Indian Inst. of Science, Bangalore, India) and R. SUNDER (National Aeronautical Lab., Bangalore, India) Fatigue & Fracture of Engineering Materials & Structures (ISSN 8756-758X) vol. 16, no. 7 July 1993 p. 707-721. refs
Copyright

Low cycle fatigue life and crack growth rates were analytically

estimated for random load sequences, generated from three combat aircraft load exceedance curves using different algorithms, including simulated rainflow cycle count, extreme-to-extreme excursions, upper to lower bound excursions and unrestricted peak-trough excursions. Also, the response of a fatigue meter to a random load sequence was simulated. Fatigue damage for the different load histories was computed using material constants for an Al-Cu alloy. Computed fatigue damage was relatively insensitive to the algorithm used for load sequence generation from combat aircraft load exceedance curves. Fatigue meter data based damage estimates were, however, sometimes unconservative.

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GEOSCIENCES

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

A93-54719

HELICOPTER NOISE - PUBLIC PERSPECTIVE

JOHN SIMSON and PAUL FREEBORN (Rendel Science and Environment, Ltd., London, United Kingdom) /n The quiet helicopter; Proceedings of the Conference, London, United Kingdom, Mar. 17, 1992 London Royal Aeronautical Society 1992 p. 1.1-1.7. refs

Copyright

Public response to the news of the development of a new helicopter facility seems to be dominated by a fear of uncontrolled expansion of operations, and the accompanying noise, which is fed by an apparent inability of the various technical experts to prove the likely impact in real terms. This paper presents examples showing that individual noise impacts on specific sensitive locations can be determined using a variety of different criteria and techniques. It is shown that helicopters can operate from city centers without causing unreasonable environmental deterioration, if proper management and control measures are put in place at the outset. It is the task of the acoustic experts to demonstrate to the public that the criteria used in noise determination properly reflect the expected noise disbenefit, and it is the task of the operators to demonstrate that the control measures used will be effective and auditable.

AIAA

A93-56236

NO(Y) FROM SUB-SONIC AIRCRAFT EMISSIONS - A GLOBAL THREE-DIMENSIONAL MODEL STUDY

PRASAD S. KASIBHATLA (Georgia Inst. of Technology, Atlanta) Geophysical Research Letters (ISSN 0094-8276) vol. 20, no. 16 Aug. 20, 1993 p. 1707-1710. refs

(Contract NSF ATM-89-05901)

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The 11-level Geophysical Fluid Dynamics Laboratory global chemical transport model (GCTM), which explicitly treats NO(x), HNO₃, and PAN as transported species, has been used to assess the impact of sub-sonic aircraft emissions on the distribution of reactive nitrogen compounds (NO(y)) in the atmosphere. A 3D aircraft source inventory compiled by Boeing and McDonnell Douglas has been used, in conjunction with previously compiled surface-based fossil-fuel combustion and stratospheric source inventories. Consistent with previous 2D model calculations, we find that aircraft emissions have a significant impact on upper tropospheric NO(x) and HNO₃ budgets in the mid- and high latitudes of the Northern Hemisphere. The relative impact of the aircraft source on upper tropospheric NO(x) levels at mid- and high northern latitudes varies longitudinally, and that in certain regions the aircraft source dominates the total NO(x) budget. Aircraft emissions appear to only minimally impact the NO(y) budget in the Northern Hemisphere lower troposphere, and in much of the Southern Hemisphere. Comparisons of model results with NO(y)

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measurements at Mauna Loa, Hawaii, and over western Alaska suggest that sources other than surface-based fossil-fuel combustion, stratospheric NO(x) production, and aircraft emissions, are significant in determining the free tropospheric NO(y) budget in these regions.

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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.

A93-54353* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

ROTOR FATIGUE MONITORING DATA ACQUISITION SYSTEM

SCOTT M. SMITH (Sterling Federal Systems, Inc.; NASA, Ames Research Center, Moffett Field, CA) /n International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 37-50. refs

Copyright

The 40 by 80 Foot Wind Tunnel of the National Full Scale Aerodynamics Complex (NFAC) had a requirement to monitor rotor fatigue during a test. This test subjected various rotor components to stress levels higher than their structural fatigue limits. A data acquisition system was developed to monitor the cumulative fatigue damage of rotor components using National Instruments hardware and LabVIEW software. A full description of the data acquisition system including its configuration and salient features, is presented in this paper.

A93-54382

UNCERTAINTY OF DERIVED RESULTS ON X-Y PLOTS

MARK L. PRICE (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) /n International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 499-510. refs

Copyright

The method is described which can be used to propagate measured parameter uncertainty to an X-Y plot of derived results. The method is valued when the derived results are independent and when they are partially dependent on the same measurements. The method can be used to estimate the net uncertainty of a derived Y result for a specific X value given measurement uncertainty.

AIAA

A93-54396

A DATA ACQUISITION SYSTEM FOR HIGH-SPEED ROTOR BALANCING

DANIEL F. GRADY and DOUGLAS S. BREINDEL (Pratt & Whitney Group, West Palm Beach, FL) /n International Instrumentation Symposium, 39th, Albuquerque, NM, May 2-6, 1993, Proceedings Research Triangle Park, NC Instrument Society of America 1993 p. 853-865. refs

Copyright

A unique real-time data acquisition system has been developed for use in a high-speed rotor balance facility. Special measurement requirements for this facility include order-tracked vibration measurements, multichannel spectral analysis, and real-time graphical data presentations. The data acquisition system utilizes dual high-speed computer systems to share the tasks of measurement, data processing, and real-time display. The first system control, an 80-channel 8 KHz low-speed measurement system, is used for order-tracked vibration and general-purpose measurements. The second system controls a 24-channel 1 MHz high-speed data acquisition system used for spectral analysis of

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vibration signals. A local area network allows on-line data transfer between the two systems and off-line data transmission to a larger central computer for storage.
Author (revised)

A93-54420

FUTURE DEVELOPMENT AND APPLICATION OF GENERAL STRUCTURAL ANALYSIS SOFTWARES IN THE AVIATION INDUSTRY IN CHINA

XIMING LI and LUXING HU (CAE, Research Inst. no. 623, Xian, China) Computational Structural Mechanics and Applications (ISSN 1000-3401) vol. 10, no. 2 May 1993 p. 210-218. In CHINESE refs

This paper briefly describes the development of certain international and domestic softwares for general structure analysis for application in the aviation industry. Comparisons between the international softwares and the domestic softwares are given in tables for their running environment, their function and properties, the material module, the load case, the pre- and post-processing, and interface to the user. The future development of the general structure analysis softwares in China is also discussed.

A93-56403

A FRONTAL APPROACH FOR INTERNAL NODE GENERATION IN DELAUNAY TRIANGULATIONS

J.-D. MUELLER (Michigan Univ., Ann Arbor; Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese, Belgium), P. L. ROE (Michigan Univ., Ann Arbor), and H. DECONINCK (Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese, Belgium) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 17, no. 3 Aug. 15, 1993 p. 241-255. refs Copyright

A frontal mechanism for the creation of the interior nodes of a Delaunay triangulation is presented. The method combines the high node distribution quality of the advancing front method with the optimal connectivity of the Delaunay triangulation. Precise control of node spacing is achieved by the use of the initial triangulation of the boundary nodes as a background mesh with no additional effort of the user. The node generation does not require explicit tracking of the front and is independent of the order in which the triangles are listed. The resulting grids are very smooth and exhibit a high degree of regularity in cells shape and node distribution. This regularity is retained at singular points like corners or trailing edges, providing the robustness of the method. The use of a background grid that is derived from the initial triangulation of the boundary nodes results in a smooth variation in cell size of many orders of magnitude. AIAA

A93-56413

SWEEPLINE ALGORITHM FOR UNSTRUCTURED-GRID GENERATION ON TWO-DIMENSIONAL NON-CONVEX DOMAINS

JIUNN FANG (Chung Yuan Christian Univ., Chungli, Taiwan), I. H. PARPIA (Texas Univ., Arlington), and STEPHEN R. KENNON (Computational Mechanics Co., Inc., Austin, TX) International Journal for Numerical Methods in Engineering (ISSN 0029-5981) vol. 36, no. 16 Aug. 30, 1993 p. 2761-2778. refs (Contract F08635-89-C-0211) Copyright

The sweepline algorithm has been modified to triangulate a set of nodes on a non-convex domain. The new method is based on a fragile sweepline which is split and rejoined in a manner which ensures that boundaries are preserved. Both the original and the modified algorithms are introduced using simple examples. It is shown that a set of N nodes is triangulated in $O(N \log N)$ time. The validity of the new method has been confirmed through testing on a variety of problems, and two test cases are presented in this paper.

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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.

A93-54718

THE QUIET HELICOPTER; PROCEEDINGS OF THE CONFERENCE, LONDON, UNITED KINGDOM, MAR. 17, 1992

London Royal Aeronautical Society 1992 130 p. For individual items see A93-54719 to A93-54725 (ISBN 1-85768-020-0) Copyright

Papers presented include those on the public perspective of helicopter noise, helicopter noise certification, helicopter aeroacoustics and the impact of noise regulations on design, a helicopter noise reduction program (Agusta achievements), and noise characteristics of helicopters with the NOTAR antitorque system. Attention is also given to the effects of regulations and codes of practice upon helicopter operations, a new methodology for the helicopter internal-noise reduction application to the AS332 L2, European research into the helicopter internal noise, a review of the helicopter noise research in Europa, and a review of noise research in USA. AIAA

A93-54720

HELICOPTER NOISE CERTIFICATION

P. R. KEARSEY (Civil Aviation Authority, Gatwick, United Kingdom) In The quiet helicopter; Proceedings of the Conference, London, United Kingdom, Mar. 17, 1992 London Royal Aeronautical Society 1992 p. 2.1-2.6. refs Copyright

The paper describes the noise certification requirements for helicopters adopted by ICAO in 1981 and points out differences between the ICAO standards and the American requirements. Described in detail are the reference procedures for take-off, overflight, and approach; the noise limits; test procedures; the noise unit; the adjustment to test data; computations of noise certification levels; and validation of the noise certification standard. A simplified scheme, agreed upon at the December 1991 meeting of the ICAO Committee on Aviation Environmental Protection, applicable to helicopters with a take-off mass of less than 2730 kg, is described. The scheme uses the sound exposure level (SEL) as the unit of measure, thereby eliminating the need for one third octave analysis and enabling the use of an integrating sound level meter which will give the measured SEL directly. AIAA

A93-54721

HELICOPTER NOISE REDUCTION PROGRAMME - AGUSTA ACHIEVEMENTS

SRINIVASA R. NAGARAJA (Agusta S.p.A., Cascina Costa di Samarate, Italy) In The quiet helicopter; Proceedings of the Conference, London, United Kingdom, Mar. 17, 1992 London Royal Aeronautical Society 1992 p. 4.1-4.13. refs Copyright

Helicopter rotor noise is about the most complicated and difficult to handle because of the nature of the complex mechanisms involved. Impulsive and rotational noise are most significant and important at large distances from the helicopter especially due to the subjective annoyance they cause on account of the low frequency content in them. An experimental research program addressing these issues involving both the main and tail rotor aerodynamics was undertaken at AGUSTA leading to specific solutions. The presentation discusses the benefits of the modifications and solutions adopted.

A93-54722

NOISE CHARACTERISTICS OF HELICOPTERS WITH THE NOTAR ANTI-TORQUE SYSTEM

RAM D. JANAKIRAM and JEFFREY M. CURRIER (McDonnell Douglas Helicopter Co., Mesa, AZ) In The quiet helicopter;

Proceedings of the Conference, London, United Kingdom, Mar. 17, 1992 London Royal Aeronautical Society 1992 p. 5.1-5.12. refs
Copyright

The acoustic advantages of helicopters with the NOTAR antitorque system are demonstrated by comparing acoustic data obtained during the recent noise certification flight tests of MD 520N (the first production helicopter featuring a NOTAR system) with data from a nearly equivalent tail rotor-equipped helicopter, MD 500E. The operation principles of the NOTAR system are described, and the flight tests are discussed with particular attention given to the acquisition and reduction of the data used. It is shown that the primary acoustic features of the NOTAR antitorque system which contribute to the low noise levels of the MD 520N are its enclosed fan with a low tip speed and the high-frequency fan tones with the associated high atmospheric absorption rates.

AIAA

A93-54725**REVIEW OF HELICOPTER NOISE RESEARCH IN EUROPE**

VALENTIN KLOEPEL (Eurocopter Deutschland GmbH, Munich, Germany) *In The quiet helicopter; Proceedings of the Conference, London, United Kingdom, Mar. 17, 1992 London Royal Aeronautical Society 1992 p. 9.1-9.8. refs*
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The research activities in the field of helicopter noise investigation and reduction in Europe are overviewed. The rotor noise research efforts of helicopter manufacturers and other companies, of national research establishments, and universities are illustrated. Finally, the European BRITE/EURAM activities in the area of rotorcraft noise are explained. Examples of the research results attained in different areas of research are presented.

Author (revised)

A93-54998**OPTIMAL CONTROL OF THE ROCKING AND DAMPING OF SWINGS [OPTIMAL'NOE UPRAVLENIE RASKACHIVANIEM I TORMOZHENIEM KACHELEJ]**

EH. K. LAVROVSKIJ and A. M. FORMAL'SKIJ Prikladnaya Matematika i Mekhanika (ISSN 0032-8235) vol. 57, no. 2 Mar.-Apr. 1993 p. 92-101. In RUSSIAN refs
Copyright

The paper is concerned with the problem of maximizing or minimizing the deviation of a swing from the vertical line at its highest point. The swing is modeled by a plane physical pendulum with a material point which can move over a limited distance along a line drawn through the suspension axis and the center of mass of the pendulum. The analysis allows for viscous and dry friction in the suspension axis as well as for the linear aerodynamic drag of the movable point. The distance from the suspension axis to the movable point is used as the control variable. Analytical and numerical examples are presented.

AIAA

A93-55176**STRAY RADIATION IN OPTICAL SYSTEMS II; PROCEEDINGS OF THE MEETING, SAN DIEGO, CA, JULY 20-22, 1992**

ROBERT P. BREAU, ED. (Breault Research Organization, Inc., Tucson, AZ) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1753) 1993 336 p. For individual items see A93-55177 to A93-55191 (SPIE-1753; ISBN 0-8194-0926-X) Copyright

Various papers on stray radiation in optical systems are presented. Individual topics discussed include: ultralightweight beryllium mirror development; imaging incoherent, off-axis, scattered radiation; correcting for diffraction in the FIR reflectance measurement of rough surfaces; effect of jet-engine exhaust on SOFIA stray-light performance; specular baffles; wavelength dependence of scatter in chemical-vapor-deposited SiC; selection processes for black baffle surfaces in optical systems; PEARLSS model for contamination effects; black surfaces for space and ground-based optical systems; very near specular measurement via incident angle scaling. Also discussed are: near-specular measurements of integrated scatter; thermal emissivity analysis of

a Gemini 8-m telescope design; design and on-orbit performance in the WIND II baffle system; knife-edged diffuse-absorptive and dual reflective baffles; stray-light analysis of the Cassini telescope; use of Siamese pseudoptics in APART; bidirectional reflectance data to support paint development and signature calculations; rugged dark materials for stray-light suppression by seeded ion beam texturing; Mueller matrix measurement of scattered light; unique out-of-plane polarimetric scatterometer.

AIAA

A93-55178* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EFFECT OF JET ENGINE EXHAUST ON SOFIA STRAYLIGHT PERFORMANCE

ANN ST. CLAIR DINGER (Sterling Software, Inc.; NASA, Ames Research Center, Moffett Field, CA) *In Stray radiation in optical systems II; Proceedings of the Meeting, San Diego, CA, July 20-22, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1993 p. 59-64. refs*
Copyright

The Stratospheric Observatory For Infrared Astronomy (SOFIA) is being designed at NASA's Ames Research Center as a replacement for the Kuiper Airborne Observatory (KAO). A 2.5-m Nasmyth telescope will be mounted in a Boeing 747 SP and flown at 41,000 ft, above most of the H₂O in the earth's atmosphere. In the original SOFIA design, the telescope is located in front of the wings, as it is in the KAO. An alternative design with the telescope placed behind the wings is being studied as part of an effort to reduce cost and weight. In this location, the emission from the engines and the hot H₂O molecules in the exhaust become significant straylight sources. The engines and exhaust radiate into the telescope cavity, and illuminate the primary and tertiary mirrors at low telescope elevation angles. The APART/PADE program was used to analyze the straylight at the SOFIA focal plane as a function of wavelength and telescope elevation angle. The emission from the engines and exhaust gas is compared to that from the earth and the telescope itself. Based on the results of this analysis, the SOFIA telescope has been moved behind the wings.

Author (revised)

A93-55331**ACOUSTIC EMISSION TECHNOLOGY FOR SMART STRUCTURES**

M. A. HAMSTAD (Denver Univ., CO) and G. P. SENDECKYJ (USAF, Wright Lab., Wright-Patterson AFB, OH) *Journal of Acoustic Emission (ISSN 0730-0050) vol. 11, no. 1 Jan.-Mar. 1993 p. 33-41. refs*

Copyright

Acoustic emission technology is reviewed for potential applications to smart structures. Deficiencies of commercial and research AE monitoring instrumentation are identified and discussed. Research issues that must be resolved before AE technology can be incorporated into smart structures are identified. Directions for future AE technology development are suggested.

A93-55666* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THEORETICAL CHARACTERIZATION OF THE REACTION NH₂ + O YIELDS PRODUCTS

STEPHEN P. WALCH (Elort Inst., Palo Alto; NASA, Ames Research Center, Moffett Field, CA) *Journal of Chemical Physics (ISSN 0021-9606) vol. 99, no. 5 Sept. 1, 1993 p. 3804-3808. refs*

(Contract NCC2-478)

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The potential energy surface for NH₂+O has been characterized using complete active space self-consistent field (CASSCF)/derivative calculations to determine stationary point geometries and frequencies followed by internally contracted configuration interaction (ICCI) calculations to determine the energetics. The calculations predict a NO bond strength of 85.8 kcal/mol for NH₂O. The barrier for isomerization of NH₂O to trans-HNOH is predicted to be 48.0 kcal/mol and the barriers for H+HNO forming NH₂O and NHOH are predicted to be 2.1 and

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8.3 kcal/mol, respectively (all corrected for zero-point energy). The computed heats of formation for NH_2O and cis- and trans- HNOH are in good agreement with the present results. The barrier for $\text{H} + \text{HNO}$ yields $\text{H}_2 + \text{NO}$ is computed to be about 0.3 kcal/mol. Author (revised)

A93-55845

THE COMMUNITY RESPONSE TO AIRCRAFT NOISE AROUND SIX SPANISH AIRPORTS

A. GARCIA, L. J. FAUS, and A. M. GARCIA (Valencia Univ., Burjasot, Spain) *Journal of Sound and Vibration* (ISSN 0022-460X) vol. 164, no. 1 June 8, 1993 p. 45-52. Research supported by Ministerio de Obras Publicas y Urbanismo refs Copyright

The community response to aircraft noise has been studied through a social survey. A total of 1800 persons living in the vicinity of six major Spanish airports have been interviewed at their homes concerning the environmental quality of the area, dissatisfaction with road traffic noise and aircraft noise, activities interfered with by noise, most disturbing aircraft types, and subjective evaluation of airport impact. All the responses obtained in this survey have been compared with aircraft noise levels corresponding to the residence locations of the people interviewed (values of NEF levels were calculated with the INM model). The results obtained in this work allow one to evaluate the impact of aircraft noise under a wide range of different situations.

A93-55852 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A GENERAL INTRODUCTION TO AEROACOUSTICS AND ATMOSPHERIC SOUND

JAMES LIGHTHILL (Univ. College, London, United Kingdom) *In International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration*, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 5-34. Previously announced in STAR as N93-12021 Research supported by Leverhulme Trust refs (Contract NAS1-18605; RTOP 505-90-51-01) Copyright

A single unifying principle (based upon the nonlinear 'momentum-flux' effects produced when different components of a motion transport different components of its momentum) is used to give a broad scientific background to several aspects of the interaction between airflows and atmospheric sound. First, it treats the generation of sound by airflows of many different types. These include, for example, jet-like flows involving convected turbulent motions (with the resulting aeroacoustic radiation sensitively dependent on the Mach number of convection) and they include, as an extreme case, the supersonic 'boom' (shock waves generated by a supersonically convected flow pattern). Next, an analysis is given of sound propagation through nonuniformly moving airflows, and the exchange is quantified of energy between flow and sound; while, finally, problems are examined of how sound waves 'on their own' may generate the airflows known as acoustic streaming.

A93-55857

RESPONSE VARIABILITY OBSERVED IN REVERBERANT ACOUSTIC TEST OF A MODEL AEROSPACE STRUCTURE

ROBERT E. POWELL (Cambridge Collaborative, Inc., MA) *In International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration*, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 89-96. refs Copyright

One of the most difficult concepts to grasp in Statistical Energy Analysis is that structural response can be considered a random variable. It is instructive to perform statistical analyses on actual test data in order to investigate assumptions about the distribution of response. These types of analyses are rarely carried out because of the relatively low number of measurements typically obtained during a test. This paper presents a statistical analysis of the structural response during a reverberant acoustic test of a prototype

aerospace component. The test article was the mass/thermal/acoustic model of the photovoltaic power management and distribution system for the NASA Space Station Freedom. The analysis takes advantage of the large number of acceleration sensors located on component attachment screws to conclude that the spatial variation of power spectral density (PSD) averaged in third octave bands can be described by a lognormal probability distribution.

A93-55859

SONIC BOOM MINIMIZATION - MYTH OR REALITY?

KENNETH J. PLOTKIN (Wyle Labs., Arlington, VA) *In International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration*, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 105-112. refs Copyright

Sonic boom, the audible shock pattern of a supersonic vehicle, is an important issue for contemplated advanced supersonic transports and for operation of supersonic military aircraft. Physical realities make sonic boom unavoidable. However, there are promising opportunities to shape sonic booms from supersonic transports so that their perceived loudness may be acceptable. Current efforts toward developing acceptable minimum-boom aircraft are discussed. These include both aircraft configuration studies and psychoacoustic studies to establish acceptability criteria. Atmospheric turbulence is known to distort sonic booms. The potential for turbulent distortion to affect the loudness of sonic booms is discussed.

A93-55861* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPARISON OF RADIATED NOISE FROM SHROUDED AND UNSHROUDED PROPELLERS

WALTER EVERSMAN (Missouri-Rolla Univ., Rolla) *In International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration*, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 121-128. Research supported by NASA refs Copyright

The ducted propeller in a free field is modeled using the finite element method. The generation, propagation, and radiation of sound from a ducted fan is described by the convected wave equation with volumetric body forces. Body forces are used to introduce the blade loading for rotating blades and stationary exit guide vanes. For an axisymmetric nacelle or shroud, the problem is formulated in cylindrical coordinates. For a specified angular harmonic, the angular coordinate is eliminated, resulting in a two-dimensional representation. A finite element discretization based on nine-node quadratic isoparametric elements is used.

AIAA

A93-55862

NOISE AND VIBRATION ANALYSIS IN PROPELLER AIRCRAFT BY ADVANCED EXPERIMENTAL MODELING TECHNIQUES

HERMAN VAN DER AUWERAER and DIRK OTTE (LMS International, Leuven, Belgium) *In International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration*, 2nd, Auburn Univ., AL, Mar. 4-6, 1992, Proceedings. Vol. 1 Auburn, AL Auburn University 1992 p. 129-136. refs Copyright

Noise and vibration control measures in large structures such as aircraft need the development of a representative model of the complex vibro-acoustic system, built up by the fuselage, the trim panels and the cabin cavity. The complexity of such systems often results in a failure of the classical multiple degree-of-freedom parameter estimation techniques to obtain a consistent modal model. This paper discusses some alternative experimental modelling techniques for such complex vibro-acoustic systems, based on singular value decomposition of a measured FRF-matrix. The physical significance of this orthogonal decomposition on the

FRF-matrix is explored. Two related modelling concepts, Principal Field Shape Analysis and the U-vector Expansion Method (Impedance Modelling) are introduced. A case study on a twin propeller aircraft, featuring Principal Field Shape Analysis is presented and commented. Finally, issues to be investigated more thoroughly are mentioned and current research topics are outlined.

A93-55995

A PREDICTION MODEL FOR THE VORTEX SHEDDING NOISE FROM THE WAKE OF AN AIRFOIL OR AXIAL FLOW FAN BLADES

C. LEE (Korea Advanced Inst. of Science and Technology, Seoul, Republic of Korea), M. K. CHUNG, and Y.-H. KIM (Korea Advanced Inst. of Science and Technology, Taejeon, Republic of Korea) *Journal of Sound and Vibration* (ISSN 0022-460X) vol. 164, no. 2 June 22, 1993 p. 327-336. refs
Copyright

An analytical model is presented for predicting the vortex shedding noise generated from the wake of axial flow fan blades. The downstream wake of a fan blade is assumed to be dominated by the von Karman vortex street, and the strength and the shedding frequency of the wake vortex are determined from the wake structure model. The fluctuating pressure and lift on the blade surface, which are induced from the vortices in the wake, are analyzed by incorporating the wake model for the von Karman vortex street with thin airfoil theory. The predicted vortex shedding frequency and the overall sound pressure level compare favorably with the measured results for the vortex shedding noise from axial flow fans.

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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.

A93-54611#

AIRSHIP INSURANCE IN LONDON

MICHAEL E. RENTELL *In* AIAA Lighter-Than-Air Systems Technology Conference, 10th, Scottsdale, AZ, Sept. 14-16, 1993, Technical Papers Washington American Institute of Aeronautics and Astronautics 1993 p. 66-74.
(AIAA PAPER 93-4043) Copyright

This paper describes the two major institutions that exist in London for insuring airships. It explores the current state of insurance generally with regard to airline and general aviation and indicates how airship operators can best achieve suitable hull and liability cover. The advisability and requirements of preunderwriting surveys as a means of reducing insurance premiums for airships are discussed in detail.

A93-54854

THE ECONOMIC EFFECTIVENESS ANALYSIS OF TECHNOLOGICAL PROGRESS IN AVIATION INDUSTRY

YONG NING, LIANJUN CHENG, and RUOEN REN (Beijing Univ. of Aeronautics and Astronautics, China) *Beijing University of Aeronautics and Astronautics, Journal* (ISSN 1001-5965) no. 4 Oct. 1992 p. 43-47. In CHINESE refs

By using the nonneutral technological progress model this paper presents an econometrics study on technological progress and economic growth in China's aviation industry from 1954 to 1988. In these 35 years in the economic growth process of China's aviation industry, the growth of labor input has made the largest contribution to the growth of output; the second is the growth of technological progress; and the last is the growth of capital input.

Some suggestions for the technological progress and economic growth policy of China's aviation industry are made.

Author (revised)

A93-56537

A GENERAL FRAMEWORK FOR ANALYZING CHOICE-OF-LAW PROBLEMS IN AIR CRASH LITIGATION

JOHN B. AUSTIN (Adler, Kaplan & Begy, Chicago, IL) *Journal of Air Law and Commerce* (ISSN 0021-8642) vol. 58, no. 4 Summer 1993 p. 909-980. refs
Copyright

The choice of law in air crash litigation using the 'most significant relationship' test of the Restatement (Second) of Conflict of Laws is discussed. A framework is presented for extending the reasoning of the Air Crash Chicago case to the choice problem. The issues of punitive and compensatory damages are examined in detail.

AIAA

A93-56540

PROMOTING GENERAL AVIATION SAFETY - A REVISION OF PILOT NEGLIGENCE LAW

ROBERT J. ANDREOTTI (Texas Soaring Association, Inc., TX) *Journal of Air Law and Commerce* (ISSN 0021-8642) vol. 58, no. 4 Summer 1993 p. 1089-1148. refs
Copyright

Changes in pilot negligence law that need to be made to promote general aviation safety are discussed. Pilot disregard of federal aviation regulations, the Airman's Information Manual, and other FAA safety literature, and of ordinary care is described. What the standard of care and liability for pilot mistakes and poor judgment should be are addressed. Res ipsa loquitur in pilot negligence cases and strict liability in general aviation are discussed.

AIAA

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SPACE SCIENCES

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

A93-56272

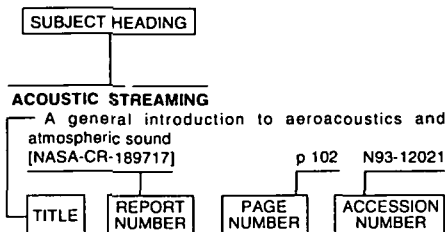
ANALYTICAL STUDY ON THE SEPARATION DYNAMICS OF LUNAR-A/PENETRATOR

YASUHIRO MORITA, TAKASHI NAKAJIMA, MOTOKI HINADA (Inst. of Space and Astronautical Science, Sagami-hara, Japan), and TOMOHIKO NAIDE (Nissan Motor Co., Ltd., Tokyo, Japan) *In* Space Sciences and Technology Conference, 35th, Nagaoka, Japan, Oct. 28-31, 1991, Proceedings Tokyo Japan Society for Astronautical and Space Sciences 1991 p. 93, 94. In JAPANESE

A lunar observation mission named LUNAR-A is conducted by the Institute of Space and Astronautical Science of Japan. Three penetrators will be deployed from a spacecraft onto the satellite's surface, constituting a seismic and heat flow measurement network of a larger span on the surface than ever before. As the penetrators are not equipped with any attitude control device, attitude and orbital perturbations caused through the separation from the spacecraft may result in an undesirable attack angle at the impact, leading to failure in penetration. This prompts an analytical study of the separation dynamics to assure proper penetration, which is described in this paper.

Author (revised)

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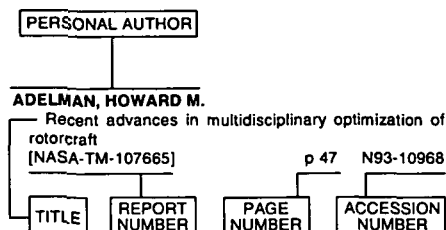
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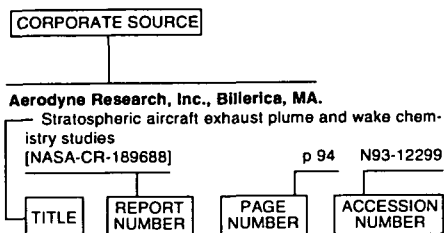
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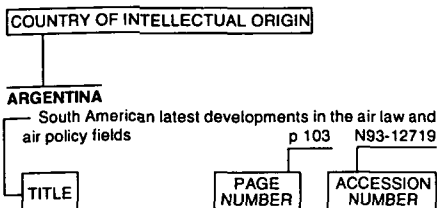
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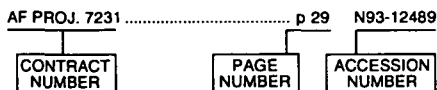
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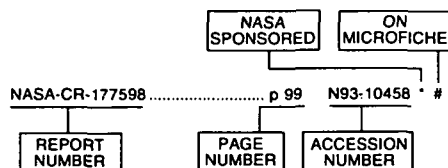
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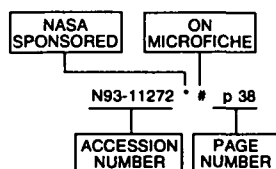
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