NASA

Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037(185)
March 1985

National Aeronautics and
Space Administration

SPECIAL NOTICE ENCLOSED
NEW FOREIGN TECHNOLOGY INDEX INCLUDED IN THIS ISSUE

ACCESSION NUMBER RANGES

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

STAR (N-10000 Series)	N85-11976 - N85-13765
IAA (A-10000 Series)	A85-12657 - A85-15966

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FOREIGN TECHNOLOGY INDEX IN THIS ISSUE

Documents referred to in this bibliography whose country of intellectual origin is other than the United States are listed in the Foreign Technology Index (see page D-1).

A great deal of excellent scientific and technical work is done throughout the world. To the extent that U.S. researchers, engineers, and industry can utilize what is done in foreign countries, we save our resources. We can thus increase our country's productivity.

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NASA SP-7037(185)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 185)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in February 1985 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

NASA Scientific and Technical Information Branch 1985
National Aeronautics and Space Administration
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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 462 reports, journal articles, and other documents originally announced in February 1985 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

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

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

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

An annual cumulative index will be published.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies of accessions are available at $8.50 per document. Microfiche(1) of documents announced in *IAA* are available at the rate of $4.00 per microfiche on demand. Standing order microfiche are available at the rate of $1.45 per microfiche for *IAA* source documents.

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

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

TYPICAL CITATION AND ABSTRACT FROM *IAA*

AVAILABLE ON MICROFICHE — AIAA ACCESSION NUMBER — TITLE — AUTHOR — AUTHOR'S AFFILIATION — TITLE OF PERIODICAL — PUBLICATION DATE

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

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

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 185)

MARCH 1985

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AERONAUTICS (GENERAL)

A85-13501#
SUPERMANEUVERABILITY
T. J. CORD and C. F. SUCHOMEL (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 4 p.
(AIAA PAPER 84-2386)

Attention is given to the comprehensive program formulated by the U.S. Air Force's Flight Dynamics Laboratory for the investigation of 'supermaneuverability' high angle-of-attack flight. Incidences approaching 90 deg are involved in some portions of the maneuvers envisioned. At such extreme attitudes, flow phenomena lead to nonlinear forces and moments, so that control forces must be generated by both aerodynamic and propulsion system-based methods. The predition, analysis and simulation techniques that will be developed may be applied to a flight demonstration vehicle for the early 1990s. O.C.

A85-13517#
METHODOLOGY TO BETTER PREDICT STRUCTURAL MAINTENANCE REQUIREMENTS FOR INDIVIDUAL AIRCRAFT
W. R. ELLIOTT and T. F. CHRISTIAN, JR. (USAF, Warner Robins Air Logistics Center, Robins AFB, GA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 8 p. refs
(AIAA PAPER 84-2411)

This paper presents an improved method of predicting airframe maintenance requirements based on individual aircraft usage. Present airframe maintenance approaches establish inspection intervals from average fleet usages. This fails to account for differences in usage severity among individual aircraft and, hence, can not predict the resulting maintenance burden or benefit from usage changes. A new methodology, using fracture mechanics principles, allows tailoring inspections to individual aircraft by accounting for the severity of their present, as well as projected future, usages. This makes possible better allocation of maintenance resources by determining the ordering of individual aircraft for inspections. The increase in maintenance resources or the decrease in service life due to a new, more severe usage can now be assessed and investigations into possible structural damage leveling among aircraft can be made more accurately. Author

A85-13522#
ROTORCRAFT EFFECTIVENESS AND SURVIVAL IN THE 1990'S AND BEYOND
N. CARAVASOS (Boeing Vertol Co., Philadelphia, PA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p.
(AIAA PAPER 84-2417)

This paper addresses the effectiveness and survival characteristics of current and future rotorcraft to withstand the present and postulated threats in the 1990s and beyond. It highlights the currently available technologies in rotorcraft performance, signatures, countermeasures, and firepower. Furthermore, it defines those research and development advances that are required to counter, fight, and survive in the future battlefields. Author

A85-13529#
ULTRALIGHT AIRCRAFT - DO THEY HAVE A FUTURE?
D. A. MARTIN AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 5 p.
(AIAA PAPER 84-2434)

Ultralight aircraft have evoked strong images for the last few years. For the potential flier, the image includes affordable flight at last. For those concerned with air traffic and public safety, however, the image is of potential disaster as untrained pilots take to the air by increasing thousands, resulting in collision with airplanes and greater danger to those on the ground. From the current viewpoint, both of these perspectives are wrong. For various reasons including mushrooming ultralight costs, sales of new machines have dropped to insignificant levels. Probable federal regulations and movement of the sport toward more sophisticated 'little airplanes' are likely to relegate simple ultralights to a footnote in history. Because of their small numbers, ultralight operations should pose few problems for air and community planners during the next few decades. Author

A85-13535*# National Aeronautics and Space Administration, Washington, D. C.
THE REVOLUTIONARY IMPACT OF EVOLVING AERONAUTICAL TECHNOLOGIES
G. G. KAYTEN (NASA, Aerodynamics Div., Washington, DC), C. DRIVER, and D. J. MAGLIERI (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 14 p. refs
(AIAA PAPER 84-2445)

Recent advances in aeronautical technologies which could produce revolutionary changes in transport aircraft if fully implemented are delineated. Laminar flow control offers a L/D improvement from the current 18 to 22 if used with a 767 configuration. Higher aspect and thickness/chord ratios could yield more efficient structural designs and further drag reduction. High-strength, fiber-reinforced composite structures can reduce structural weight by 10-30 percent. Improved engine cooling methods, higher stage loadings and exhaust temperatures can lower the SFC by 15 percent, engine weight by 15 percent, and the parts count by 50 percent. Aft-mounted counterrotating propellers can potentially decrease the SFC an additional 15-20 percent. Supersonic transport aircraft with L/D ratios of 18 and 70 seat miles/gal fuel efficiency can now be built that weigh half as much as the Concorde and carry the same load. The new SST would have superplastic-molded Al alloy structures. M.S.K.

A85-13552#
FUTURE TECHNOLOGIES USING THE LOCKHEED HTB AIRCRAFT
A. J. YOUNGS (Lockheed-Georgia Co., Marietta, GA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p.
(AIAA PAPER 84-2466)

The High Technology Test Bed (HTTB) aircraft is a modified C-130 cargo transport that will be used to evaluate technology applicable to 1990s tactical airlifters. The HTTB's STOL capability, electronics and avionics, advanced flight station, and survivability improvements over current generation aircraft are intended to contribute to such goals as runway independence, all-weather operations, passive navigation, and automatic controls. O.C.

A85-13582#
HIGH TEMPERATURE DUCTS - A COMPOSITE ALTERNATIVE
G. HOWARTH (Martin Marietta Aerospace, Baltimore, MD) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 5 p.
(AIAA PAPER 84-2519)

The use of composites in aerospace applications is in most cases associated with requirements to reduce component weight. It is pointed out, however, that it may be possible to employ composites as an alternative material in order to reduce manufacturing costs and improve producibility, while also benefitting from a weight saving. The present investigation is concerned with the design of a new derivative of a fan reverser, including a revised duct geometry to meet new interfaces. The fan reverser formed a part of a modern aircraft engine. One of the major design parameters was related to the capability to withstand aircraft type environment including oils, fuels, and chemicals. An evaluation of existing design possibilities showed cost advantages in the nonrecurring and recurring cost areas in the case of a selection of a composite duct. G.R.

A85-13676
ISRAEL ANNUAL CONFERENCE ON AVIATION AND ASTRONAUTICS, 25TH, TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY, HAIFA AND TEL AVIV, ISRAEL, FEBRUARY 23-25, 1983, COLLECTION OF PAPERS
Conference supported by Technion - Israel Institute of Technology, Ministry of Defence, Israel Aircraft Industries, Ltd., et al. Haifa, Technion - Israel Institute of Technology, 1984, 316 p. For individual items see A85-13677 to A85-13705.

Output feedback root clustering in parameter space is considered along with the reliability of axially compressed cylindrical shells with general nonsymmetric imperfections, modular potential flow computation including fuselage and wing tip effects, the investigation of the axial velocities induced along rotating blades by trailing helical vortices, and resonance phenomena in mechanical systems due to periodical movement of the loading. Attention is given to roll divergence of a canard-controlled missile with freely spinning tail, boundary layer flow along a noncircular cylinder, pressures in vortex breakdown flowfields, suppression of biodynamic disturbances and pilot induced oscillations in vehicular control by adaptive filtering, and the dynamic behavior of elementary structures after reaching the limit of stability. Other subjects explored are related to matrix mode failure of composite materials, lifting rotor analysis at subsonic and transonic flow, aeroelastic tailoring of rotor blades for vibration reduction in forward flight, and the local buckling of thin shells. G.R.

A85-13695#
A NEW TECHNIQUE TO DETERMINE INFLIGHT STORE SEPARATION TRAJECTORIES
E. GERSCH (Rafael Armament Development Authority, Data Reduction Div., Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 185-191. refs

A data reduction technique for determining the six-dimensional trajectory of an unguided store released from an aircraft is presented. The technique is targeted at the first 2-3 m after release and accuracies of 0.01 m in displacement, 1 deg in yaw and pitch angles, and 3 deg in the roll angle. Data are gathered on 16 mm film, 5-10 mm lenses, and at film speeds up to 400 frames/sec. Account is taken of spherical and tangential optical distortions, the camera location, orientation, focal length and principal photogrammetric point, and the store center of gravity coordinates and attitude. The resulting algorithm, when compared with one- and two-camera test data, revealed that one-camera data are half as accurate as two-camera data. Optical distortions are dependent on the image location in the film frame. The algorithm is concluded capable of generating simulations as accurate as two-camera data. M.S.K.

A85-13702#
VALIDATION OF ZERO-ORDER FEEDBACK STRATEGIES FOR MEDIUM-RANGE AIR-TO-AIR INTERCEPTION IN A HORIZONTAL PLANE
J. SHINAR (Technion - Israel Institute of Technology, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 257-265. refs

The results of a comparison of open-loop (OL) and feedback approximation (FA) methods of solving medium range (4-20 km) air-to-air zero sum combat game problems are reported. FA involves use of the forces singular perturbation method (FSP) while OL comprises decoupling the game optimality conditions into two one-sided optimal control problems, each amenable to independent solution. The FSP technique is found to satisfy a 0.01 accuracy criterion in middle-ranges, assuming a 6 g turn limitation and an altitude of 20,000 ft. A formulation is devised for quantifying the initial ranges for a valid zero-sum game FSP analysis. The discussion is noted to be valid solely for horizontal engagements, yet is judged suitable for incorporation into operational fire-and-flight control systems. M.S.K.

A85-14047
INSPECTION AND REPAIR OF ADVANCED COMPOSITE AIRFRAME STRUCTURES FOR HELICOPTERS
T. N. COOK (Sikorsky Aircraft, Stratford, CT) and T. E. CONDON (U.S. Army, Research and Technology Laboratories, Fort Eustis, VA) American Helicopter Society, Journal (ISSN 0002-8711), vol. 29, Oct. 1984, p. 31-37.

A program was conducted to develop and demonstrate techniques for the inspection and repair of advanced composite airframe structures in the Army aircraft field environment. Field repair methods were developed for primary airframe structures. Test panels were fabricated and ballistically damaged. The damaged test panels were repaired and statically tested to failure. The strength of the repaired panels was compared to the strength of undamaged panels, and the quality and feasibility of the repairs were evaluated. A demonstration of modular airframe repair was conducted using a tool proofing model of the Black Hawk Helicoper Composite Rear Fuselage (CRF). The strength of the repair joints was verified through static testing. R and M guidelines were established for the design of advanced composite airframes. Author

A85-15591
LIGHT HELICOPTER FAMILY (LHX) - THE U.S. ARMY'S FUTURE LIGHT ROTORCRAFT FLEET
G. T. SINGLEY, III and W. A. LAWSON Vertiflite (ISSN 0042-4455), vol. 30, Nov.-Dec. 1984, p. 18-22.

U.S. Army's program of the Light Helicopter Family (LHX) is discussed. The program is aimed to replace over 7000 rotorcraft, including the AH-1, OH-58A/C and OH-6, and to satisfy the Army's Airland Battle Doctrine and Army's 21 Concepts; it is currently in the exploration phase of the acquisition cycle. Among the goals considered are: target acquisition and long term mission capability in adverse weather conditions; precise navigation; amount of pilot workload; mission reliability and simplified maintenance. Under the Advanced Rotorcraft Technology Integration Program (ARTI) one of the projects also considered is the single-pilot SCAT (Scout and Light Attack) of 8000 lbs. Such issues as the development and production strategy and planned initiatives are discussed. The LHX system development contract award is planned for June 1986. L.T.

A85-15592
JOINT SERVICES VERTICAL LIFT DEVELOPMENT (JVX) PROGRAM - LOOKING TO THE FUTURE
J. CREECH (U.S. Marine Corps, Washington, DC) Vertiflite (ISSN 0042-4455), vol. 30, Nov.-Dec. 1984, p. 24, 25.

The development of the tilt-rotor joint services vertical lift (JVX) aircraft for the Marine Corps is discussed. The design involves fly-by-wire systems and considers the following missions: amphibious assault (two waves of troops), or cargo lift (8,300 lbs) from 50 n.m. offshore; land assault with 24 troops transported 200 n.m., off-loaded and return to origin; Navy combat search and rescue; Air Force long range operations with 12 combat-equipped troops. The introduction of the JVX is aimed for 1991. L.T.

A85-15959#
MAGNAWEAVE SHAPES FOR AIRCRAFT - INTEGRALLY WOVEN WING SECTIONS, STIFFENED SHEAR PANELS, AND OTHERS
R. A. FLORENTINE (Cumagna Corp., Norristown, PA) IN: Reinforced Plastics/Composites Institute, Annual Conference, 39th, Houston, TX, January 16-19, 1984, Preprints . New York, Society of the Plastics Industry, Inc., 1984, p. 11-B-1 to 11-B-5. refs

The Magnaweave process for three-dimensional composite material reinforcement fabrication has been applied to the production of complex shapes suitable for incorporation in advanced aircraft. These shapes have thus far included hollow boxes, 'J' and 'T' sections, channels, and simple 'hat' sections. The production of an integral wing contour-stiffener for drone aircraft involves an integration of both Cartesian and Circular Magnaweave loom technologies. Attention is given to the mechanical properties thus far obtained for Magnaweave structures incorporating different fibers in a variety of matrices. O.C.

A85-15960#
COMPOSITE NACELLE DEVELOPMENT
R. ANDERSON and L. M. POVEROMO (Grumman Aerospace Corp., Bethpage, NY) IN: Reinforced Plastics/Composites Institute, Annual Conference, 39th, Houston, TX, January 16-19, 1984, Preprints . New York, Society of the Plastics Industry, Inc., 1984, p. 11-C-1 to 11-C-5.

An assessment is made of the results of an advanced composite material engine nacelle development program whose fan cowl door meets all the form, fit, function, and FAA-stipulated requirements for a currently manufactured aluminum honeycomb fan cowl door. The composite cowl door design is a single-cure sandwich assembly having graphite/epoxy cloth and unidirectional tape hybrid laminate face sheets, yielding a weight saving of 28 percent over the metallic door. O.C.

N85-11977# Politecnico di Torino (Italy). Dept. of Aerospace Engineering.
REPORT OF THE DEPARTMENT OF AEROSPACE ENGINEERING Annual Report, 1983
Apr. 1984 40 p
Avail: NTIS HC A03/MF A01

The objectives and activities in the department of aerospace engineering of the Twin Polytechnic Institute are outlined. Progress in research and development is reported. The areas of research include: (1) aeronautics and astronautics; (2) fluid dynamics and propulsion; (3) structures and materials; and (4) systems engineering and management. E.A.K.

N85-11978# Defense Systems Management School, Fort Belvoir, Va.
DOD ROBOTICS APPLICATION WORHSHOP PROCEEDINGS
1983 482 p
(AD-A145867) Avail: NTIS HC A21/MF A01 CSCL 13H

The ten robotics-related technical areas addressed in this workshop were: (1) Applications; (2) Installation/Design Concepts; (3) Safety and Security; (4) Languages; (5) Controls and Integrated Systems; (6) Mechanical Systems and Precision Operations; (7) Vision systems; (8) Band and End Effectors; (9) Sensors; and (10) Transportability/Mobility. That robotics is a systems issue embedded in an automation framework is most apparent because the roundtable-developed menus in these ten technical areas show considerable interaction and overlap. However, a remarkable range of distinct applications, needs, and potential project investments emerged in each technical area, many of which were unique and did not overlap the concepts developed in other roundtables.

N85-11980# Oklahoma City Air Logistics Center, Tinker AFB, Okla.
AIR FORCE ENGINE REPAIR - OKLAHOMA CITY AIR LOGISTICS CENTER, PROPULSION DIVISION
M. LEBLANC *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 117-126 1983
(AD-P003999) Avail: NTIS HC A21/MF A01 CSCL 21E

This paper provides an introduction to the jet engine overhaul facilities and process at the Oklahoma City Air Logistics Center, which produces approximately 200 aircraft, 1200 engine and 300,000 component items each year. GRA

N85-11981# Warner Robins Air Materiel Area, Robins AFB, Ga.
ELECTRONICS/AVIONICS DEPOTS IN THE UNITED STATES AIR FORCE WARNER ROBINS AIR LOGISTICS CENTER
B. RAMSEY *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 127-131 1983
(AD-P004000) Avail: NTIS HC A21/MF A01 CSCL 01C

Maintaining complex Airborne Electronic Systems has historically been accomplished at three repair levels. The technical level of repair is dependent upon the complexity of the test equipment needed to isolate the malfunctions and then to functionally test a repaired item. No less important is the repair requirements involving facilities (heating, air conditioning, humidity, cleanrooms) and the special tools, fixtures and equipment with the skilled technicians and engineers whose knowledge utilize these resources. The Electronic Depots at Ogden ALC, UT; Sacramento ALC, CA; San Antonio ALC, TX and Warner Robins ALC, GA meet the need of repairing these items that cannot be repaired at field level. GRA

N85-11982# Ogden Air Logistics Center, Hill AFB, Utah.
AIR FORCE LANDING GEAR REPAIR - OGDEN AIR LOGISTICS CENTER INDUSTRIAL PRODUCTS AND LANDING GEAR DIVISION
T. HRUSKOCY *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 132-265 1983
(AD-P004001) Avail: NTIS HC A21/MF A01 CSCL 01C

The repair process for worn aircraft landing gear assemblies at Hill Air Force Base, Utah is outlined. The facilities used in the overhaul sequence are described. R.S.F.

N85-11983# Oklahoma City Air Logistics Center, Tinker AFB, Okla.
JET ENGINE BLADE REPAIR AT THE OKLAHOMA AIR LOGISTICS CENTER, PROPULSION DIVISION
M. LEBLANC *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 266-276 1983
(AD-P004003) Avail: NTIS HC A21/MF A01 CSCL 21E

This report provides an introduction to the facilities and processes which are required to overhaul jet engine blades at the Oklahoma City ALC. In recent years, jet engine blade repair has become an increasingly important part of the overhaul requirements. Cost factors and availability of materials have resulted in repair processes being implemented to salvage blades which, in past years, would have been condemned. GRA

N85-11984# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
AIR FORCE PLASMA SPRAY AT SA-ALC (SAN ANTONIO AIR LOGISTICS CENTER)
S. LEE *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 277-290 1983
(AD-P004004) Avail: NTIS HC A21/MF A01 CSCL 13H

The challenge in the Manufacturing Technology (MT) program is to improve productivity and minimize operator safety hazards by establishing an integrated computerized thermal spray cell that encompasses automated surface preparation, process control, part manipulation and spray gun control. The automated systems must be flexible and adaptable to changes in work load requirements and part configuration. The automated plasma spray cell is the first building block for eventual establishment of a thermal spray processing center that will include flame spray, wire spray and possibly vacuum plasma spray cells. Many operations such as parts handling, pre/cost coating surface treatments, maskings, parts flow, etc., are largely common to all three thermal spray processes used at the ALC. The MT program should clearly identify cost drivers and impediments to productivity using methodical ICAM modeling techniques. These factors will be accounted for in designing and implementing the automated plasma spray cell. The cell will be implemented at San Antonio Air Logistics Center at Kelly AFB, TX in late 1984. GRA

N85-11985# Sacramento Air Logistics Center, McClellan AFB, Calif.
AIR FORCE HONEYCOMB SHAPING AT SM-ALC (SACRAMENTO AIR LOGISTICS CENTER)
G. BETZ *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 291-306 1983
(AD-P004005) Avail: NTIS HC A21/MF A01 CSCL 17H

The system described in this paper is being developed by Robotic Vision Systems, Inc. and is part of the Manufacturing Technology for Integration of Advance Repair Bonding Technique. At present repair of bonded metal honeycomb aircraft structure is performed with manual techniques which are labor intensive and result in repair quality dependent on the skill and patience of the repairman. These manual techniques are not only costly in terms of repair labor and materials but also, as a consequence of the long cycle time, costly in terms of aircraft availability. The system described in this paper will substantially decrease repair cycle time and improve quality of repair by providing an automated means to dimensionally define the repair area and accomplish accurate cutting and inspection of honeycomb structures. The optical measurement system is able to accurately digitize the entire surface contours of the area to be repaired in significantly less time than provided by contacting systems. Further, since the optical measurement technique will be used, there will be no danger of core damage which can be caused by contact measurement probes. GRA

N85-11996# General Accounting Office, Washington, D. C. National Security and International Affairs Div.
LOGISTICS SUPPORT COSTS FOR THE B-1B AIRCRAFT CAN BE REDUCED
20 Sep. 1984 49 p
(AD-A145846; GAO/NSIAD-84-36) Avail: NTIS HC A03/MF A01 CSCL 14D

While the Air Force's logistics support planning for the B-1 bomber has been extensive, the inadequacy of the logistics data developed during research and development of the B-1B's predecessor-the B-1A-and the concurrent development and production schedule necessitated by a congressional mandate that the aircraft be operational not later than 1987 have forced Air Force planners to make logistics support decisions before they had sufficient data to support them. This has increased the risk that operating and support costs will be more than they would have been had normal Defense development procedures been employed before starting production. GAO has identified opportunities to reduce these costs which should be considered. They are: (1) combining the purchase of investment spares (components that can be repaired and reused) with the purchase of production components; (2) buying spares directly from the manufacturers instead of through the four B-1B contractors; (3) reducing the number of bases from four to three; and (4) centralizing all avionics maintenance repair at the B-1B airframe and engine depot repair facility and not establishing any repair shops at the planned B-1B bases. GRA

N85-11997# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FOR THE SACRED AIR SPACE OF OUR MOTHERLAND; AN INTERVIEW WITH OUR COUNTRY'S FAMOUS AIRCRAFT DESIGNER, LU HSIAO-PENG
C. LIANG-CHIN and K. CHING-PO 18 Sep. 1984 9 p Transl. into ENGLISH from Hangkong Zhishi (China), no. 8, Aug. 1983 p 2-3
(AD-A146291; FTD-ID(RS)T-0967-84) Avail: NTIS HC A02/MF A01 CSCL 01C

The history of China's aircraft industry is discussed. The lives of some aircraft designers are discussed. R.J.F.

N85-12002# Joint Publications Research Service, Arlington, Va.
USSR REPORT: TRANSPORTATION
4 Oct. 1984 101 p Transl. into ENGLISH from various Russian articles
(JPRS-UTR-84-028) Avail: NTIS HC A06/MF A01

Aspects of Soviet civil aviation covered include ground and air traffic control systems, aircraft maintenance; and the effects of lightning on aircraft systems. Highway construction, motor vehicles, flood control, navigation of inland waterways, and shipbuilding activities are also discussed.

N85-12004# Joint Publications Research Service, Arlington, Va.
EDITORIAL URGES IMPROVED AVIATION REPAIR WORK QUALITY
In its USSR Rept.: Transportation (JPRS-UTR-84-028) p 3-5 4 Oct. 1984 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 25 Aug. 1984 p 1
Avail: NTIS HC A06/MF A01

The multithousand member collective of aviation repair enterprises is voluntarily toiling on fulfillment of the tasks assigned it. The plan for the first 6 months of 1984 was fulfilled with good economic and financial indicators. In amount of realized output by 103 percent, in commodity output volume by 101.8 percent. Labor productivity exceeded the plan task by 3.2 percent and the reduction in prime production costs exceeded it by 3.7 percent. Almost 90 percent of the growth in output volume came from raising labor productivity. However, in the matter of insuring quality of aviation repair, there are still serious deficiencies and omissions. A number of substantiated complaints were made against plants No.'s 403, 411, 421 and 21. As checks made at the civil aviation plants have indicated, the main causes of these deficiencies were violations of the technology, poor technical training of operators, poor production rhythm, and lack of responsive monitoring on the part of OTK's. And not everywhere has discipline been well established. And where its levels has fallen and where slackness and irresponsibility are manifested, the resulting defects lead to material and psychological harm. A.R.H.

N85-12857 Arizona State Univ., Tempe.
LOW POWER LAMINAR AIRCRAFT STRUCTURES
A. STROJNIK 1984 215 p
Avail: Issuing Activity
A method by which to build a safe, lightweight aircraft is presented. Aerodynamic loads, aircraft structural materials, spar design, and stressed skins are addressed. R.S.F.

02

AERODYNAMICS

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

A85-12703*# University of Western Ontario, London.
WAVELENGTH SELECTION AND GROWTH OF GOERTLER VORTICES
J. M. FLORYAN (Western Ontario, University, London, Canada) and W. S. SARIC (Virginia Polytechnic Institute and State University, Blacksburg, VA) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1529-1538. Research supported by the Natural Sciences and Engineering Research Council of Canada. Previously cited in issue 19, p. 3449, Accession no. A80-44145. refs
(Contract NSG-1255)

A85-12704*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EFFECT OF A BURIED-WIRE GAGE ON THE SEPARATION BUBBLE NUMERICAL STUDY
D. DEGANI (NASA, Ames Research Center, Moffett Field, CA; Technion Israel Institute of Technology, Haifa, Israel) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1539-1543. refs
A numerically simulated buried-wire separation gage is investigated with emphasis on its effect on the separation bubble. The conjugated problem of a supersonic, time-dependent, two-dimensional flowfield above a conductive solid wall with an embedded heat source is solved using implicit finite difference algorithms. Steady-state and transient cases were computed for different locations of the heat source within the bubble. Results show that by using a steady heat source, the flow direction near the wall can be detected, without distorting the flowfield, only if the source is located in regions where the bubble is thick (i.e., not too close to the separation). The flow direction near separation can be detected by using a temperature pulse at the solid/fluid interface with insignificant distortion of the flowfield. Author

A85-12708*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A TIME-SPLIT FINITE-VOLUME ALGORITHM FOR THREE-DIMENSIONAL FLOWFIELD SIMULATION
C. M. HUNG (NASA, Ames Research Center, Computational Fluid Dynamics Branch, Moffett Field, CA) and W. KORDULLA (NASA, Ames Research Center, Computational Fluid Dynamics Branch, Moffett Field, CA; Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer theoretische Stroemungsmechanik, Goettingen, West Germany) (Computational Fluid Dynamics Conference, 6th, Danvers, MA, July 13-15, 1983, Collection of Technical Papers, p. 494-504) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1564-1572. Previously cited in issue 18, p. 2636, Accession no. A83-39400. refs

A85-12711#
FORCED OSCILLATIONS OF TRANSONIC CHANNEL AND INLET FLOWS WITH SHOCK WAVES
A. F. MESSITER and T. C. ADAMSON, JR. (Michigan, University, Ann Arbor, MI) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1590-1599. refs
(Contract N00019-80-C-0587)
In transonic channel or inlet flow, large-amplitude motions of a shock wave can be caused by small-amplitude oscillations of the walls or the back pressure. Previous work, which included only the latter effect, has been extended, and both types of impressed disturbances are considered here. Asymptotic solutions are obtained for the velocity and pressure distributions throughout a two-dimensional channel, with emphasis on flows which accelerate through sonic speed at the channel throat and with special attention given to small regions near the channel entrance and throat and near the shock wave. Solutions for the shock-wave velocity are derived, and for sufficiently strong disturbances it is shown how the shock wave moves rapidly upstream through the subsonic flow ahead of the throat. The details of the problem formulation and solution depend on the relative orders of magnitude of the nondimensional amplitude and frequency of the impressed oscillations; one case is considered in detail, and two others are discussed more briefly. Numerical results are shown for illustrative examples. Author

A85-12714#
APPLICATION OF THE GODUNOV METHOD AND ITS SECOND-ORDER EXTENSION TO CASCADE FLOW MODELING
S. EIDELMAN, R. P. SHREEVE (U.S. Naval Postgraduate School, Monterey, CA), and P. COLELLA (California, University, Berkeley, CA) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1609-1615. Research supported by the U.S. Department of Energy and U.S. Defense Nuclear Agency. refs
(AIAA PAPER 83-1941)
The Godunov method and a new second-order accurate extension of the method are used for the solution of two-dimensional Euler equations. Both numerical schemes are described in detail. Their performances in the subsonic, transonic, and supersonic flow regimes are first tested on the problem of flow in a channel with a circular arc bump. The methods are then applied to calculate the transonic flow through a supercritical compressor cascade designed by Sanz. For this case, the solution with the second-order extension of the Godunov method gives very good agreement with the design distribution of parameters given by Sanz. Author

A85-12717#
A CHARACTERISTICS APPROACH TO SWEPT SHOCK-WAVE/BOUNDARY-LAYER INTERACTIONS
R. J. STALKER (Queensland, University, Brisbane, Australia; Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer experimentelle Stroemungsmechanik, Goettingen, West Germany) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1626-1632. Previously cited in issue 15, p. 2345, Accession no. A82-31950. refs

A85-12726#
MASS FLUX BOUNDARY CONDITIONS IN LINEAR THEORY
R. E. MELNIK and W. H. MASON (Grumman Aerospace Corp., Bethpage, NY) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1691, 1692.
A perturbation analysis is used to demonstrate that the commonly used mass flux boundary condition is inconsistent, in that it neglects a term that is of the same order in thickness ratio as the extra term included in the mass flux boundary conditions (BCs) proposed most recently by Ehlers et al. (1979). When the consistent mass flux BC is used, the results using either the exact vorticity or mass flux BCs are shown to be essentially equivalent. O.C.

A85-12771#

A NUMERICAL STUDY OF GAS-PARTICLE SUPERSONIC FLOW PAST BLUNT BODIES - THE CASE OF AXISYMMETRIC FLOW

H. SUGIYAMA (Muroran Institute of Technology, Muroran, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 27, Sept. 1984, p. 1913-1919. refs

A numerical method (inverse method) was developed for a gas-particle supersonic flow past axisymmetric blunt bodies. This method is based on a stream function coordinate system, which makes it convenient to determine the shock layer flow fields and body shapes. Using the method, the gas-solid particle flows in the shock layers around blunt bodies (nearly spheres) were solved for freestream Mach number two. The effects of freestream loading ratio and particle diameter on the shock layer thickness, the body surface pressure, and the flow quantities along the stagnation streamline are shown, and the flow patterns (gas streamlines and particles streamlines) in the shock layers are presented. Author

A85-12870

THEORETICAL STUDY OF THE TRANSONIC FLOW PAST WEDGE PROFILES WITH DETACHED SHOCK WAVES

M. ABBOUD (Karlsruhe, Universitaet, Karlsruhe, West Germany) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 146, Sept. 1984, p. 181-201. refs

The two-dimensional steady inviscid flow of a perfect gas past a wedge profile is investigated analytically, considering the case of a detached shock wave for free-stream Mach numbers 1.05-1.44. A finite-difference scheme with Cartesian coordinates and iteration between the elliptic and hyperbolic regions is used to solve the boundary-value problem formulated by applying the Molenbroek-Chaplygin hodograph transformation (Ferrari and Tricomi, 1968); the flow field between the limiting Mach wave and the shock wave is then obtained by transforming the solution back to the physical plane. The results of numerical computations are presented graphically and compared with experimental data, the results of small-perturbation theory, and exact analysis: good agreement is found in most cases. T.K.

A85-13507*# Rockwell International Corp., Columbus, Ohio.

THE AERODYNAMIC CHARACTERISTICS OF A PROPULSIVE WING/CANARD CONCEPT IN STOL

V. R. STEWART (Rockwell International Corp., Columbus, OH) and J. W. JR. PAULSON (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p. refs

(AIAA PAPER 84-2396)

The potential of the propulsive wing in developing very high lift coefficients for STOL operation has been investigated with several nozzle aspect ratios. The use of the propulsive wing/canard appears to offer an approach to managing the large negative pitching moments associated with trailing-edge blowing. A full-span model of a wing/canard concept representing a fighter configuration has been tested at STOL conditions in the Langley 4 by 7 Meter Tunnel. The results of this test are presented, and comparisons are made to previous tests of the same configuration tested as a semispan model (Stewrt, 1983). Also presented are data showing the effects of large flap deflection and the effect of nozzle span. Comparisons of the test results with jet-flap theory are made and indicate good agreement. Author

A85-13509#

NUMERICAL SOLUTIONS OF THE EULER EQUATIONS FOR COMPLEX THREE-DIMENSIONAL AERODYNAMIC CONFIGURATIONS

J. E. DEESE, R. K. AGARWAL (McDonnell Douglas Research Laboratories, St. Louis, MO), and R. R. UNDERWOOD (McDonnell Douglas Automation Co., St. Louis, MO) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 11 p. refs

(AIAA PAPER 84-2399)

An Euler code has been developed for the treatment of flowfields about several three-dimensional aircraft components. The Euler equations are solved on body-conforming curvilinear grids using an explicit Runge-Kutta time-marching finite-volume method. Grids are generated using both algebraic and elliptic partial differential equation methods. Results are presented for nacelle inlet, wing, wing-body, and wing-with-nacelle configurations. These results are compared with experimental data, solutions of the potential equation, and other Euler solutions when available. Author

A85-13562#

COMPARISON OF MODEL AND FULL SCALE INLET DISTORTIONS FOR SUBSONIC COMMERCIAL TRANSPORT INLETS

D. L. MOTYCKA (Pratt and Whitney Group, East Hartford, CT), S. W. WELLING, and F. A. LEWIS-SMITH (Boeing Commercial Airplane Co., Seattle, WA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p.

(AIAA PAPER 84-2487)

The paper shows that the common practice of using scale model inlet distortion to evaluate high angle of attack engine/inlet compatibility on subsonic commercial aircraft is conservative, especially when the inlet lower lip is separated. The angle of attack at separation is shown to be Reynolds number sensitive; the higher Reynolds number full scale configuration separates at a higher angle. The magnitude of distortion with a separated inlet is reduced by the favorable coupling effect of the fan and inlet. Author

A85-13570*# Texas A&M Univ., College Station.

DESIGN PARAMETERS FOR FLOW ENERGIZERS

D. T. WARD and R. S. BINFORD (Texas A&M University, College Station, TX) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 8 p. Research supported by Texas A&M University. refs

(Contract NAG1-344)

(AIAA PAPER 84-2499)

One of the most significant uses of flow energizers, which are small highly swept strakes mounted immediately above a lifting surface, is in flow control over regions where a lifting surface is joined to another body, such as a fuselage or nacelle. In the presently reported systematic wind tunnel test study of flow energizers, 14 different geometric configurations using a 75-deg sweep flow energizer were tested on a light twin-engine general aviation aircraft model. It is found that cambered flow energizers perform better than their flat counterparts. All but two of the energizer installations developed lower L/D at cruise angles of attack, lower maximum lift coefficients, and lower stall angles of attack than the baseline model. O.C.

A85-13651

AIR FLOW AND PARTICLE TRAJECTORIES AROUND AIRCRAFT FUSELAGES. I - THEORY

W. D. KING (Commonwealth Scientific and Industrial Research Organization, Cloud Physics Laboratory, Sydney, Australia) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 1, March 1984, p. 5-13. refs

A potential-flow sink-source technique is used to model the flows around fuselage shapes. It is shown that the flow in any plane can be approximated reasonably well using an axisymmetric model of similar shape and that at a few fuselage radii from the nose the flow is determined principally by the size of the fuselage radius. Departures from the free-stream velocity are typically less than 10 percent and vary as the inverse square of the scaled distance from the nose. Analyses of water drop trajectories around three different aircraft shapes show that two of the more important features of the trajectories, the width of the shadow zone and the concentration enhancement factors, can be described quite generally in terms of a scaled fuselage radius and a parameter similar to the Stokes number. Thus the maximum width of the shadow zone is shown to be about one-fifth of the fuselage radius and occurs for a combination of particle size and aircraft speed for which the modified Stokes parameter has a value of about 6. Author

A85-13677#

MODULAR POTENTIAL FLOW COMPUTATION INCLUDING FUSELAGE AND WING TIP EFFECTS

A. LUNTZ and B. EPSTEIN (Israel Aircraft Industries, Ltd., Lod, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 5-8. refs

In a satisfactory analysis of the potential flow around an aircraft, it is necessary to take into consideration interaction effects related to the different parts of the aircraft. Luntz (1982) has used for such an analysis the Modular Computation approach. In this approach, independent codes are used for the transonic flow computation around different parts of the aircraft. In the present investigation, the Modular Computation approach is employed to solve a different problem. It was found that results obtained with the aid of the FLO22 code are not satisfactory in the wing tip region, especialy for highly swept wings. In the current study, arguments are provided in support of statements that the inaccuracy is due mostly to the inadequate approximation of the flow outboard of the wing tip, while the flow representation on the wing itself is satisfactory. Attention is also given to approaches for achieving good analytical results in the wing tip region. G.R.

A85-13678#

INVESTIGATION OF THE AXIAL VELOCITIES INDUCED ALONG ROTATING BLADES BY TRAILING HELICAL VORTICES

O. RAND and A. ROSEN (Technion - Israel Institute of Technology, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 9-16. refs

An efficient scheme to calculate the axial velocities which are induced by helical vortex lines trailing behind rotating blades, is presented. This scheme reduces the numerical effort by up to three orders of magnitude compared to regular numerical integration. The new numerical scheme is then used in order to investigate the influence of the number of blades and the velocity of the vortex elements, on the induced velocities. It is shown that the numerical results converge to the existing results for infinite number of blades. The approximation where the helical lines are replaced by straight vortex filament is also examined. Author

A85-13689#

LIFTING ROTOR ANALYSIS AT SUBSONIC AND TRANSONIC FLOW

R. ARIELI (Rafael Armament Development Authority, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 115-120. refs

An analysis is presented of the quasi-steady supercritical flow over a lifting rotor blade in hover or forward flight. The three dimensional flow effects are properly accounted for by solving the full velocity potential equation for a blade of arbitrary geometry and location on the rotor disc. Vortex interactions are incorporated in the analysis via: (1) Appropriate boundary conditions across the blade trailing vortex sheet, and (2) The approximate Willmer's method is used to simulate the preceding blade tip vortex. Viscous and unsteady effects are neglected. The computations compare well with wind tunnel test data, and qualitatively fit the classical rotor blade loading. Author

A85-13698#

THE AERODYNAMIC DRAG CHARACTERISTICS OF THE LOCHKEGELLEITWERK

G. GLOTZ, J. LEEKER, and H. SCHILLING (Rheinmetall GmbH, Duesseldorf, West Germany) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 221-227.

The aerodynamics of the Lochkegelleitwerk (LKL) empennage developed to control the flight characteristics and range of practice ammunition projectiles are described. The LKL was developed to mimic regular ammunition for the first 2500 m of flight, and then cause the projectile flight to be curtailed by drag forces shortly thereafter. Holes of specific diameters and at a calculated distances from the projectile axis were drilled clear through the tail cone. The holes formed a concentric circle around the projectile. Schlieren photographs are provided of Mach 1, 1.5, and 2.5 flows past the LKL, which introduces increased wave drag. The LKL can be fired from both smooth and rifled gun tubes. M.S.K.

A85-13723* Imperial Coll. of Science and Technology, London (England).

ON THE STABILITY OF AN INFINITE SWEPT ATTACHMENT LINE BOUNDARY LAYER

P. HALL (Imperial College of Science and Technology, London, England), M. R. MALIK (High Technology Corp., Hampton, VA), and D. I. A. POLL (Cranfield Institute of Technology, Cranfield, Beds., England) Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences (ISSN 0080-4630), vol. 395, no. 1809, Oct. 8, 1984, p. 229-245. Previously announced in STAR as N84-19285. refs

(Contract NAS1-17070; NAS1-16916; NAS1-14605)

The instability of an infinite swept attachment line boundary layer is considered in the linear regime. The basic three dimensional flow is shown to be susceptible to travelling wave disturbances which propagate along the attachment line. The effect of suction on the instability is discussed and the results suggest that the attachment in boundary layer on a swept wing can be significantly stabilized by extremely small amounts of suction. The results obtained are in excellent agreement with the available experimental observations. Author

A85-13794

TRANSFORMATION OF ACOUSTIC DISTURBANCES INTO COHERENT STRUCTURES IN THE TURBULENT WAKE OF AN AIRFOIL [PREOBRAZOVANIE AKUSTICHESKIKH VOZMUSHCHENII V KOGERENTNYE STRUKTURY V TURBULENTNOM SLEDE ZA PROFILEM]

S. P. BARDAKHANOV, V. V. KOZLOV, and N. N. IANENKO (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Inzhenerno-Fizicheskii Zhurnal (ISSN 0021-0285), vol. 47, Oct. 1984, p. 533-536. In Russian.

The effect of a superimposed acoustic field on turbulent flow in the wake of an airfoil was investigated in a subsonic wind tunnel at an incident flow velocity of 16.5 m/s, and at model angles of attack of 0 and 8.5 deg. Results presented for a body with a sharp trailing edge indicate that the acoustic disturbances are transformed into coherent vortex structures with a frequency corresponding to the acoustic-oscillation frequency. At a sufficient sound intensity, these structures can affect the integral flow characteristics and produce a significant change in the heat and mass transfer in the flow. It is noted that such factors should be taken into account in the investigation of turbomachinery. L.M.

A85-13795
CERTAIN FEATURES CHARACTERIZING THE DEVELOPMENT OF COHERENT FLOW STRUCTURES IN THE INITIAL REGION OF THREE-DIMENSIONAL TURBULENT JETS [NEKOTORYE OSOBENNOSTI RAZVITIIA KOGERENTNYKH STRUKTUR TECHENIIA NA NACHAL'NOM UCHASTKE TREKHMERNYKH TURBULENTNYKH STRUI]
L. N. UKHANOVA and L. N. VOITOVICH Inzhenerno-Fizicheskii Zhurnal (ISSN 0021-0285), vol. 47, Oct. 1984, p. 537-543. In Russian. refs

An experimental study was made of the characteristics of coherent structures within the initial region of submerged air jets issuing from shaped nozzles with rectangular outlet cross sections (lambda = 4.77 and 9.85) and a rectangular slot with an aspect ratio of 9.77 in a flat diaphragm. The Reynolds number based on the outflow velocity and the width of the outlet orifice was (4-9.2) x 10 to the 4th. The initial outflow conditions were found to have a significant effect on the coherent structure within the initial region of the three-dimensional jet. In addition, the convection velocity of the coherent structure along the initial region was found to vary over the cross section. Finally, the response of the three-dimensional jet to acoustic effects was found to be similar to the responses of two-dimensional and circular jets. L.M.

A85-13951#
COMPUTATIONAL SIMULATION OF FREE VORTEX FLOWS USING AN EULER CODE
P. RAJ (Lockheed-California Co., Burbank, CA) International Council of the Aeronautical Sciences, Congress, 14th, Toulouse, France, Sept. 9-14, 1984, Paper. 10 p. Research supported by Lockheed-California Co. refs

Three-dimensional flows dominated by free vortices, such as the flow about a small aspect-ratio slender wing at high angles of attack, are simulated by an Euler code. The basic solution algorithm of this code is based on finite-volume spatial discretization and Runge-Kutta time-stepping technique. Additional modifications to improve computational efficiency and accuracy have been incorporated. Correlations of computed results with experimental data are presented at subsonic and transonic Mach numbers. In all cases, the flow is impulsively started and the vorticity is automatically captured. The present approach promises to evolve into a powerful method for engineering analysis and design of high-speed aircraft. Author

A85-13952#
A MULTIGRID METHOD FOR COMPUTING THE TRANSONIC FLOW OVER TWO CLOSELY-COUPLED AIRFOIL COMPONENTS
G. VOLPE (Grumman Research and Development Center, Bethpage, NY) International Council of the Aeronautical Sciences, Congress, 14th, Toulouse, France, Sept. 9-14, 1984, Paper. 14 p. refs

The supercritical potential flow over a general configuration composed of two airfoil elements is solved by a multigrid-approximate factorization method. The infinite physical domain is mapped conformally into an annulus whose boundaries represent the two airfoil components. A stretched polar coordinate grid within the annulus provides the computational mesh for the numerical scheme. The continuity equation, which describes the flow, is discretized in full conservation form, and an artificial compressibility scheme introduces the necessary bias for stability in regions of supersonic flow. The method is fully second-order accurate in subsonic regions and partially so in supersonic regions. It is at least one order of magnitude faster than relaxation methods despite the highly nonuniform grid. Viscid-inviscid interaction is computed by iterating on the outer inviscid flow using a surface source distribution determined from the inner boundary layer flow. The boundary layer development is calculated by Green's lag-entrainment method, and empirical corrections are used in regions of high interaction such as trailing edges. The method proposed has been tested on a wide variety of cases, and good agreement with experimental data has been observed, especially in cases where no flow separation is present. Author

A85-13960*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
CALCULATION OF UNSTEADY FAN ROTOR RESPONSE CAUSED BY DOWNSTREAM FLOW DISTORTIONS
W. F. OBRIEN, S. M. RICHARDSON, and W. F. NG (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 8 p. refs
(Contract NAG1-156)
(AIAA PAPER 84-2282)

The present model for fan rotor/support strut airfoil interaction uses a time-marching code for the rotor flow, coupled with a potential flow model for the stator-strut region. Study of the effect of strut design variables indicates that rotor flow disturbance is increased by the primary variables of larger strut thickness and circumferential spacing, while decreasing exponentially with increased rotor-strut separation. The time-marching code predicts local rotor pressure and flow perturbations in response to an unsteady downstream boundary condition. O.C.

A85-13964*# Lockheed-Georgia Co., Marietta.
NUMERICAL SIMULATION OF THE TRANSONIC FLOWFIELD FOR WING/NACELLE CONFIGURATIONS
E. H. ATTA and J. VADYAK (Lockheed-Georgia Co., Marietta, GA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 15 p. Research supported by the Lockheed Independent Research and Development Program. refs
(Contract NAS2-11285)
(AIAA PAPER 84-2430)

An efficient grid-interfacing zonal algorithm has been developed for computing the three-dimensional transonic flow field about wing/nacelle multicomponent configurations. The algorithm uses the full-potential formulation and the AF2 fully-implicit approximate factorization scheme. The flow field position is computed using a component-adaptive grid approach in which separate grids are employed for the individual components in the multicomponent configuration, where each component grid is optimized for a particular geometry such as the wing or nacelle. The wing and nacelle component grids are allowed to overlap, and flow field information is transmitted from one grid to another through the overlap region using trivariate interpolation. This paper presents a discussion of the computational methods used to generate both the wing and nacelle component grids, the technique used to interface the component grids, and the method used to obtain the inviscid multicomponent flow field solution. Computed results and correlations with experiment are presented to illustrate application of the analysis. Author

A85-14008
STEADY BASE FLOWS
M. TANNER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer theoretische Stroemungsmechanik, Goettingen, West Germany) Progress in Aerospace Sciences (ISSN 0376-0421), vol. 21, no. 2, 1984, p. 81-157. refs

This article begins with a discussion of the physical properties of base flows and of various velocity profiles used in theories for predicting the base pressure. Then the theories based on the Chapman-Korst flow model are briefly described with particular reference to their reattachment criteria, which are central to these theories. A new theory of the present author is then introduced which does not use a reattachment criterion but applies the relation between the drag of the body and the entropy increase in the flow. Predicted results are compared with experimental data and this new theory is shown to give better agreement than the older ones. Author

A85-14239

THE EFFECT OF COOLING ON SUPERSONIC BOUNDARY-LAYER STABILITY

V. L. LYSENKO and A. A. MASLOV (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 147, Oct. 1984, p. 39-52. refs

An experimental wind tunnel study of the development of small natural disturbances in the boundary layer of a cooled flat plate for Mach numbers two, three, and four is described, and the results are compared with calculative findings. The results confirm the main conclusions of the linear theory of hydrodynamic stability with regard to surface cooling. It is found that surface cooling stabilizes the first-mode disturbances, destabilizes the second-mode disturbances, may lead to the region of unstable frequencies of the first mode being divided into two, and does not affect the interaction of acoustic waves and the supersonic boundary layer. C.D.

A85-14242

UNSTEADY BOUNDARY LAYERS CLOSE TO THE STAGNATION REGION OF SLENDER BODIES

T. CEBECI, S. M. SCHIMKE (Douglas Aircraft Co., Long Beach, CA), and K. STEWARTSON Journal of Fluid Mechanics (ISSN 0022-1120), vol. 147, Oct. 1984, p. 315-332. refs

(Contract F49620-82-C-0055; NSF MEA-80-18565)

The evolution of the unsteady boundary layer on the line of symmetry of a paraboloid that is set impulsively into motion with uniform velocity and at angles of attack between 30 and 50 deg is studied. It is shown that if the angle of attack is less than roughly 41 deg and the steady state boundary layer exists everywhere on this line, the unsteady solution approaches it reasonably quickly and without any significant special features. The same is true for angles larger than 41 deg on the windward side. On the leeward side the steady state boundary layer separates, and the solution must terminate there because the external pressure gradient is fixed. The unsteady boundary layer is initially unseparated, but develops a region of reversed flow after a finite time. A short time later the first displacement thickness develops a pronounced peak, and it is argued that this is associated with an incipient singularity which terminates the calculation. C.D.

A85-14244

REYNOLDS-STRESS MEASUREMENTS IN A TURBULENT TRAILING VORTEX

W. R. C. PHILLIPS (Melbourne, University, Parkville, Victoria, Australia; McGill University, Quebec, Canada) and J. A. H. GRAHAM (Pratt and Whitney Canada, Longueuil; McGill University, Quebec, Canada) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 147, Oct. 1984, p. 353-371. Research supported by the Defence Research Board; National Research Council of Canada. refs

(Contract NRC A-7096)

An experimental investigation of a turbulent trailing vortex in zero pressure gradient, including the mean velocities and all the components of the Reynolds stress tensor, is described. The measurements were made using linearized hot wires at stations downstream of the wing. Axisymmetric jets or wakes were added coaxially to the vortex while the total circulation was held constant, and their effect was examined. It was found that increasing the flow force hastens the radial dispersion of vorticity; this phenomenon is seen to be concurrent with higher turbulence intensities and Reynolds shear stresses. A balance of terms in the mean momentum equations is presented and discussed. It is seen that the terms that contain the radial velocity cannot be ignored unless the magnitude of the flow force is much less than the square of the total circulation. C.D.

A85-14344#

ORGANIZED STRUCTURES IN WAKES AND JETS - AN AERODYNAMIC RESONANCE PHENOMENON

W. KOCH (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer theoretische Stroemungsmechanik, Goettingen, West Germany) IN: Symposium on Turbulent Shear Flows, 4th, Karlsruhe, West Germany, September 12-14, 1983, Proceedings . University Park, PA, Pennsylvania State University, 1984, p. 5.13-5.18. refs

An attempt is made to determine the shedding frequency of the flow past blunt edged plates by computing the natural frequencies of the system. The flow is split into a steady viscous part which is modeled and an unsteady inviscid part which defines a resonance condition. According to linear theory this resonance condition requires a bifurcation of the instability eigenvalue which provides a surprisingly good estimate of the shedding frequency if a realistic mean wake model is employed. Author

A85-14345#

TURBULENT BOUNDARY LAYER-WAKE INTERACTION

E. P. TSIOLAKIS, E. KRAUSE, and U. R. MUELLER (Aachen, Rheinisch-Westfaelische Technische Hochschule, Aachen, West Germany) IN: Symposium on Turbulent Shear Flows, 4th, Karlsruhe, West Germany, September 12-14, 1983, Proceedings . University Park, PA, Pennsylvania State University, 1984, p. 5.19-5.24. refs

The interaction of a two-dimensional, incompressible, turbulent boundary layer on a flat plate with a plane wake of a circular cylinder was investigated experimentally and theoretically. The cylinder was positioned at various distances above the plate, with the axis normal to the free-stream direction and parallel to the surface of the plate. The time-averaged velocity components, the Reynolds stresses, the wall-pressure distribution and the wall shear stresses were measured downstream from the cylinder in the wake and in the boundary layer. Mean and fluctuating velocities were measured with hot-wire probes, conventional data reduction was used. It could be shown that the wake retains its self-preserving characteristics in the outer part and approximately in the inner layer as well. The profiles of the Reynolds stresses in the interacting part of the flow were used to deduce a mixing-length closure assumption, which was incorporated in a numerical finite-difference simulation of the relaxing boundary layer. Author

A85-14355#

MEASUREMENTS IN A TURBULENT RECTANGULAR FREE JET

A. POLLARD, G. F. MARSTERS (Queen's University, Kingston, Ontario, Canada), and W. R. QUINN IN: Symposium on Turbulent Shear Flows, 4th, Karlsruhe, West Germany, September 12-14, 1983, Proceedings . University Park, PA, Pennsylvania State University, 1984, p. 7.1-7.6. Research supported by the Natural Sciences and Engineering Research Council of Canada. refs

Mean velocities and turbulence quantities have been measured using hot-wire anemometry in the two central planes of a turbulent free jet of air issuing into still air surroundings from a sharp-edged rectangular slot of aspect ratio 10. It is found that the mean streamwise velocity decay on the jet centerline consists of four regions: a core region, a typical decay region, a transition region and a final decay region; also the mean streamwise velocity profiles in the plane of the slot major axis are characterized by off-center peaks within the typical decay region. The data imply that there may be some negative production of turbulence kinetic energy in the neighborhood of the off-center velocity peaks. The flow does not seem to be completely self-preserving in the region investigated. Author

A85-14357#
ON A FORCED ELLIPTIC JET
E. GUTMARK and C. M. HO (Southern California, University, Los Angeles, CA) IN: Symposium on Turbulent Shear Flows, 4th, Karlsruhe, West Germany, September 12-14, 1983, Proceedings . University Park, PA, Pennsylvania State University, 1984, p. 7.13-7.17. refs
(Contract F49620-82-K-0019)

A forced elliptic jet of small aspect ratio (2:1) was studied experimentally. The measurements included flow visualization in a water jet and hot-wire measurements in an air jet. The flow visualization results show clearly the switching of the major and minor axes of the elliptic vortex rings convected downstream. At low forcing frequencies, the deformation of the vortex rings in the jet, agrees with the analysis of an isolated elliptic vortex. At high forcing frequencies, vortex merging occurred. The evolution of the vortices during merging was very complicated. The measured velocity field of the forced jet was similar to the unforced case. For example, the difference of the flow fields in the major and minor sides was evident. The large spreading rate of the minor axis side relative to the low rate of the major axis side resulted in a switching of the jet axes. Author

A85-14390*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LARGE-SCALE COHERENT STRUCTURE AND FAR-FIELD JET NOISE
K. B. M. Q. ZAMAN (NASA, Langley Research Center, Hampton, VA) IN: Symposium on Turbulent Shear Flows, 4th, Karlsruhe, West Germany, September 12-14, 1983, Proceedings . University Park, PA, Pennsylvania State University, 1984, p. 16.23-16.28. refs

The phenomenon of broadband noise amplification/suppression under controlled excitation is investigated. The suppression is found to occur only at low jet speeds when the exit boundary layer is laminar; excitation at a Strouhal St(theta) number of about 0.017 results in optimum suppression of the far-field broadband noise as well as of the near-flow-field turbulence. The noise amplification is found to be a function of the Mach number, the amplification is higher at higher Mach number for a given excitation Strouhal number and level. The amplification also depends on the Strouhal number (St D), the maximum occurring in the range 0.65-0.85. Vortex pairing induced by the excitation appears to be at the heart of the noise amplification phenomenon under excitation. Author

A85-14590
A STUDY OF SEPARATED FLOW BEHIND TWO- AND THREE-DIMENSIONAL BODIES EXPOSED TO A SPHERICAL SHOCK WAVE [ISSLEDOVANIE OTRYVNOGO TECHENIIA ZA PLOSKIMI I PROSTRANSTVENNYMI TELAMI PRI DEISTVII NA NIKH SFERICHESKOI UDARNOI VOLNY]
A. N. IVANOV and V. I. MIKHAILOV PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), July-Aug. 1984, p. 60-64. In Russian. refs

The incidence of a spherical shock wave on stationary bodies has been studied using high-speed cinematography. The dynamics of the evolution of a trailing vortex behind bodies is discussed, and differences between steady and unsteady flow patterns are demonstrated. Results are presented for subsonic velocities of the incoming flow over a large range of Strouhal and Reynolds numbers. V.L.

A85-14591
HYPERSONIC FLOW PAST A WING AT LARGE ANGLES OF ATTACK [GIPERZVUKOVOE OBTEKANIE KRYLA PRI BOL'SHIKH UGLAKH ATAKI]
V. N. GOLUBKIN PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), July-Aug. 1984, p. 65-70. In Russian. refs

The method of a thin shock layer is used to investigate three-dimensional hypersonic flow past a slender finite-span wing at large angles of attack. The boundary value problem is formulated, and similarity laws are obtained. It is found that the flow component of vorticity remains constant along the lines of flow. Analytical expressions for gas dynamic functions are obtained, as are systems of equations for the shape of the shock wave. V.L.

A85-14851
SOME EFFECTS OF SWEEP DIRECTION AND STRAKES FOR WINGS WITH SHARP LEADING EDGES
D. I. A. POLL (Cranfield Institute of Technology, Cranfield, Beds., England) and C.-H. QIU (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) Aeronautical Journal (ISSN 0001-9240), vol. 88, Oct. 1984, p. 337-347. refs

An experiment which demonstrates the effects of sweep direction on the aerodynamic characteristics of several wing planforms has been carried out. The wings have biconvex airfoil sections and the planforms are untwisted thus reducing the number of independent variables as well as allowing the wings to be tested in both the forward-swept and backward-swept configurations. Measurements of lift, drag and pitching moment have been made for angles of incidence in the range -5 to +50 deg. These measurements and the oil-flow visualizations were performed at a wind speed of 30 m/s, giving a Reynolds number based upon the mean aerodynamic chord of the wings of between 120,000 and 180,000. The investigation has shown that, in low-speed flow, the aerodynamic characteristics of untwisted wing planforms having biconvex airfoil sections exhibit a dependence upon sweep direction which varies with incidence, sweep angle magnitude, taper ratio and aspect ratio. To complement the force and moment measurements, a comprehensive series of surface oil-flow visualizations have also been considered, together with the aerodynamic characteristics of simple strakes, which improved the lifting characteristics of all the configurations. M.D.

A85-14852
HIGH FREQUENCY PROPERTIES IN THE UNSTEADY LINEARISED POTENTIAL FLOW OF A COMPRESSIBLE FLUID
D. J. SALMOND (Royal Aircraft Establishment, Farnborough, Hants., England) and F. T. SMITH (Imperial College of Science and Technology, London, England) Aeronautical Journal (ISSN 0001-9240), vol. 88, Oct. 1984, p. 348-356. refs

The unsteady planar flow of inviscid compressible fluid past an oscillating airfoil is considered. Many recent computational studies have experienced difficulties in obtaining accurate, or any, results at medium or higher frequencies of oscillation. This may well be due to the emergence of multi-scaling and multi-regions according to the present analytical study which concentrates on the large frequency properties of the linearized flowfield. Multi-scaled dependence in the solution is found to occur in both the streamwise and transverse directions. Comparisons are made with computational results. Author

A85-14853
HYPERSONIC LARGE-DEFLECTION SIMILITUDE FOR OSCILLATING DELTA WINGS
K. GHOSH (Indian Institute of Technology, Kanpur, India) Aeronautical Journal (ISSN 0001-9240), vol. 88, Oct. 1984, p. 357-361. refs

A similitude has been obtained for delta wings with attached leading edge shock at large incidence in hypersonic flow. A strip theory in which flow at a spanwise location is two-dimensional has been developed. This combines with the similitude to lead to a piston theory which gives closed form solutions for unsteady derivatives in pitch and roll. The derivatives in pitch are independent of and the roll damping derivative varies linearly with the aspect ratio. Substantially the same results as the theory of Liu and Hui are obtained with remarkable computational ease. Author

A85-14854
WING TIP SAILS WHICH GIVE LOWER DRAG AT ALL NORMAL FLIGHT SPEEDS
J. J. SPILLMAN and A. M. MCVITIE (Cranfield Institute of Technology, Cranfield, Beds., England) Aeronautical Journal (ISSN 0001-9240), vol. 88, Oct. 1984, p. 362-369. Research supported by the Science and Engineering Research Council and British Technology Group.

Wing tunnel tests on a simple untapered, unswept wing with wing tip sails have been described in order to examine the benefits from such a design approach and subsequent flight tests on an aircraft to confirm them. The wing has a constant chord of 0.61 m and a span of 1.68 m with an airfoil section having a 12 percent thickness to chord ratio. Tests results showed that the big wing and all the configurations with sails had greater drag coefficients than the basic wing at lift coefficients below 0.2 to 0.3 but had lower drag coefficients at the higher lift coefficients. Three series of flight tests, involving fuel flow measurements, rolling performance and stalling checks were made and the performance and handling characteristics with and without sails was evaluated. By fitting the sails, the fuel flow rate was reduced over the whole working speed range of the aircraft. The tests prove that handling characteristics are not impaired by the addition of wing tip sails and that the drag of a wing can be reduced over the full lift if wing tips sails are designed to replace the tip of a planar wing.
M.D.

A85-14889#
A METHOD FOR CALCULATING TURBULENT 3-D FLOWS IN DIFFUSERS
B. COURBET (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 3, May-June 1984, p. 1-11. refs

A method is described for calculating turbulent 3-D flows through diffusers. The pseudo-unsteady Reynolds equations, complemented by a 'mixing length' type model of turbulence, are expressed in a curvilinear coordinate system and are discretized through space by a staggered grid technique. For the time integration, an ADI method was applied, found by approximate factorization of a linearized implicit scheme. The numerical results are compared with experimental data for an axial diffuser and for a centrifugal compressor diffuser. Author

A85-14893#
COMPUTATION OF UNSTEADY AERODYNAMIC PRESSURE COEFFICIENTS IN A TRANSONIC STRAIGHT CASCADE
G. D. MORTCHELEWICZ and J. J. ANGELINI (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 3, May-June 1984, p. 57-68. refs

A numerical solution for an inviscid ideal gas is presented. The approach is that of unsteady transonic small disturbance theory, applied to a straight cascade. The method is applied to the case of compressor blades (sharp leading edge, slightly cambered). The unsteady problem is solved in a configuration where all the blades are vibrating with a constant relative phase angle, making it possible to limit the calculation to two interblade channels. The method is an extension of the A.D.I. method. Numerical examples are given for steady and unsteady cases.
Author

A85-14894#
CALCULATION OF STREAMLINES FROM WALL PRESSURES ON A FUSIFORM BODY
C. GLEYZES and J. COUSTEIX (ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 3, May-June 1984, p. 69-77. refs

The proposed method for calculating streamlines from a wall pressure distribution is based on the integration of the Euler equations. The initial conditions are determined by a preliminary calculation in the neighborhood of the stagnation point: the equations are integrated by marching against the flow and the direction of the velocity is adjusted by a shooting method in such a way that the streamlines cross the stagnation point. From the initial conditions, the equations are integrated by marching in the flow direction. This integration is performed in an axis-system, the pole of which coincides with the stagnation point. Such an axis-system can also be of use in boundary layer calculations.
Author

A85-15077
METHOD OF FUNDAMENTAL SOLUTIONS - A NOVEL THEORY OF LIFTING SURFACE IN A SUBSONIC FLOW
L. DRAGOS (Bucuresti, Universitatea, Bucharest, Rumania) Archiwum Mechaniki Stosowanej (ISSN 0373-2029), vol. 35, no. 5-6, 1983, p. 579-590. refs

A three-dimensional analysis is performed of compressible fluids in a subsonic flow by means of a model wherein the solid body is replaced by a continuous distribution of momentum sources. A typical momentum source is defined for one point on the body and integrated over the surface. Disturbances in the fluid are treated as discontinuous superpositions of perturbations. The model is used to define a solution for the theory of lifting surfaces by assuming that the perturbations produced in the fluid by an airfoil can be described by linearized equations of motion. An integral equation is formulated for the lifting surface and solutions are obtained for the planar problem and Prandtl's lifting line equation.
M.S.K.

A85-15327*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ANALYSIS OF AIRFOIL LEADING-EDGE SEPARATION BUBBLES
V. N. VATSA (NASA, Langley Research Center, Hampton, VA; University Technologies Research Center, East Hartford, CT) and J. E. CARTER (United Technologies Research Center, East Hartford, CT) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1697-1704. Previously announced in STAR as N83-10018. refs
(Contract NAS1-16585)
(AIAA PAPER 83-0300)

A local inviscid-viscous interaction technique was developed for the analysis of low speed airfoil leading edge transitional separation bubbles. In this analysis an inverse boundary layer finite difference analysis is solved iteratively with a Cauchy integral representation of the inviscid flow which is assumed to be a linear perturbation to a known global viscous airfoil analysis. Favorable comparisons with data indicate the overall validity of the present localized interaction approach. In addition numerical tests were performed to test the sensitivity of the computed results to the mesh size, limits on the Cauchy integral, and the location of the transition region. Author

A85-15329#
THE CIRCULAR CYLINDER IN SUBSONIC AND TRANSONIC FLOW
O. RODRIGUEZ (Lille I, Universite, Lille, France) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1713-1718. Research supported by the Direction des Recherches, Etudes et Techniques. refs

This paper provides new results describing compressible fluid flow around a cylinder. The investigation was restricted to subsonic and transonic flow at Reynolds numbers of about 100,000. The experiments showed that a strong coupling exists between the flow over a cylinder and the vortex street formed in the near wake. The phenomenon was investigated using high-speed visualization synchronized with unsteady pressure measurements. Various coupling regimes were classified, and instantaneous pressure distributions were obtained at different times during the vortex street period. From these elements it was possible to deduce the unsteady force. Author

A85-15331*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EFFECT OF INITIAL CONDITIONS ON TURBULENT REATTACHMENT DOWNSTREAM OF A BACKWARD-FACING STEP
R. V. WESTPHAL (NASA, Ames Research Center, Moffett Field; Stanford University, Stanford, CA) and J. P. JOHNSTON (Stanford University, Stanford, CA) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1727-1732. NSF-supported research. refs
(Contract NAG2-42)

The reattachment of a fully turbulent, two-dimentional shear layer downstream of a backward-facing step has been studied experimentally. The work examines the effect of variations in inlet conditions on the process of reattachment. A series of experiments was conducted in a low-speed wind tunnel using specialized instrumentation suited to the highly turbulent reversing flow near reattachment. Accurate characterization of the time-mean features of the reattaching flows was possible. Assuming linear scaling normalized on distance from reattachment, distributions of normalized pressure coefficient and forward flow fraction, and time-averaged skin friction coefficient appear universal for two-dimensional reattachment, independent of initial conditions and step height, for given duct geometry (area ratio) and for high step-height Reyolds numbers with thin separating boundary layers. The results suggest universal flow structure in the reattachment zone. Author

A85-15332#
LIFT HYSTERESIS OF AN OSCILLATING SLENDER ELLIPSE
M. A. TAKALLU (Old Dominion University, Norfolk, VA) and J. C. WILLIAMS, III (Auburn University, Auburn, AL) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1733-1741. refs

A theoretial investigation has been conducted to determine the timewise variation of lift on a slender elliptic cylinder moving at uniform speed but oscillating in pitch. The analysis couples a potential flow calculation, including the effect of a vortical wake, for the flow past the cylinder with a calculation of the unsteady, two-dimensional, laminar boundary layer on the surfaces of the pitching ellipse. The coupling is achieved by matching the rate at which boundary-layer-developed vorticity is shed into the wake with the time rate of circulation about the ellipse. The unsteady lift is determined from an integration of the unsteady pressure distribution on the body. The effects of mean angle of attack and oscillation frequency on the lift hysteresis loops are determined. It is shown that the hysteresis loops change direction as the mean angle of attack is increased through the angle of attack corresponding to maximum steady lift. Author

A85-15334*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A GENERAL PERTURBATION APPROACH FOR COMPUTATIONAL FLUID DYNAMICS
L. J. CHOW, T. H. PULLIAM (NASA, Ames Research Center, Moffett Field, CA), and J. L. STEGER (Stanford University, Stanford, CA) (Computational Fluid Dynamics Conference, 6th, Danvers, MA, July 13-15, 1983, Collection of Technical Papers, p. 609-620) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1748-1754. Previously cited in issue 18, p. 2637, Accession no. A83-39411. refs

A85-15335*# Iowa State Univ. of Science and Technology, Ames.
APPLICATION OF THE IMPLICIT MACCORMACK SCHEME TO THE PARABOLIZED NAVIER-STOKES EQUATIONS
S. L. LAWRENCE, J. C. TANNEHILL (Iowa State University of Science and Technology, Ames, IA), and D. S. CHAUSSEE (NASA, Ames Research Center, Moffett Field, CA) (Computational Fluid Dynamics Conference, 6th, Danvers, MA, July 13-15, 1983, Collection of Technical Papers, p. 483-493) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1755-1763. Research supported by the Iowa State University of Science and Technology. Previously cited in issue 18, p. 2636, Accession no. A83-39399. refs
(Contract NCA2-OR-340-301)

A85-15336#
SURFACE PHENOMENA IN A THREE-DIMENSIONAL SKEWED SHOCK WAVE/LAMINAR BOUNDARY-LAYER INTERACTION
G. DEGREZ (Bruxelles, UniversiteLibre, Brussels, Belgium) and J. J. GINOUX (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese; Bruxelles, UniversiteLibre, Brussels, Belgium) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1764-1769. Previously cited in issue 17, p. 2446, Accession no. A83-37228. refs
(Contract AF-AFOSR-82-0051)

A85-15337#
ROLE OF CONSTRAINTS IN INVERSE DESIGN FOR TRANSONIC AIRFOILS
G. VOLPE and R. E. MELNIK (Grumman Aerospace Corp., Bethpage, NY) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1770-1778. Previously cited in issue 18, p. 3066, Accession no. A81-40322. refs
(Contract N00014-78-C-0476)

A85-15505#
EVALUATION OF MISSILE AERODYNAMIC CHARACTERISTICS USING RAPID PREDICTION TECHNIQUES
J. SUN and R. M. CUMMINGS (Hughes Aircraft Co., Canoga Park, CA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 21, Nov.-Dec. 1984, p. 513-520. Previously cited in issue 05, p. 581, Accession no. A83-16573. refs

A85-15506#
EFFECTS OF SLIP AND CHEMICAL REACTION MODELS ON THREE-DIMENSIONAL NONEQUILIBRIUM VISCOUS SHOCK-LAYER FLOWS
C. H. LEWIS (Virginia Polytechnic Institute and State University, Blacksburg, VA), S. SWAMINATHAN, and D. J. SONG Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 21, Nov.-Dec. 1984, p. 521-527. Previously cited in issue 15, p. 2120, Accession no. A83-34902. refs

A85-15838#
COMPUTATION OF UNSTEADY AERODYNAMIC PRESSURE COEFFICIENTS IN A TRANSONIC STRAIGHT CASCADE. II
G. D. MORTCHELEWICZ and J. J. ANGELINI (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (International Union of Theoretical and Applied Mechanics, Symposium on Unsteady Aerodynamics of Turbomachines and Propellers, Cambridge University, Cambridge, England, Sept. 23-27, 1984) ONERA, TP, no. 1984-118, 1984, 13 p. refs
(ONERA, TP NO. 1984-118)

A numerical solution for an inviscid ideal gas is presented. The approach is that of unsteady transonic small disturbance theory applied to a straight cascade. The method is applied to the case of compressor blades (sharp leading edges, slightly cambered) with a large stagger angle (50-70 degrees) and angle of attack (5-10 degrees). The unsteady problem is solved in a configuration where all the blades are vibrating with a constant relative phase angle. This allows calculation in two channels. This method is an extension of the A.D.I. method (Balhaus et al.). The main difficulty has been in the representation of periodic conditions both in space and time. Numerical examples are given for steady and unsteady cases. Author

A85-15840#
AERODYNAMIC METHODS USED IN FRANCE FOR THE STUDY OF PROPELLERS FOR HIGH-SPEED AIRCRAFT [METHODES AERODYNAMIQUES UTILISEES EN FRANCE POUR L'ETUDE DES HELICES POUR AVIONS RAPIDES]
J. M. BOUSQUET (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Symposium on Aerodynamics and Acoustics of Propellers, Toronto, Canada, Oct. 1-4, 1984) ONERA, TP, no. 1984-120, 1984, 16 p. In French. Research supported by the Direction des Recherches, Etudes et Techniques. refs
(ONERA, TP NO. 1984-120)
Computational techniques and programs currently in use in the design analysis of aircraft propellers are surveyed and illustrated with diagrams and graphs of typical results. Methods examined include lifting-line, incompressible lifting-surface, three-dimensional compressible, and three-dimensional Euler; both classical and advanced propeller designs are considered. The Euler analysis of the experimental propeller HT1 being developed for ONERA is explored in detail, evaluating the effects of tip-speed ratio, Mach number, number of blades, hub diameter, and a tapered-diameter hub shroud. T.K.

A85-15841#
MODERN PROPELLER PROFILES [PROFILS MODERNES POUR HELICES]
A. M. RODDE, J. J. THIBERT (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France), and J. J. CUNY (Societe Ratier-Figeac, Figeac, Lot, France) (NATO, AGARD, Symposium on Aerodynamics and Acoustics of Propellers, Toronto, Canada, Oct. 1-4, 1984) ONERA, TP, no. 1984-121, 1984, 13 p. In French. refs
(ONERA, TP NO. 1984-121)
The design of a family of advanced-profile composite aircraft propellers is presented, and the results of wind-tunnel tests performed at the ONERA Modane S3 and CEAT S10 facilities are reported. The design specifications are outlined; the definition of profiles with relative thicknesses 4, 7, 12, and 20 percent is explained; and the test results are presented in graphs and diagrams. Significant performance improvements (relative to a NACA 16707 reference profile) are observed, including 43 and 8 percent better lift/drag ratios for cruising and ascent, respectively, 15-percent better Cz max, and equivalent critical Mach number at lower drag. The first planned application is to the Transall C160 two-engine turboprop transport aircraft. T.K.

A85-15848#
ON THE USE OF INVERSE MODES OF CALCULATION IN 2D CASCADES AND DUCTS
G. MEAUZE (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (International Conference in Inverse Design Concepts in Engineering Sciences, Austin, TX, Oct. 17-19, 1984) ONERA, TP, no. 1984-132, 1984, 16 p. refs
(ONERA, TP NO. 1984-132)
Various applications of inverse or semiinverse mode calculations are reviewed. All the methods use time-marching, inviscid flow techniques. The methods are described, and their use in channel or duct flow and blade cascade flow is examined. C.D.

A85-15872
THEORETICAL AND EXPERIMENTAL RESEARCH TO DETERMINE LOAD LIMITS FOR HIGHLY LOADED AXIAL FLOW FANS [THEORETISCHE UND EXPERIMENTELLE UNTERSUCHUNGEN ZUR BESTIMMUNG DER BELASTUNGSGRENZE BEI HOCHBELASTETEN AXIALVENTILATOREN]
F. SCHILLER Braunschweig, Technische Universitaet, Fakultaet fuer Maschinenbau und Elektrotechnik, Dr.-Ing. Dissertation, 1984, 256 p. In German. Research supported by the Arbeitsgemeinschaft industrieller Forschungsvereinigungen and Forschungsvereinigung fuer Luft- und Trocknungstechnik. refs
The design and cost evaluation of highly loaded one-step axial fans are theoretically and experimentally investigated using design diagrams and loss curves developed by Lieblein. The question is studied whether an upper limit can be given for the characteristic blade load diffusion number of a blade element, a limit which cannot be exceeded in the design operation. The corrections to the two-dimensional cascade coefficients necessary for determining the requisite triangle of velocities is also addressed. A computer program based on a design by Lieblein is developed for the blading design and for simplified theoretical calculation of characteristic curves and fields. Nine bladings with different head clearances and separations between impellers were tested on an axial flow fan test bed, and the results are presented and discussed. C.D.

A85-15873
DEVELOPMENT OF A PROCEDURE FOR CALCULATING TWO-DIMENSIONAL BOUNDARY LAYERS AT GAS TURBINE BLADES [ENTWICKLUNG EINES VERFAHRENS ZUR BERECHNUNG ZWEIDIMENSIONALER GRENZSCHICHTEN AN GASTURBINENSCHAUFELN]
G. SCHEUERER Karlsruhe, Universitaet, Fakultaet fuer Maschinenbau, Dr.-Ing. Dissertation, 1983, 151 p. In German. Research supported by the Forschungsvereinigung Verbrennungskraftmaschinen. refs
A procedure for determining the external heat transfer rate for convectively cooled gas turbine blades is developed. The method is based on a numerical solution of the stationary, two-dimensional conservation equations for mass, momentum, and energy which characterize the velocity and temperature fields at the blades. The effect of turbulence on the mean flow field is described by the k-epsilon turbulence model. The turbulent heat flow is modelled by a turbulent Prandtl number concept. The equations of continuity, momentum, and energy as well as the model equations of turbulence k and epsilon are solved in boundary layer form using an adapted version of Spaulding's (1977) differential procedure. The developed procedure is applied to fully turbulent flows in which relevant effects such as external turbulence, pressure gradient, and curvature occuring at the turbine blades can be separately treated. The predictive power of the turbulence model is assessed and model weaknesses are identified and ameliorated. C.D.

A85-15884
A NUMERICAL ANALYSIS OF UNSTEADY SEPARATED FLOW BY THE DISCRETE VORTEX METHOD COMBINED WITH THE SINGULARITY METHOD
T. INAMURO, T. SAITO, and T. ADACHI (Mitsubishi Heavy Industries, Ltd., Nagasaki Technical Institute, Nagasaki, Japan) Computers and Structures (ISSN 0045-7949), vol. 19, no. 1-2, 1984, p. 75-84. refs
An innovative numerical method is described, which was developed to analyze unsteady aerodynamic forces acting on a structure in a separated flow. In this method, the flow around the structure is assumed to be a potential flow except in the region of free shear layers, and the region and the structure are represented by discrete vortices. This method is applied to calculations of the lift and drag coefficients and the Strouhal numbers for a stationary and a transversely oscillating square prism. The calculated results are compared with the experimental data, and a good agreement is shown. Author

N85-12008*# GMAF, Inc., Freeport, N.Y.
INVERSE DESIGN TECHNIQUE FOR CASCADES Final Report
L. ZANNETTI and M. PANDOLFI Washington NASA Nov. 1984 33 p refs
(Contract NAS3-22772)
(NASA-CR-3836; E-2275; NAS 1.26:3836) Avail: NTIS HC A03/MF A01 CSCL 01A
A numerical technique to generate cascades is presented. The basic prescribed parameters are: inlet angle, exit pressure, and distribution of blade thickness and lift along a blade. Other sets of parameters are also discussed. The technique is based on the lambda scheme. The problem of stability of the computation as a function of the prescribed set of parameters and the treatment of boundary conditions is discussed. A one dimensional analysis to

indicate a possible way for assuring stability for any two dimensional calculation is provided. E.A.K.

N85-12009*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
THE LATERAL-DIRECTIONAL CHARACTERISTICS OF A 74-DEGREE DELTA WING EMPLOYING GOTHIC PLANFORM VORTEX FLAPS
A. C. GRANTZ Washington NASA Nov. 1984 146 p refs
(Contract NGT-47-004-802)
(NASA-CR-3848; NAS 1.26:3848) Avail: NTIS HC A07/MF A01 CSCL 01A

The low speed lateral/directional characteristics of a generic 74 degree delta wing body configuration employing the latest generation, gothic planform vortex flaps was determined. Longitudinal effects are also presented. The data are compared with theoretical estimates from VORSTAB, an extension of the Quasi vortex lattice Method of Lan which empirically accounts for vortex breakdown effects in the calculation of longitudinal and lateral/directional aerodynamic characteristics. It is indicated that leading edge deflections of 30 and 40 degrees reduce the magnitude of the wing effective dihedral relative to the baseline for a specified angle of attack or lift coefficient. For angles of attack greater than 15 degrees, these flap deflections reduce the configuration directional stability despite improved vertical tail effectiveness. It is shown that asymmetric leading edge deflections are inferior to conventional ailerons in generating rolling moments. VORSTAB calculations provide coarse lateral/directional estimates at low to moderate angles of attack. The theory does not account for vortex flow induced, vertical tail effects. E.A.K.

N85-12011*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
WIND TUNNEL WALL INTERFERENCE ASSESSMENT AND CORRECTION, 1983
P. A. NEWMAN, ed. and R. W. BARNWELL, ed. Washington 1984 417 p refs Workshop held in Hampton, Va., 25-26 Jan. 1983
(NASA-CP-2319; L-15812; NAS 1.55:2319) Avail: NTIS HC A18/MF A01 CSCL 01A

Technical information focused upon emerging wall interference assessment/correction (WIAC) techniques applicable to transonic wind tunnels with conventional and passively or partially adapted walls is given. The possibility of improving the assessment and correction of data taken in conventional transonic wind tunnels by utilizing simultaneously obtained flow field data (generally taken near the walls) appears to offer a larger, nearer-term payoff than the fully adaptive wall concept. Development of WIAC procedures continues, and aspects related to validating the concept need to be addressed. Thus, the scope of wall interference topics discussed was somewhat limited.

N85-12012*# Boeing Commercial Airplane Co., Seattle, Wash.
WALL INTERFERENCE MEASUREMENTS FOR THREE-DIMENSIONAL MODELS IN TRANSONIC WIND TUNNELS: EXPERIMENTAL DIFFICULTIES
R. L. BENGELINK and N. J. ZINSERLING *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 21-42 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A

The purpose is not to provide a detailed discussion of several wall interference experiments, but rather to use these experiments (recently accomplished in the Boeing Transonic Wind Tunnel (BTWT) to illustrate the problems associated with many of the measurements required by current wall interference assessment/correction (WIAC) procedures. The wall correction to lift is emphasized. It is shown that, because conventional tunnels and relatively small models continue to be used, the flow field or flow boundary measurements to be made impose severe requirements on the experiment itself. In some cases, existing instrumentation and test techniques may not be adequate to obtain the data accuracies needed. R.J.F.

N85-12013*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
SURVEY OF ONERA ACTIVITIES ON ADAPTIVE-WALL APPLICATIONS AND COMPUTATION OF RESIDUAL CORRECTIONS
J. P. CHEVALLIER *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 43-60 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A

The research undertaken concerning the computation and/or reduction of wall interference follows two main axes: improvement of wall correction determinations, and use of adaptive flexible walls. The use of wall-measured data to compute interference effects is reliable when the model representation is assessed by signatures with known boundary conditions. When the computed interferences are not easily applicable to correcting the results (especially for gradients in two-dimensional cases), the flexible adaptive walls in operation in T2 are an efficient and assessed means of reducing the boundary effects to a negligible level, if the direction and speed of the flow are accurately measured on the boundary. The extension of the use of adaptive walls to three-dimensional cases may be attempted since the residual corrections are assumed to be small and are computable. R.J.F.

N85-12014*# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).
WIND TUNNEL WALL INTERFERENCE IN CLOSED, VENTILATED AND ADAPTIVE TEST SECTIONS
H. HOLST *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 61-78 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A

A wall interference correction method for closed rectangular test sections was developed which uses measured wall pressures. Measurements with circular discs for blockage and a rectangular wing as a lift generator in a square closed test section validate this method. These measurements are intended to be a basis of comparison for measurements in the same tunnel using ventilated (in these case, slotted) walls. Using the vortex lattice method and homogeneous boundary conditions, calculations were performed which show sufficiently high pressure levels at the walls for correction purposes in test sections with porous walls. In Gottingen, an adaptive test section (which is a deformable rubber tube of 800 mm diameter) was built and a computer program was developed which is able to find the necessary wall adaptation for interference-free measurements in a single step. To check the program prior to the first run, the vortex lattice method was used to calculate wall pressure distributions in the nonadapted test section as input data for the one-step method. Comparison of the pressure distribution in the adapted test section with free-flight data shows nearly perfect agreement. An extension of the computer program can be made to evaluate the remaining interference corrections. R.J.F.

N85-12015*# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.
TWO- AND THREE-DIMENSIONAL MODEL AND WALL DATA FROM A FLEXIBLE-WALLED TRANSONIC TEST SECTION
M. J. GOODYER and I. D. COOK *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 79-88 1984 refs Sponsored in part by the British Science and Engineering Research Council
(Contract NSG-7172)
Avail: NTIS HC A18/MF A01 CSCL 01A

Both two- and three-dimensional model testing is being carried out in the transonic flexible-walled wind tunnel test section. The test section has flexible top and bottom walls with rigid sidewalls. Interference is eliminated by adjustments based on data taken at walls in two dimensional models. Cast-7 data will illustrate agreement between various flexible-walled tunnels. In three-dimensional models interference cannot be eliminated but wall adjustments can control and relieve the principal sources of wall-induced errors. Estimates of magnitudes of the control which

may be exercised on flow by movement of one wall jack are presented. A wall control algorithm (still in analytic development stage) based on use of this data is described. Brief examples of control of wall-induced perturbations in region of model are given.
B.W.

N85-12016*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ASSESSMENT OF LIFT- AND BLOCKAGE-INDUCED WALL INTERFERENCE IN A THREE-DIMENSIONAL ADAPTIVE-WALL TUNNEL
E. T. SCHAIRER *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 89-100 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
A three-dimensional adaptive-wall wind tunnel experiment was conducted at Ames Research Center. This experiment demonstrated the effects of wall interference on the upwash distribution on an imaginary surface surrounding a lifting wing. This presentation demonstrates how the interference assessment procedure used in the adaptive-wall experiments to determine the wall adjustments can be used to separately assess lift- and blockage-induced wall interference in a passive-wall wind tunnel. The effects of lift interference on the upwash distribution and on the model lift coefficient are interpreted by a simple horseshoe vortex analysis. Author

N85-12017*# Calspan Field Services, Inc., Arnold Air Force Station, Tenn.
A DATA BASE FOR THREE-DIMENSIONAL ALL-INTERFERENCE CODE EVALUATION
W. L. SICKLES *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 101-118 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
A validation of a measured boundary condition technique was carried out to demonstrate the feasibility of a wall interference assessment/correction (WIAC) system. An experimental evaluation was also carried out to compare performances of various techniques, to define the number of necessary boundary measurements for accurate assessment/corrections and to define the envelope of test conditions for which accurate assessment/corrections are achieved. The relative merits of a WIAC system and an adaptive wall tunnel are compared. The measurement surface boundary data is performed with a system of two rotating pipes. These pipes sweep out a cylindrical measurement surface near the tunnel walls, approximately one inch from the wall at the closest point. The experimental model was specially designed and fabricated for the adaptive wall experiments. The model is a wing/tail/body configuration with swept lifting surface. The boundary data taken in Tunnel 1T with the rotating pipe system has been shown to offer several attractive features for WIAC code evaluation. Good spatial resolution of measurements is achieved and measurements are made upstream and downstream of the model. Also, two velocity components are determined. B.W.

N85-12018*# Tennessee Univ. Space Inst., Tullahoma.
INVESTIGATIONS OF FLOW FIELD PERTURBATIONS INDUCED ON SLOTTED TRANSONIC-TUNNEL WALLS
J. M. WU and F. G. COLLINS *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 119-142 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
The free-stream interference caused by the flow through the slotted walls of the test sections of transonic wind tunnels has continuously a problem in transonic tunnel testing. The adaptive-wall transonic tunnel is designed to actively control the near-wall boundary conditions by sucking or blowing through the wall. In order to make the adaptive-wall concept work, parameters for computational boundary conditions must be known. These parameters must be measured with sufficient accuracy to allow numerical convergence of the flow field computations and must be measured in an inviscid region away from the model that is placed inside the wind tunnel. The near-wall flow field was mapped in detail using a five-port cone probe that was traversed in a plane transverse to the free-stream flow. The initial experiments were made using a single slot and recent measurements used multiple slots, all with the tunnel empty. The projection of the flow field velocity vectors on the transverse plane revealed the presence of a vortex-like flow with vorticity in the free stream. The current research involves the measurement of the flow field above a multislotted system with segmented plenums behind it, in which the flow is controlled through several plenums simultaneously. This system would be used to control a three-dimensional flow field. B.W.

N85-12019*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECT OF UPSTREAM SIDEWALL BOUNDARY LAYER REMOVAL ON AN AIRFOIL TEST
C. B. JOHNSON, A. V. MURTHY, E. J. RAY, P. L. LAWING, and J. J. THIBODEAUX *In its* Wind Tunnel Wall Interference Assessment and Correction, 1983 p 143-163 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
Sidewall boundary layer effects were investigated by applying partial upstream sidewall boundary layer removal in the Langley 0.3-m transonic cryogenic tunnel. Over the range of sidewall boundary layer displacement thickness of these tests the influence on pressure distribution was found to be small for subcritical conditions; however, for supercritical conditions the shock position was affected by the sidewall boundary layer. For these tests (with and without boundary layer remove) comparisons with predictions of the GRUMFOIL computer code indicated that Mach number corrections due to the sidewall boundary layer improve the agreement for both subcritical and supercritical conditions. The results also show that sidewall boundary layer removal reduces the magnitude of the sidewall correction; however, a suitable correction must still be made. R.S.F.

N85-12020*# Ohio State Univ., Columbus.
PERFORMANCE OF TWO TRANSONIC AIRFOIL WIND TUNNELS UTILIZING LIMITED VENTILATION
J. D. LEE and G. M. GREGOREK *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 165-170 1984
Avail: NTIS HC A18/MF A01 CSCL 01A
A limited-zone ventilated wall panel was developed for a closed-wall icing tunnel which permitted correct simulation of transonic flow over model rotor airfoil sections with and without ice accretions. Candidate porous panels were tested in the Ohio State University 6- x 12-inch transonic airfoil tunnel and result in essentially interference-free flow, as evidenced by pressure distributions over a NACA 0012 airfoil for Mach numbers up to 0.75. Application to the NRC 12- x 12-inch icing tunnel showed a similar result, which allowed proper transonic flow simulation in that tunnel over its full speed range. Author

N85-12021*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EXPERIMENTS SUITABLE FOR WIND TUNNEL WALL INTERFERENCE ASSESSMENT/CORRECTION
J. G. MARVIN *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 171-190 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
Three experiments suitable for wall interference assessment and evaluation of proposed correction methods are presented. The experiments are: (1) a series of airfoil tests using a newly designed transonic flow facility that employs side-wall boundary layer suction and upper- and lower-wall shaping; (2) tests on a swept airfoil section spanning a solid-wall wind tunnel with fixed contouring on all four walls; and (3) tests on a swept wing of aspect ratio 3 mounted in a solid-wall wind tunnel with fixed flat walls. Each of the experiments provides data on the airfoil sections as well as on the wind tunnel walls. All the experiments were

performed in solid wall wind tunnels corrected for boundary layer displacement effects. Although the experiments were performed primarily to evaluate computer code performance, it is believed that they also provide information that can be used to evaluate methods for assessing and correcting wall interference effects.
R.S.F.

N85-12022*# Rockwell International Science Center, Thousand Oaks, Calif.
ASYMPTOTIC METHODS FOR WIND TUNNEL WALL CORRECTIONS AT TRANSONIC SPEED
N. D. MALMUTH, J. D. COLE, and F. ZEIGLER *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 193-203 1984
Avail: NTIS HC A18/MF A01 CSCL 01A
The effort to develop classical methods to compute wall interference at transonic speeds is outlined. The two-dimensional theory and three-dimensional development are discussed. Also, some numerical application of the two-dimensional work are indicated. The basic advantages of the asymptotic theory are noted. R.S.F.

N85-12023*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECT OF BOUNDARY LAYERS ON SOLID WALLS IN THREE-DIMENSIONAL SUBSONIC WIND TUNNELS
J. B. ADCOCK and R. W. BARNWELL *In its* Wind Tunnel Wall Interference Assessment and Correction, 1983 p 205-218 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
A solution for the tunnel wall boundary layer effects for three-dimensional subsonic tunnels is presented. The model potentials are represented with simple singularities placed on the centerline of the tunnel and Laplace's equation in cylindrical coordinates is solved for either the conventional homogeneous slotted-wall boundary condition, the solid-wall viscous boundary condition, or a combination of them. The most pronounced wall boundary layer effect is on solid blockage for completely closed wind tunnels. Boundary layers on the wall reduce the blockage from the solid-wall, no-boundary-layer case in a manner similar to opening slots in a solid wall. Additionally, for solid-wall tunnel configurations, the streamline curvature interference factor is reduced by a significant amount, whereas the lift interference factor at the model station does not depend on the boundary layer parameter. For combination wall configurations, the slot effect of the horizontal walls dominates the viscous effect of the solid sidewalls. R.S.F.

N85-12025*# National Aeronautical Establishment, Ottawa (Ontario).
PROGRESS IN WIND TUNNEL WALL INTERFERENCE ASSESSMENT/CORRECTION PROCEDURES AT THE NAE
L. H. OHMAN, M. MOKRY, and Y. Y. CHAN *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 231-257 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
Wall corrections as a function of wall porosity in the transonic wall interference problem was assessed. Effective porosities primarily for the two dimensional case were established as follows: (1) comparison of experimental data for two geometrically similar models of different chord/height ratio, an overall value of wall porosity could be deduced; (2) theoretical development which allows for unequal porosity for the floor and ceiling and wall boundary pressure measurements, porosities for floor and ceiling could be deduced; (3) a scheme was developed which allowed unequal porosity of floor and ceiling and streamwise varying porosity. The boundary layer development along the perforated floor and ceiling under the influence of the model pressure field, variations in boundary layer thickness underlining the difficulties in deducing meaningful values of wall porosity were determined. Wall boundary pressure measurement, in combination with singularity modelling of the airfoil, was sufficient to yield required information on the wall interference flow without having to establish some value for wall porosity. The singularity modelling of the airfoil initially covered only lift and volume but was extended to include drag and pitching moment, and second order volume term. It is shown by asymptotic transonic small disturbance analysis, that the derived corrections to angle of attack and free stream Mach number are correct to the first order. E.A.K.

N85-12027*# Lockheed-Georgia Co., Marietta.
TUNNEL CONSTRAINT FOR A JET IN CROSSFLOW
D. J. WILSDEN and J. E. HACKETT *In* NASA. Langley Research Center. Wind Tunnel Wall Interference Assessment and Correction, 1983 p 273-290 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
A facet of a unified tunnel correction scheme which uses wall pressures to determine tunnel induced blockage and upwash is described. With this method, there is usually no need to use data concerning model forces or power settings to find the interference; it follows directly from the pressures and tunnel dimensions. However, highly inclined jets do not produce good pressure signatures and are highly three dimensional, so they must be treated differently. Flow modeling is also discussed. E.A.K.

N85-12028*# Royal Inst. of Tech., Stockholm (Sweden).
INTERFERENCE FROM SLOTTED WALLS
S. B. BERNDT *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 293-300 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
Wall interference is made predominant in tunnel models and by wall geometries to facilitate the study of slot flow. The viscous effects in slots are studied by two dimensional measurements of flow. Wall interference is assessed by measuring pressure distributions at two levels near the walls. Interference on lifting delta wings is calculated. Pressure distributions at inner boundaries show basis axisymetries between the pressure side and the suction side, pointing to the necessity of having wider slots on the pressure side. E.R.

N85-12029*# Flow Research, Inc., Kent, Wash. Research and Technology Div.
WIND TUNNEL WALL INTERFERENCE CORRECTION FOR AIRCRAFT MODELS
M. H. RIZK, M. G. SMITHMEYER, and E. M. MURMAN (MIT) *In* NASA. Langley Research Center. Wind Tunnel Wall Interference Assessment and Correction, 1983 p 301-322 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
Wall interference correction procedures seek to determine the required changes in certain flow or geometric parameters so that the difference between the flow properties at the model's surface in the tunnel and free air are minimized. A transonic and a linear correction procedure were developed for aircraft models. In addition to Mach number and angle of attack corrections, an estimate of the accuracy of the corrections is provided by the transonic correction procedure. Lift, pitching moment and pressure measurements near the tunnel walls are required. The efficiency and accuracy of the correction procedure are improved. Moreover, correction of both the wing and tail angles of attack is allowed. The procedure is valid for transonic as well as subcritical flows. However, for subcritical flows further approximations and simplifying assumptions are made, leading to a very simple and efficient correction procedure. Author

N85-12030*# Virginia Associated Research Center, Newport News.
AN INERFERENCE ASSESSMENT APPROACH FOR A THREE-DIMENSIONAL SLOTTED TUNNEL WITH SPARSE WALL PRESSURE DATA
W. B. KEMP, JR. *In* NASA. Langley Research Center. Wind Tunnel Wall Interference Assessment and Correction, 1983 p 323-334 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A
The various procedures referred to as wall interference assessment and correction procedures presume the existence of

a surface distribution of data (usually static pressure) measured over a surface on or near the tunnel walls for each test point to be assessed. An alternative approach in which a reasonably sophisticated computer model of the test section flow would be fitted parametrically to a sparse set of measured data is presented. The measurements provides line distributions of static pressure near the center lines of the top, side and bottom walls. The development of a test section model incorporating explicit recognition of discrete slots of finite length with controlled flow reentry into the solid wall downstream portion of the tunnel is shown. Author

N85-12031*# Calspan Field Services, Inc., Arnold Air Force Station, Tenn.
DETERMINATION OF EQUIVALENT MODEL GEOMETRY FOR TUNNEL WALL INTERFERENCE ASSESSMENT/CORRECTION
C. F. LO *In* NASA. Langley Research Center Wind Tunnel Wall Interference Assessment and Correction, 1983 p 335-342 1984
Avail: NTIS HC A18/MF A01 CSCL 01A

A formula for the determination of equivalent model geometry with two variables measured at the interface is derived, based on two dimensional subsonic flow. This predicted model profile is a reasonable initial estimate for transonic flow as long as the sonic region does not reach the interface. A general formula is given in two forms. One is in terms of complex variable functions and the other is an integral equation. The complex-function formula has the advantage of using analytic expressions. The integral equation form requires a numerical solution after assuming the model geometry as a polynomial function. Examples are given to illustrate the application of the formulas. Author

N85-12033*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
REVIEW OF THE ADVANCED TECHNOLOGY AIRFOIL TEST PROGRAM IN THE 0.3-METER TRANSONIC CRYOGENIC TUNNEL
E. J. KAY and C. L. LADSON *In its* Wind Tunnel Wall Interference Assessment and Correction, 1983 p 361-374 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A

The following areas were addressed: interchangeable test sections in the 0.3-M Transonic Cryogenic Tunnel (TCT); typical airfoil installation; airfoil capability; advanced technology airfoil test (ATAT); effects of the Reynolds number on the normal force coefficient; effects of the Reynolds number on the drag coefficient; and comparison of experimental results with theory. B.G.

N85-12034*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SOME EXPERIENCE WITH BARNWELL-SEWALL TYPE CORRECTION TO TWO-DIMENSIONAL AIRFOIL DATA
R. V. JENKINS *In its* Wind Tunnel Wall Interference Assessment and Correction, 1983 p 375-392 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A

A series of airfoils were tested in the Langley 0.3-Meter Transonic Cryogenic Tunnel (TCT) at Reynolds numbers from 2 to 50 million. The 0.3-m TCT is equipped with Barnwell slots designed to minimize blockage due to the tunnel flow and ceiling. This design suggests that sidewall corrections for blockage is needed, and that a lifting airfoil produces a change in angle of attack. Sidewall correction methods were developed for subsonic and subsonic-transonic flow. Comparisons of theory with experimental data obtained in the 0.3-m TCT for two airfoils, the British NPL 9510 and the German R-4 are presented. The NPL 9510 was tested as part of the NASA/United Kingdom Joint Aeronautical Program and R-4 was tested as part f the DFVLR/NASA Advanced Airfoil Research Program. For the NPL 9510 airfoil, only those test points that one would anticipate being difficult to predict theoretically are presented. B.G.

N85-12035*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ADAPTATION OF A FOUR-WALL INTERFERENCE ASSESSMENT/CORRECTION PROCEDURE FOR AIRFOIL TESTS IN THE 0.3-M TCT
C. R. GUMBERT, P. A. NEWMAN, W. B. KEMP, JR., and J. B. ADCOCK *In its* Wind Tunnel Wall Interference Assessment and Correction, 1983 p 393-414 1984 refs
Avail: NTIS HC A18/MF A01 CSCL 01A

Based upon limited, initial observations of wall interference corrections obtained for one airfoil test, there is a need for assessing the upstream flow direction. If there is no direct measurement then a two-pass correction procedure similar to the one described here is required. Questions have arisen pertaining to the correct interpretation of the pressure coefficients measured on the slats of a slotted tunnel wall, the interpretation of just what the calculated equivalent body encompasses or should include, and what can or should be considered as quantitative criteria for data correctability. Further studies using this modified procedure will address these questions. Hopefully, a meaningful WIAC procedure can be validated for the airfoil tests in the 0.3-m TCT. Author

N85-12037*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STATUS AND PROSPECTS OF COMPUTATIONAL FLUID DYNAMICS FOR UNSTEADY TRANSONIC VISCOUS FLOWS
W. J. MCCROSKEY, P. KUTLER, and J. O. BRIDGEMAN Oct. 1984 27 p refs Sponsored in part by Army
(NASA-TM-86018; A-9877; USAAVSCOM-TM-84-A-8; NAS 1.15:86018) Avail: NTIS HC A03/MF A01 CSCL 01A

Applications of computational aerodynamics to aeronautical research, design, and analysis have increased rapidly over the past decade, and these applications offer significant benefits to aeroelasticians. The past developments are traced by means of a number of specific examples, and the trends are projected over the next several years. The crucial factors that limit the present capabilities for unsteady analyses are identified; they include computer speed and memory, algorithm and solution methods, grid generation, turbulence modeling, vortex modeling, data processing, and coupling of the aerodynamic and structural dynamic analyses. The prospects for overcoming these limitations are presented, and many improvements appear to be readily attainable. If so, a complete and reliable numerical simulation of the unsteady, transonic viscous flow around a realistic fighter aircraft configuration could become possible within the next decade. The possibilities of using artificial intelligence concepts to hasten the achievement of this goal are also discussed. Author

N85-12038*# United Technologies Research Center, East Hartford, Conn.
EXTENDED AEROELASTIC ANALYSIS FOR HELICOPTER ROTORS WITH PRESCRIBED HUB MOTION AND BLADE APPENDED PENDULUUM VIBRATION ABSORBERS
R. L. BIELAWA Dec. 1984 217 p refs
(Contract NAS1-16803)
(NASA-CR-172455; NAS 1.26:172455) Avail: NTIS HC A10/MF A01 CSCL 01A

The mathematical development for the expanded capabilities of the G400 rotor aeroelastic analysis was examined. The G400PA expanded analysis simulates the dynamics of all conventional rotors, blade pendulum vibration absorbers, and the higher harmonic excitations resulting from prescribed vibratory hub motions and higher harmonic blade pitch control. The methodology for modeling the unsteady stalled airloads of two dimensional airfoils is discussed. Formulations for calculating the rotor impedance matrix appropriate to the higher harmonic blade excitations are outlined. This impedance matrix, and the associated vibratory hub loads, are the rotor dynamic characteristic elements for use in the simplified coupled rotor/fuselage vibration analysis (SIMVIB). Updates to the development of the original G400 theory, program documentation, user instructions and information are presented. E.A.K.

N85-12039*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INCOMPRESSIBLE LIFTING-SURFACE AERODYNAMICS FOR A ROTOR-STATOR COMBINATION
S. M. RAMACHANDRA Oct. 1984 32 p refs
(NASA-TM-83767; E-2258; NAS 1.15:83767) Avail: NTIS HC A03/MF A01 CSCL 01A

Current literature on the three dimensional flow through compressor cascades deals with a row of rotor blades in isolation. Since the distance between the rotor and stator is usually 10 to 20 percent of the blade chord, the aerodynamic interference between them has to be considered for a proper evaluation of the aerothermodynamic performance of the stage. A unified approach to the aerodynamics of the incompressible flow through a stage is presented that uses the lifting surface theory for a compressor cascade of arbitrary camber and thickness distribution. The effects of rotor stator interference are represented as a linear function of the rotor and stator flows separately. The loading distribution on the rotor and stator flows separately. The loading distribution on the rotor and stator blades and the interference factor are determined concurrently through a matrix iteration process. Author

N85-12040*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLOW VISUALIZATION STUDY OF A VORTEX-WING INTERACTION
R. D. MEHTA and T. T. LIM Nov. 1984 43 p refs Original contains color illustrations
(NASA-TM-86656; REPT-85013; NAS 1.15:86656) Avail: NTIS HC A03/MF A01 CSCL 01A

A flow visualization study in water was completed on the interaction of a streamwise vortex with a laminar boundary layer on a two-dimensional wing. The vortex was generated at the tip of a finite wing at incidence, mounted perpendicular to the main wing, and having the same chord as the main wing. The Reynolds number based on wing chord was about 5000. Two different visualization techniques were used. One involved the injection of two different colored dyes into the vortex and the boundary layer. The other technique utilized hydrogen bubbles as an indicator. The position of the vortex was varied in a directional normal to the wing. The angle of attack of the main wing was varied from -5 to +12.5 deg. The vortex induced noticeable cross flows in the wing boundary layer from a distance equivalent to 0.75 chords. When very close to the wing, the vortex entrained boundary layer fluid and caused a cross flow separation which resulted in a secondary vortex. B.G.

N85-12041# Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.
INTERACTION BETWEEN AN AIRFOIL AND A STREAMWISE VORTEX
K. W. MCALISTER and C. TUNG 27 Jun. 1984 24 p
(AD-A145823) Avail: NTIS HC A02/MF A01 CSCL 20D

The tip of a finite-span airfoil was used to generate a streamwise vortical flow, the strength of which could be varied by changing the incidence of the airfoil. The vortex that was generated traveled downstream and interacted with a second airfoil on which measurements of lift, drag, and pitching moment were made. The flow field, including the vortex core, was visualized in order to study the structural alterations to the vortex resulting form various levels of encounter with the downstream airfoil. These observations were also used to evaluate the accuracy of a theoretical model. Author (GRA)

N85-12042# Naval Surface Weapons Center, White Oak, Md.
AN INVISCID COMPUTATIONAL METHOD FOR SUPERSONIC INLETS Final Report
A. B. WARDLAW, JR., D. SHUMWAY, and F. BALTAKIS 22 Mar. 1984 78 p
(AD-A145997; NSWC/TR-83-428) Avail: NTIS HC A05/MF A01 CSCL 20D

An extension to the SWINT code is described which permits inviscid calculations to be performed on the supersonic portion of inlet flow fields. Also described is an interface program which rezones the external flow field applied to several examples. A listing of the extension to SWINT and the interface program are provided in the Appendices along with a set of user instructions and a sample case. Author (GRA)

N85-12043# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung fuer Entwurfsaerodynamik.
DESIGN OF A BASIC AIRFOIL FOR A SLIGHTLY SWEPT WING. PART 1: THEORETICAL TRANSONIC AIRFOIL DESIGN
G. WICHMANN Mar. 1984 47 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-892)
(DFVLR-FB-84-19-PT-1) Avail: NTIS HC A03/MF A01; DFVLR, Cologne DM 15.50

The design procedure of a basic airfoil for a slightly swept transport aircraft wing is described. It is shown that transonic wing technology reduces sweep by retaining wing thickness and cruise Mach number. Author (ESA)

N85-12045# Rolls-Royce Ltd., Derby (England).
A FINITE ELEMENT METHOD FOR THE SOLUTION OF TWO-DIMENSIONAL TRANSONIC FLOWS IN CASCADES
D. S. WHITEHEAD (Cambridge University) and S. G. NEWTON 1 Aug. 1984 38 p refs
(PNR-90216) Avail: NTIS HC A03/MF A01

Steady two-dimensional transonic flow was calculated in cascades of compressor and turbine blades using a mesh of triangular finite elements. A velocity potential is used, the equations being solved by the Newton-Raphson technique. The resulting computer program is fast, and is shown to give good accuracy. Shock waves are well represented, if they are not too strong. The method copies with supercritical designs. For supersonic inlet flows with shocks, the results are comparable with time-marching. The program can calculate the flow in a cascade of flat plates operating like tip sections of transonic fan blades in which the flow is spilling round the leading edge and the unique incidence condition does not apply. Author (ESA)

N85-12860*# Stanford Univ., Calif. Joint Inst. of Aeronautics and Acoustics.
A STUDY OF FLOW PAST AN AIRFOIL WITH A JET ISSUING FROM ITS LOWER SURFACE
A. KROTHAPALLI and D. LEOPOLD Jun. 1984 44 p refs
(Contract NCC2-198; NAG2-111)
(NASA-CR-166610; NAS 1.26:166610) Avail: NTIS HC A03/MF A01 CSCL 01A

The aerodynamics of a NACA 0018 airfoil with a rectangular jet of finite aspect ratio exiting from its lower surface at 90 deg to the chord were investigated. The jet was located at 50% of the wing chord. Measurements include static pressures on the airfoil surface, total pressures in the near wake, and local velocity vectors in different planes of the wake. The effects of jet cross flow interaction on the aerodynamics of the airfoil are studied. It is indicated that at all values of momentum coefficients, the jet cross flow interaction produces a strong contra-rotating vortex structure in the near wake. The flow behind the jet forms a closed recirculation region which extends up to a chord length down stream of the trailing edge which results in the flow field to become highly three dimensional. The various aerodynamic force coefficients vary significantly along the span of the wing. The results are compared with a jet flap configuration. E.A.K.

N85-12862*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
APPLICATION OF THE ONERA MODEL OF DYNAMIC STALL
K. W. MCALISTER, O. LAMBERT (Service Technique des Programmes Aeronautiques, Paris), and D. PETOT (ONERA, Chatillon, France) Nov. 1984 65 p refs
(NASA-TP-2399; A-9824; AVSCOM-TR-84-A-3; NAS 1.60:2399)
Avail: NTIS HC A04/MF A01 CSCL 01A

A semiempirical model to predict the unsteady loads on an airfoil that is experiencing dynamic stall, is investigated. The mathematical model is described from an engineering point of view, demonstrates the procedure for obtaining various empirical parameters, and compares the loads predicted by the model with those obtained in the experiment. It is found that the procedure is straightforward, and the final calculations are in qualitative agreement with the experimental results. Comparisons between calculations and measurements also indicate that a decrease in accuracy results when the values of both the reduced frequency and the amplitude of oscillation are large. Potential quantitative improvements in the accuracy of the calculations are discussed for accounting of both the hysteresis in the static data and the effects of stall delay in the governing equations. E.A.K.

N85-12863*# Vigyan Research Associates, Inc., Hampton, Va.
NATURAL LAMINAR FLOW AIRFOIL DESIGN CONSIDERATIONS FOR WINGLETS ON LOW-SPEED AIRPLANES
C. P. VANDAM NASA Washington Dec. 1984 28 p refs
(Contract NAS1-17797)
(NASA-CR-3853; NAS 1.26:3853) Avail: NTIS HC A03/MF A01 CSCL 01A

Winglet airfoil section characteristics which significantly influence cruise performance and handling qualities of an airplane are discussed. A good winglet design requires an airfoil section with a low cruise drag coefficient, a high maximum lift coefficient, and a gradual and steady movement of the boundary layer transition location with angle of attack. The first design requirement provides a low crossover lift coefficient of airplane drag polars with winglets off and on. The other requirements prevent nonlinear changes in airplane lateral/directional stability and control characteristics. These requirements are considered in the design of a natural laminar flow airfoil section for winglet applications and chord Reynolds number of 1 to 4 million. E.A.K.

N85-12866*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DEVELOPMENT OF COMPUTATIONAL FLUID DYNAMICS AT NASA AMES RESEARCH CENTER
M. INOUYE Oct. 1984 10 p refs
(NASA-TM-86021; A-9887; NAS 1.15:86021) Avail: NTIS HC A02/MF A01 CSCL 01A

Ames Research Center has the lead role among NASA centers to conduct research in computational fluid dynamics. The past, the present, and the future prospects in this field are reviewed. Past accomplishments include pioneering computer simulations of fluid dynamics problems that have made computers valuable in complementing wind tunnels for aerodynamic research. The present facilities include the most powerful computers built in the United States. Three examples of viscous flow simulations are presented: an afterbody with an exhaust plume, a blunt fin mounted on a flat plate, and the Space Shuttle. The future prospects include implementation of the Numerical Aerodynamic Simulation Processing System that will provide the capability for solving the viscous flow field around an aircraft in a matter of minutes. Author

N85-12868*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A COMPARISON OF WORTMANN AIRFOIL COMPUTER-GENERATED LIFT AND DRAG POLARS WITH FLIGHT AND WIND TUNNEL RESULTS
A. H. BOWERS and A. G. SIM Nov. 1984 16 p refs Prepared in cooperation with NASA. Dryden Flight Research Center
(NASA-TM-86035; H-1231; NAS 1.15:86035) Avail: NTIS HC A02/MF A01 CSCL 01A

Computations of drag polars for a low-speed Wortmann sailplane airfoil are compared with both wind tunnel and flight test results. Excellent correlation was shown to exist between computations and flight results except when separated flow regimes were encountered. Smoothness of the input coordinates to the PROFILE computer program was found to be essential to obtain accurate comparisons of drag polars or transition location to either the flight or wind tunnel flight results. Author

N85-12869*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECT OF A VARIABLE CAMBER AND TWIST WING AT TRANSONIC MACH NUMBERS
J. C. FERRIS Dec. 1984 56 p refs
(NASA-TM-86281; L-15577; NAS 1.15:86281) Avail: NTIS HC A4/MF A01 CSCL 01A

The effects of changing from a symmetrical wing section to one with camber and twist on the longitudinal aerodynamic characteristics of a 1/15-scale generic fighter model were determined. The wing had a 40 deg leading edge sweep, a taper ratio of 0.29, and aspect ratio of .36, and a maximum thickness ratio of 0.04. The model was a single engine configuration with a single vertical tail and an all movable horizontal tail mounted below the wing reference plane. It is indicated that in incremental increase in lift coefficient of 0.18 to 0.28 is obtained with the camber and twist over the angle of attack range. E.A.K.

N85-12870*# Vanderbilt Univ., Nashville, Tenn. School of Engineering.
THE ROLE OF FREESTREAM TURBULENCE SCALE IN SUBSONIC FLOW SEPARATION Interim Report, 1 Jul. 1984 - 31 Dec. 1984
J. L. POTTER, W. R. SEEBAUGH, R. J. BARNETT, and R. B. GOKHALE 31 Dec. 1984 35 p refs
(Contract NAG1-483)
(NASA-CR-174172; NAS 1.26:174172; IPR-1) Avail: NTIS HC A03/MF A01 CSCL 01A

The ojective of this work is the clarification of the role of freestream turbulence scale in determining the location of boundary layer separation. An airfoil in subsonic wind tunnel flow is the specific case studied. Hot-film and hot-wire anemometry, liquid-film visualization and pressure measurements are the principal diagnostic techniques in use. The Vanderbilt University subsonic wind tunnel is the flow facility being used. B.W.

N85-12871*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
PHYSICS ON AIRCRAFT WAKES Progress Report, 15 May - 14 Nov. 1984
H. A. HASSAN 1984 14 p refs
(Contract NCC1-84)
(NASA-CR-174105; NAS 1.26:174105; PR-1) Avail: NTIS HC A02/MF A01 CSCL 01A

The roll-up of a vortex sheet is analyzed by two approaches. The first is based on exact compressible Euler equations while the second is based on the exact incompressible Navier-Stokes equations. The inviscid calculations for the two-dimensional problem do not indicate any roll-up of the sheet. On the other hand, the viscous calculations capture the dynamics of the roll-up rather well. This suggests that the generally held views regarding the roll-up process of aircraft wakes, namely, that it be treated as an inviscid process, may not be completely accurate. Author

N85-12872# Institut Franco-Allemand de Recherches, St. Louis (France).
LASER ANEMOMETER STUDY OF SEPARATED FLOW ON WING PROFILES [ETUDE PAR ANEMOMETRIE LASER D'ECOULEMENTS DECOLLES SUR DES PROFILS D'AILE]
B. C. JAEGGY and P. MEYER 17 May 1983 79 p refs In FRENCH Presented at DFVLR Zentrums Conf., Brunswick, 5 May 1983
(Contract DRET-82/318)
(ISL-CO-214/83) Avail: NTIS HC A05/MF A01
Subsonic wind tunnel tests were carried out using a 2 dimensional laser velocimeter on the NACA 65213 and RA 16 SC1 profiles. The results show the average velocity components and the turbulent parameters in the separated flow. The influence of a spoiler on an RA 16 SC1 profile was also examined. The efficiency of the numerical methods to describe the results is discussed. Author (ESA)

N85-12874# Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Versuchs- und Forschungsanlage.
SINGULARITY MODEL FOR THE ANALYSIS OF WALL INTERFERENCE IN CLOSED WIND TUNNELS ACCORDING TO THE WALL PRESSURE SIGNATURE METHOD (BLOCKAGE AND LIFT) [SINGULARITAETEN-MODELL ZUR ANALYSE DER WANDINTERFERENZ IN GESCHLOSSENEN WINDKANALEN NACH DER WANDDRICKSIGNATUR-METHODE (BLOCKIERUNG UND AUFTRIEB)]
B. MUELLER 2 Sep. 1982 91 p refs In GERMAN
(FW-FO-1612) Avail: NTIS HC A05/MF A01
Correction methods for wall influence in large wind tunnels are considered. Tunnel blockage up to any desired angle of attack was determined by mathematically modeled wall pressure signatures. A qualitative definition of blockage and lift correction is obtained by a swell/drop and vortex modeling for typical aircraft models. Author (ESA)

N85-12875# Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Versuchs- und Forschungsanlage.
WALL INFLUENCE CORRECTIONS IN WIND TUNNELS: BLOCKAGE CORRECTION ACCORDING TO THE WALL PRESSURE SIGNATURE METHOD [WANDEINFLUSS-KORREKTUREN IN WINDKANAELEN: BLOCKIERUNGSKORREKTUR NACH DER WANDRUCKSIGNATUR-METHODE]
B. MUELLER 14 Sep. 1983 60 p refs In GERMAN
(FW-FO-1613) Avail: NTIS HC A04/MF A01
Blockage correction methods for large models or high angles of attack in closed wind tunnels are discussed. The wall pressure signature method based on a FORTRAN program was used. A correction calculation without computing of problem parameters is outlined. Author (ESA)

N85-12876# Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Versuchs- und Forschungsanlage.
PARAMETRIC DETERMINATION OF BLOCKAGE INTERFERENCE OF 3-DIMENSIONAL MODELS IN THE EMMEN FEDERAL AIRCRAFT WORKS TRANSONIC TUNNEL (SWITZERLAND) [PARAMETRISCHE BESTIMMUNG DER BLOCKIERUNGSINTERFERENZEN FUER DREI-DIMENSIONALE MODELLE IM TRANSONIC-KANAL DES EIDGENOESSISCHES FLUGZWERK, EMMEN]
G. CAPITAINE 9 Dec. 1982 36 p refs In GERMAN
(FW-FO-1636) Avail: NTIS HC A03/MF A01
Blockage correction for three dimensional, compressible flow in a rectangular measuring section is treated. Upper and lower walls were slotted, side walls were closed. Results show that the weakest blockage appears when slot and porosity parameters are situated near to 1. Author (ESA)

N85-12877# Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Versuchs- und Forschungsanlage.
INVESTIGATIONS OF BOUNDARY LAYERS IN THE EMMEN FEDERAL AIRCRAFT WORKS TRANSONIC TUNNEL, SWITZERLAND [GRENZSCHICHTUNTERSUCHUNGEN IM TRANSONIC-KANAL DES EIDGENOESSISCHES FLUGZWERKE, EMMEN]
N. CANTUNIAR 11 Mar. 1983 136 p refs In GERMAN
(FW-FO-1641) Avail: NTIS HC A07/MF A01
Boundary layer generation along transonic wind tunnel walls was investigated. Initial and boundary conditions were determined by a computer program. Results make it possible to determine the porosity factors of slotted tunnel walls. Author (ESA)

N85-12878# Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Versuchs- und Forschungsanlage.
COMPARATIVE FLOW CALCULATION ON TRANSONIC CONE/CYLINDER STANDARD MODELS IN CONNECTION WITH THE WALL INTERFERENCE PROBLEM [VERGLEICHENDE STROEMUNGSRECHNUNG AN TRANSSONISCHEN KEGEL/ZYLINDER-EIDHMODELLEN IM ZUSAMMENHANG MIT DEM WANDINTERFERENZPROBLEM]
M. BOFFO and R. POZZORINI 5 Dec. 1983 133 p refs In GERMAN
(FW-FO-1689) Avail: NTIS HC A07/MF A01
A computer program (RAXBOD) was used for the calculation of frictionless flow over slim bodies with sharp pointed and discontinuous profiles. For cone half-angles of 7.5 to 13.75 deg arc good accordance with measured results is obtained, while for half-angles of 20 deg arc and 30 deg only partly satisfying results are found. The reasons for this are not clear. Author (ESA)

N85-12879# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
A LOCAL SLOT BOUNDARY CONDITION FOR TRANSONIC FLOW CALCULATIONS IN SLOTTED-WALL TEST SECTIONS OF WIND TUNNELS
N. AGRELL, Y. C. J. SEDIN (SAAB-SCANIA AB, Linkoeping, Sweden), and N. ZHANG (Northwestern Polytechnical Univ., Xian, China) Sep. 1984 30 p refs
(Contract FMV-FLYGFL-82260-83-053-25-001)
(FFA-TN-1984-34) Avail: NTIS HC A03/MF A01
A local slot boundary condition is outlined and numerical results where the wall interference is calculated using a small perturbation equation in a rectangular test section with 16 equal slots are shown. The slots are locally substituted by wall strips located symetrically around each slot when calculating the test section flows. The flow through the slots are treated separately giving Dirichlet conditions along the strips in terms of the slot fluxes. Between the strips on the wall, Neumann conditions are applied. The test section flow is interactively solved with an inviscid slot flow model. Results for a delta wing at different Mach numbers and angles of attack are given. The numerical procedure is convergent, and encouraging results are obtained in terms of wall pressures and model pressures as well as integrated forces.
Author (ESA)

03

AIR TRANSPORTATION AND SAFETY

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

A85-13513#

RECENT DATA FROM THE AIRLINES LIGHTNING STRIKE REPORTING PROJECT

J. A. PLUMER (Lightning Technologies, Inc., Pittsfield, MA), N. O. RASCH, and M. S. GLYNN (FAA, Aircraft and Airport Systems Technology Div., Atlantic City, NJ) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p.

(AIAA PAPER 84-2406)

Nearly 800 lightning strike reports accumulated over the period 1971-1984 by transport aircraft have been subjected to computerization and processing aimed at the establishment of correlations among the numerous reported conditions and effects. Attention is given to the degrees of correlation between lightning strike events and ambient air temperature, cloud formations, precipitation, turbulence, amount of cloud cover, and time of year. Lightning strikes are characterized with respect to attachment points, EM interference and damage, and effects on personnel. O.C.

A85-13514#

OPERATIONAL EVALUATION OF AN EXPERIMENTAL TCAS

J. W. ANDREWS and W. M. HOLLISTER (MIT, Lexington, MA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p. FAA-sponsored research.

(AIAA PAPER 84-2407)

An experimental Traffic Alert and Collision Avoidance System (TCAS) furnishing an on-board, airborne backup to ATC has been installed in a twin-engine general aviation aircraft and evaluated under operational conditions. The installation provided automated traffic advisories for traffic with respect to range, bearing, relative altitude, and climb/descent on a color CRT. In the case of traffic presenting an imminent danger of collison, a resolution advisory is provided by the TCAS that indicates the vertical rate needed for safe altitude separation. O.C.

A85-13515#

THE DETERMINATION OF OPTIMUM FLIGHT PROFILES FOR SHORT HAUL ROUTES

L. R. JENKINSON and D. SIMOS (Loughborough University of Technology, Loughborough, Leics., England) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 8 p. refs

(AIAA PAPER 84-2408)

This paper examines the optimization of flight profiles for aircraft flying short-haul routes, for which the climb and descent segments are significant in terms of fuel used and operating costs. By using multivariate optimization (MVO) methods it is possible to find sub-optimal flight profiles which can be flown by a pilot using common flight techniques and not assisted by an autopilot. These methods are suitable for the investigation of operational and Air Traffic control limitations. The results of studies using a typical commuter aircraft are presented and discussed. Author

A85-13560#

SURVEY OF LIGHTNING HAZARD AND LOW ALTITUDE DIRECT LIGHTNING STRIKE PROGRAM

N. O. RASCH and M. S. GLYNN (FAA, Aircraft and Airport Systems, Technology Div., Atlantic City, NJ) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p.

(AIAA PAPER 84-2485)

The increasing presence of poorly conducting composite materials in aircraft airframes, together with sensitive digital avionics systems, has compelled the resumption of studies of the lightning-associated EM environment at 2000-20,000 ft altitudes, as well as nuclear blast-induced EM pulse (EMP). The research flight program formulated to investigate the effects of these phenomena involves flights that are to be conducted in and near the areas of active thunderstorms for durations of 2-3 hours. The aircraft will be flown over an instrumented ground station to record associated EM field data. About 100 flights/year are anticipated in support of this research program, which will be conducted in the vicinity of NASA's Kennedy Space Center, in Florida. The experimental aircraft will be an instrumented CV-580. O.C.

A85-13578#

EXTENDED RANGE OPERATION OF TWIN-ENGINED TRANSPORT AIRCRAFT (ETOPS)

L. RINGQVIST (Scandinavian Airlines System, Technical Div., Bromma, Sweden) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 4 p.

(AIAA PAPER 84-2512)

The various factors impinging on the prospective use of twin engined aircraft (TEA) for long distance passenger transport are outlined. The increased safety levels and operational economies of modern TEA are encouraging the transition. ICAO regulations, however, will need changing to recognize the newly acceptable safety margins available for two, rather than three or four, engines. It is noted that TEA, being of smaller size than previous long range transport aircraft, will require scheduling more frequent departures for transoceanic flights and thereby will provide expanded service. The improved safety levels which would made the flight feasible from a regulatory point of view arise from automated monitoring equipment which can protect against even crew errors. M.S.K.

A85-13579#

EXTENDED RANGE OPERATIONS WITH TWO-ENGINE AIRPLANES - A REGULATORY VIEW

J. M. DAVIS (FAA, Washington, DC) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p.

(AIAA PAPER 84-2513)

In a consideration of extended range operations with two-engine aircraft, the overall objective is to assure that these oeprations are consistent with the level of safety required for existing operations over these routes with threeand four-engine turbine powered aircraft. A challenge arises to develop and implement an evaluation, approval, and continuing surveillance process that will establish conditions under which extended range operations with these aircraft can be safely conducted. Attention is given to a definition of the concepts which should be used in evaluating extended range operations with two-engine aircraft. G.R.

A85-15165

THE HAZARD OF LIGHTNING

J. K. BOGARD (Boeing Commercial Airplane Co., Renton, WA) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, Sept. 1984, p. 124-130.

The current level of understanding of lightning and its effects on modern jet aircraft is assessed and research projects into the effects are described. The electrical charge of lightning is carried into the sky by evaporating moisture transporting negative ions from the surface of the earth. The energy is discharged in cloud-ground, cloud-cloud, ground-cloud, and bolt from the blue lightning bolts, St. Elmo's fire, and glow discharges at cloud tops. Aircraft designers consider three zones of lightning attachment: direct stroke, swept-stroke with repeated attachment, and low probability areas. Attention is extended to areas such as the nose and wing tips where the bolt may hang on. Sufficient protection must be incorporated into the structure to meet FAA criteria for minimum skin thicknesses to prevent burn through, resistance bonding to stop arcing, and the structure must form a Faraday cage to protect passengers and crew. Nonmetallic components are fitted with conductors to lead the energy to the airframe.

NASA has flown F106B missions through storms to characterize lightning strikes and test the effectiveness of protective measures. No correlation has been observed between the occurrence of lightning and the presence of turbulence. M.S.K.

A85-15167
BIRD STRIKE PREVENTION AT AIRPORTS
A. H. VAN GEUNS (Amsterdam Airport Schiphol, Schiphol, Netherlands) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, Sept. 1984, p. 140, 141.

The policy and approach to bird control at Amsterdam Schiphol Airport are described. The airport is in an area favored by many species of birds. To prevent birds from being attracted to the farmland surrounding the airport, only a few crop varieties are allowed, no tilling is permitted, and weed control is enforced to prevent the growth of seeds which might draw birds. Potatoes do not attract birds, and growing tall grass on unused lands discourages seagulls and lapwings from landing. Dayglow windmills, windmill-driven scarecrows, gas cannons, pyrotechnics and cassette-fed car loudspeakers are employed to drive away birds which do land. A squad of 12 men maintains a 24 hr bird patrol. The measures have led to a steady decline in the number of bird fatalities reported per 10,000 aircraft movements at Schiphol. M.S.K.

A85-15168
GROUND NAVIGATION SYSTEMS FOR AIRCRAFT - AN URGENT NEED
H. M. VERMEULEN International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, Sept. 1984, p. 142-145.

Regulations for taxiing procedures at airports are asserted to be more directed at aircraft design than operation. It is recommended that runways be restricted to takeoffs and landing. ICAO regulations should mandate that means be made available for pilots to identify their position unambiguously at an airport. Successful location identification systems using distinctive signs and intersecting labels are cited, noting that blow-up maps of those airports with well-marked runways are standard. The signs need illumination at night and the actual route should be equipped with center line lighting with precisely defined spacing and continuous operation requirements. Finally, it is stressed that the pilot must be informed of the minimum visibility along a runway, not just patches of greater visibility. M.S.K.

A85-15170
DEVELOPING AIRCRAFT PASSENGER SEATS FOR SAFETY AND ECONOMY
R. J. BUTLER (Cranfield Institute of Technology, Cranfield, England) and P. J. SAJIC (Futair/Aeroform, Ltd., England) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, Sept. 1984, p. 158-160.

Functional safety and comfort features of lightweight, carbon fiber/Kevlar epoxy foam sandwich seats for the 747 are outlined. Tests have shown the seats to have greater strength and stiffness than conventional metal-frame seats. The new seats, with all equipment, weigh 42 lb each, thereby offering a potential one ton in weight savings if standard on 747s. Cabin noise levels would be reduced due to high damping factors of the materials. Anthropometric studies guided the design of the seat shape, which is tailored to the 99th pertile male during a long-distance flight. Flammability requirements have been met and dynamic crash certification tests are being configured. A notable innovation of the seat is the option of complete forward breakover of the seat back, thereby providing extra storage space and room. M.S.K.

A85-15595
ICING FLIGHT TESTS
R. WARD (U.S. Army, Aviation Engineering Flight Activity, Edwards AFB, CA) Vertiflite (ISSN 0042-4455), vol. 30, Nov.-Dec. 1984, p. 51-54.

The methodics of artificial and natural icing flight tests, conducted by the U.S. Army, and their results are studied. The artificial ice cloud is produced at temperatures below freezing by a Helicopter Icing Spray System (HISS), fitted on a CH-47 helicopter, by atomizing water at high pressure. The performance of anti-ice and deice systems is evaluated from observations of the crew members stationed on the open aft ramp of the HISS, and using photography. Major advantages of the artificial icing tests are: relative independence from weather conditions; control of test conditions for an extended period of time; and ability to vacate the icing conditions upon necessity. Natural icing tests, however, can provide conditions that are difficult to simulate. Army's icing flight tests conducted in 1984 with the UH-60 equipped with the external stores support system, an EH-60, a Marine CH-53E and UH-1 are studied. Among the deice systems discussed is a new pneumatic system, previously tested on a UH-1 helicopter. L.T.

A85-15867
MODELING OF TURBULENT BUOYANT FLOWS IN AIRCRAFT CABINS
K. T. YANG, J. R. LLOYD, A. M. KANURY, and K. SATOH (Notre Dame, University, Notre Dame, IN) Combustion Science and Technology (ISSN 0010-2202), vol. 39, no. 1-6, 1984, p. 107-118. refs
(Contract NBS-NB-81-NADA-2000)

The spread of hot gases and smoke in an aircraft cabin with and without seats due to a fire located inside the cabin is simulated by a two-dimensional finite-difference field model. Results of calculations based on several scenarios of fire locations and seating configurations show significant variations in the movement of hot gases and smoke as well as in the temperature and smoke concentration levels in the seating areas. Author

N85-12005# Joint Publications Research Service, Arlington, Va.
STUDY OF EFFECTS OF LIGHTNING ON AIRCRAFT SYSTEMS STRESSED
Y. KOBZAREV and M. ALEKSANDROV *In its* USSR Rept.: Transportation (JPRS-UTR-84-028) p 6-8 4 Oct. 1984 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 25 Aug. 1984 p 3
Avail: NTIS HC A06/MF A01

Interferences from lightning discharges can be used for practical purposes. Determining the distance and direction to the source of the radio waves (lightning) enables finding the position of dangerous thunderstorm cells. There is need for equipment to prevent aircraft from getting into atmospheric areas where serious negative effects are possible. Microelectronics can provide a solution to this problem. Algorithms were developed for processing received signals and sensors were designed. All that is needed is a single set of airborne equipment which would consist of several sensors, a computer complex linked with the onboard radar, and one colored indicator for information output to the crew about all dangerous weather along the aircraft's route. A.R.H.

N85-12046# Boeing Commercial Airplane Co., Seattle, Wash. Flight Deck Research Dept.
FLIGHT PHASE STATUS MONITOR STUDY. PHASE 1: SYSTEMS CONCEPTS Final Report, Jun. 1983 - Jul. 1984
L. G. SUMMERS, B. L. BERSON, D. C. HANSON, and C. ROSSI Jul. 1984 141 p refs
(Contract DTFA01-83-20033)
(DOT/FAA/PM-84/18) Avail: NTIS HC A07/MF A01

Phase I of a study conducted for the FAA to develop flight status monitor concepts is reported herein. Previous studies of crew alerting systems suggested the concept of a flight status monitor (FSM) which could monitor a flight, alert the crew to abnormal operations as well as aircraft system failures, and guide the crew through the appropriate response action procedures. The major Phase I activities include: (1) reviewing the results of Phase IV of the Aircraft Alerting System Standardization Study to identify the requirements for expanding the alerting system into an FSM; (2) developing preliminary FSM candidate concepts and identifying design issues relating to concept implementation; (3) performing a literature review to obtain data for answering design questions; (4) developing realistic demonstration scenarios, based upon previous accidents/incidents, to provide a mechanism for evaluating the candidate concepts; (5) implementing the FSM concepts and demonstration scenarios in a flight deck simulator for concept demonstration/evaluation; and (6) conducting demonstrations and developing a questionnaire to solicit pilot comments/opinions for refining the candidate concepts and to provide data for resolving FSM implementation issues. Author

N85-12880# Factory Mutual Research Corp., Norwood, Mass.
MODELING OF AIRCRAFT CABIN FIRES
M. A. DELICHATSIOS Sep. 1984 117 p refs Sponsored in part by FAA
(NBS-GCR-84-473) Avail: NTIS HC A06/MF A01

In this work, simple fire dynamic models for various components of an aircraft cabin fire are developed. These simple integral models can be incorporated in global zone models for aircraft cabin fires occurring in flight or caused by an impact-survivable crash. The major accomplishment of this work was the development of simple expressions for the burning of vertical walls, simulating, for example, the burning of wall panels in the fuselage. Flame heights of vertical wall fires are predicted and correlated by a simple expression. In addition, critical conditions for extinction of rapid flame spread have been investigated for fires in vertical walls consisting of charring materials, allowing for the prediction of flame spread rates. These critical conditions were developed based on simple vertical wall burning and flame height correlations, as well as on a simple model for charring pyrolysis. Preliminary analysis of integral models for ceiling flows (such as that along the aircraft cabin ceiling) including combustion indicates that an equation for the decay of turbulence is required for describing such flows. One of the outcomes of this work is the identification of material properties controlling flammability. B.W.

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A85-12664
DEPTH OF FIELD FOR SAR WITH AIRCRAFT ACCELERATION
P. N. ROBINSON (Norden Systems, Santa Ana; Hughes Aircraft Co., El Segundo, CA) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, Sept. 1984, p. 603-616. refs

The effects of aircraft acceleration on the depth of field are analyzed for three types of SAR processing: (1) conventional processing (range-Doppler processing); (2) variable pulse-repetition frequency (VPRF); and (3) polar format. It is shown that the depth of field for SAR can be greatly increased by a nonlinear transformation of the video phase history data using variable VPRF and polar format. The VPRF compensates for aircraft acceleration, while polar format compensates for both aircraft acceleration and motion through range-Doppler cells. B.J.

A85-13442
INSTITUTE OF NAVIGATION, ANNUAL MEETING, 39TH, HOUSTON, TX, JUNE 20-23, 1983, PROCEEDINGS
Washington, DC, Institute of Navigation, 1984, 133 p. For individual items see A85-13443 to A85-13446.

Recent developments in the technology of marine and aerospace navigation are discussed in reviews and reports. Topics examined include job attitudes of Air Force navigators, the use of Landsat for navigation products, Shuttle orbiter navigation during reentry and landing, the Soviet threat to U.S. space systems, an ARGO/Syledis net for the Gulf of Mexico, three-dimensional seismic surveys, and GPS geodesy. Consideration is given to the DASH II inertial system, breaking the precision barrier for aircraft inertial systems, a hybrid strapdown attitude and heading reference system, and the sensitivity of an integrated Navstar GPS/INS system to component failure. T.K.

A85-13445#
DENEB, DUBHE, & DALLAS
P. S. NOE and J. H. PAINTER (Texas A&M University, College Station, TX) IN: Institute of Navigation, Annual Meeting, 39th, Houston, TX, June 20-23, 1983, Proceedings . Washington, DC, Institute of Navigation, 1984, p. 93-95. refs

Techniques for obtaining accurate position data for harbor and harbor-entrance navigation from the Navstar GPS system despite denial-of-accuracy (DOA) and selective-access measures being imposed by the DOD for national-security reasons are discussed, and the implementation of a pseudolite/differential-pseudorange (PDP) system is proposed. The PDP system combines to two principles derived by Beser and Parkinson (1982) and depends on the pseudolite concept, which is explained by analogy to air navigation practices of the 1940's (when a ground landmark such as Dallas was substituted for a star such as Deneb or Dubhe). The pseudolite (a ground station at a carefully surveyed location) obtains high-precision corrections to the satellite ranges by Kalman filtering of the DOA-degraded range signals from the GPS satellites being used by a ship (or helicopter) and transmits them to the user via a data link. The error introduced by the displacement of the user from the PDP station up to 16 km is estimated as about 1 m, assuming 500-m DOA error. The structure of the pseudolite data message is illustrated in a figure. T.K.

A85-13446#
FLIGHT TRIAL RESULTS OF A HYBRID STRAPDOWN ATTITUDE AND HEADING REFERENCE SYSTEM
D. B. REID, J. Z. ZYWIEL, J. S. A. HEPBURN (Huntec, Ltd., Toronto, Canada), and D. F. LIANG (Defence Research Establishment Ottawa, Ottawa, Canada) IN: Institute of Navigation, Annual Meeting, 39th, Houston, TX, June 20-23, 1983, Proceedings . Washington, DC, Institute of Navigation, 1984, p. 109-117. refs

The results of flight tests comparing the performance of a prototype attitude and heading reference system (AHRS, as described by Reid et al., 1980 and 1981, comprising a missile-grade strapdown inertial-measurement unit; a 3-axis strapdown flux-gate magnetometer; and static-pressure, differential-pressure, and atmospheric-temperature sensors) with that of a conventional Doppler radar, an inertial-navigation system, a vertical gyroscope, and a Ce total-field magnetometer are reported. The operating principle of the AHRS and the U-D-factorized Kalman filter used in the integration of all data are explained, and the results are presented in tables and graphs. Accuracies determined for the AHRS include ground-calibration heading accuracy 0.1 deg rms, in-air heading accuracy 0.5 deg rms, attitude and heading accuracy over 1.3 h 10 arcmin, and radial velocity-error growth rate 9.9 n.m./h; the velocity-error growth rate for the integrated Doppler/inertial-navigation system is 7.0 n.m./h, reflecting the generally higher precision of that instrument package under the test conditions. T.K.

A85-13512*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
USING SATELLITES TO IMPROVE CIVILIAN AIRCRAFT SURVEILLANCE COVERAGE
K. MCGRAW (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 4 p. FAA-NASA-sponsored research.
(AIAA PAPER 84-2405)

Surveillance of aircraft is presently accomplished through the use of terrestrial based secondary radar sensors, which are capable of interrogating transponders aboard aircraft. Transponder responses provide the basis for determining radial distance by measuring round-trip signal time while antenna angular position is used to determine azimuthal position. These interrogating radar beams are line-of-sight and thus have their coverage obscured by mountains and tall buildings. The addition of more radar sites is rendered unfeasible by the lack of easy access to the required additional site locations. A possible solution to this problem is to deploy satellites that interrogate transponder-equipped aircraft from a position that provides an unobstructed view. Author

A85-13518#
MINIMIZATION OF THE MAINTENANCE IMPACT ASSOCIATED WITH THE INTRODUCTION OF HIGH TECHNOLOGY ELECTRONICS TO ROTARY WING AIRCRAFT
T. L. DAHLIN (McDonnell Douglas Astronautics Co., Huntington Beach, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p.
(AIAA PAPER 84-2413)

The Mast Mounted Sight (MMS) and Test Support Systems (TSS) were developed to meet U.S. Army requirements for increased scout helicopter effectiveness and survivability. The TSS performs self-diagnostics by means of a self-test transition frame, while the MMS consists of TV and thermal imaging sensors together with a laser range finder and designator. The MMS has been tested aboard the OH-58D scout helicopter. Attention is given to the MSS's built-in test system. O.C.

A85-13530*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
OPERATIONAL AIR TRAFFIC CONTROL REQUIREMENTS FOR THE NEW VOICE SWITCHING AND CONTROL SYSTEM
N. LEON (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 16 p.
(AIAA PAPER 84-2435)

Final user requirements defined for the Voice Switching and Control System (VSCS) to be implemented for ATC functions as part of the Area Control Facility (ACF) concept for the National Airspace System (NAS) are described. The VSCS will be communications equipment at operational stations, supervisory positions, and support systems, the switching system itself, and interfaces between the VSCS and other systems. Supervisory users will include the Area Manager, Traffic Management Coordinator, a Military Operations Specialists, a Weather Coordinator, a NAS manager, Maintenance, and a flight Data Communications Specialist. The VSCS will supply computerized communications capability within and among ATC centers. Details of the efforts used to define the system requirements are recounted, noting the heavy reliance on recommendations from active ATC personnel. M.S.K.

A85-13531#
COMPUTER OPTIMIZED TACAN NAVIGATION FOR HIGH PERFORMANCE AIRCRAFT
J. R. CRUMP (USAF, Columbus AFB; Mississippi State University, Starkville, MS) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 4 p.
(AIAA PAPER 84-2436)

The paper discusses the computer algorithm needed to optimize cross country flights with respect to fuel useage. The optimum route and altitude are computer generated after a series of comparative iterations. This optimum flight plan is corrected for magnetic variation and then presented to the user in a standard format. All types of high performance jet aircraft can potentially utilize this system. Author

A85-13556#
CONFORMAL EO SENSOR DEVELOPMENT FOR THE AFTI/F-16
J. W. TUTTLE (General Dynamics Corp., Avionics Dept., Fort Worth, TX) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 8 p.
(AIAA PAPER 84-2478)

The Sensor Tracker Set (STS) provides precision air-to-air and air-to-surface targeting functions for the Advanced Fighter Technology Integrator (AFTI/F-16). The AFTI/F-16 is a flyable testbed loaned to General Dynamics by the Air Force Flight Dynamics Laboratory to evaluate technologies having potential military aircraft applications. The compact sensor head design incorporates shared aperture optics and partitioning of power and computer processing functions off gimbal to achieve minimum aircraft performance impact. An advanced forward looking infrared sensor (FLIR) and a Nd YAG laser rangefinder share the front end afocal optics. The strake installation provides hyper-hemispherical coverage necessary for AFTI/F-16 automated low altitude turning weapon delivery and air-to-air combat maneuvers. The video tracker is designed for smooth angle tracking and clutter rejection. A Kalman filter fuses angle track, laser and radar data to generate target state estimates. The processor and interface design enabled integration of the external signal interface and evaluation of many STS software functions prior to delivery of the hardware. Author

A85-13568*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FLIGHT TEST CONFIGURATION FOR VERIFYING INERTIAL SENSOR REDUNDANCY MANAGEMENT TECHNIQUES
W. H. BRYANT, F. R. MORRELL (NASA, Langley Research Center, Flight Control Systems Div., Hampton, VA), and M. L. BAILEY (Kentron International, Inc., Hampton, VA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p. refs
(AIAA PAPER 84-2496)

The Redundant Strapdown Inertial Measurement Unit presently tested in flight configuration consists of a semioctahedral array of four dynamically tuned, two-degree-of-freedom (TDOF) gyros and four TDOF accelerometers which can provide dual, fail-operational performance for integrated avionics systems. Attention is given to the multilevel algorithm used for the detection and isolation of three ranges of sensor failure in an integrated avionics context. A technique for the generation of accelerometer and gyro error thresholds which is sensitive to dynamic sensor errors and separation effects is presented, together with simulation results. Emphasis is placed on the ensuring of highly reliable data for flight control/navigation functions, while minimizing false or missed alarms. O.C.

A85-13684#
GPS AIDED LOW COST STRAPDOWN INS FOR ATTITUDE DETERMINATION
I. Y. BAR-ITZHACK (Technion - Israel Institute of Technology, Haifa, Israel) and Y. MEDAN IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 73-78. Research sponsored by Tamam Precision Instrument Industries.

This work deals with the idea of adding azimuth information to GPS by augmenting a GPS receiver, a low cost strapdown INS (SDINS) and a microprocessor. GPS position measurements are fed into the processor which performs Kalman filter computations to estimate and correct the SDINS errors. In order to meet accuracy requirements without subjecting the vehicle to high acceleration maneuvers, sensor cluster indexing has to be performed periodically. This paper presents a performance and sensitivity analyses of the system. Results of covariance simulation runs are presented and discussed. It is shown that a low cost, low accuracy SDINS can meet the required attitude accuracies of 0.15 mrad in tilt and 5.0 mrad in azimuth. Author

A85-14012#
ROBUST COUNTERMEASURES HELP 'LEAP-FROG' THE THREAT
R. WALKER (USAF, Washington, DC) Aerospace America (ISSN 0740-722X), vol. 22, Nov. 1984, p. 54-56.

After relating a brief development history for the electronic countermeasures (ECM) systems of the B-52, FB-111, and B-1A strategic aircraft, attention is given to the state-of-the-art ALQ-161A ECM system of the B-1B bomber and to the foreseeable ECM requirements of next-generation penetrator aircraft. These requirements are driven by substantial improvements in the offensive capabilities of both airborne interceptors and surface-to-air weapons systems. To cope with near-term threats, the ALQ-161A encompasses an RF surveillance RF surveillance/ECM system, a tail warning system, integrated cockpit controls and displays, and an expendable countermeasures system. ALQ-161A is highly modular, and distributes 100 integrated LRUs throughout the aircraft; this permits the rapid reconfiguring of the system for different mission requirements, as well as the incorporation of improved LRUs. O.C.

A85-14440
AIRCRAFT TRACK INITIATION WITH SPACE BASED RADAR
J. K. CLINE and D. C. TORRETTA (McDonnell Douglas Astronautics Co., St. Louis, MO) IN: EASCON '83; Proceedings of the Sixteenth Annual Electronics and Aerospace Conference and Exposition, Washington, DC, September 19-21, 1983 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 123-129.

Initiating tracks on target aircraft with a Space Based Radar (SBR) requires an ability to correlate SBR reports of the aircraft in an environment of background traffic. A promising motion feasibility algorithm for report-to-report correlation of SBR observations of aircraft has been developed, and its predicted performance is the subject of this paper. Probabilistic methodology for analyzing algorithm performance is described and applied to the SBR algorithm. The theoretical discussion is followed by a presentation of the results of a Monte Carlo computer simulation in which an enhanced version of the algorithm is tested against a realistic scenario of air traffic motion. During a 14-hour period of the scenario, the enhanced algorithm had a correct association decision rate on the well-behaved traffic of over 94 percent, assuming a constant SBR revisit interval of 24 minutes. The algorithm performance predictions of the theoretical and simulation studies are compared and show similar characteristics and trends. Author

A85-14443
AN APPROACH TO THE MULTI-SENSOR INTEGRATION PROBLEM
D. L. ALSPACH (Orincon Corp., La Jolla, CA) IN: EASCON '83; Proceedings of the Sixteenth Annual Electronics and Aerospace Conference and Exposition, Washington, DC, September 19-21, 1983 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 149-157.

Various approaches to developing data fusion circuits for observation systems to which are added additional sensors are discussed. The goals of the fusion boxes are to faithfully absorb as much sensor data as possible while accounting for any negative effects caused by the presence of the new sensor element(s). The sensor array data can be examined for target tracks, processed for correlations, then smoothed and filtered to present a single target track. Another option is to return to the actual sensor data that produced a correlated track, process the data through an extended Kalman filter, then produce a fused master target track. Sensor control can also be implemented to update the processing steps to the presence of friendly platforms or new extraneous images. M.S.K.

A85-14454
COMMUNICATION CONTROL GROUP TECHNOLOGY INSERTION FOR THE S-3A
A. J. GOLDSTEIN (Teledyne Systems, Inc., Northridge, CA) IN: EASCON '83; Proceedings of the Sixteenth Annual Electronics and Aerospace Conference and Exposition, Washington, DC, September 19-21, 1983 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 269-277.

Techniques implemented in an attempt to provide high reliability and maintainability levels in an integrated communications system for the S-3A antisubmarine warfare aircraft are described. The previous system had multiple degraded failure modes and a hard-wired failsafe mode, centralized audio and digital interface switching, a central control panel, and a simple logic bus that did not allow expansion. Six new service test modules are being designed which encompass six major weapons replaceable assemblies, the 15553B data bus, electronic circuitry that reduces the parts count, and built-in test functions. Intercommunications capabilities can be altered with replacement memory modules. The communication system controller has PROM program plug-in receptors, 8085A microprocessor-based operation, and lower weight and power requirements than its predecessor. M.S.K.

A85-14638
AIR NAVIGATION [VOZDUSHNAIA NAVIGATSIIA]
I. G. KHIVRICH, N. F. MIRONOV, and A. M. BELKIN Moscow, Izdatel'stvo Transport, 1984, 328 p. In Russian. refs

The theory of air navigation is expounded, with particular attention given to the use of navigational information sources, the effect of wind on the flight, and principles of the determination of motion parameters and aircraft coordinates. The principal navigational aids and instrumentation are characterized, and methods for determining navigational elements are discussed. In particular, the discussion covers the use of course-indicating systems, determination of the flight altitude and velocity, the use of inertial navigation systems, and visual orientation. V.L.

A85-14826
INSTITUTE OF NAVIGATION, ANNUAL MEETING, 40TH, CAMBRIDGE, MA, JUNE 25-28, 1984
Meeting sponsored by ION, General Motors Corp., Northrop Corp., et al. Washington, DC, Institute of Navigation, 1984, 177 p. For individual items see A85-14827 to A85-14841.

Existing, planned, and prototype systems for aiding land, marine, and aircraft navigation, positioning, and landing approaches are described. Attention is given to navigation aid data processing in the 737-300 FMC, the accuracy of OMEGA navigation system position fix, and features of the planned Geostar commercial navigation and communications system. The implementation of artificial intelligence expert systems in fighter avionics is discussed, along with inertial sensor systems, suboptimal filtering of GPS signals, and VLF radio compass for Arctic navigation. Clock coasting and error analysis, a pseudo-satellite beacon system, a receiver processor, and a data base for the GPS navigation system are considered. Finally, a low-cost GPS receiver/processor is detailed and an integrated surveillance/navigation system is outlined. M.S.K.

A85-14827#
NAVIGATION PROCESSING OF THE FLIGHT MANAGEMENT COMPUTER SYSTEM FOR THE BOEING 737-300
S. P. KARATSINIDES and R. L. BUSH (Lear Siegler, Inc., Grand Rapids, MI) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 24-31. refs

The navigation processing of the Flight Management Computer System, jointly developed by Lear Siegler, Inc. and the Boeing Co. for the new Boeing 737-300 aircraft, is presented in this paper. It is designed to operate in either radio assisted or stand alone mode. The radio assisted mode utilizes a Kalman filter with slant range and bearing measurements to correct the outputs of a strapdown inertial reference system. The stand alone mode extrapolates the last available Kalman estimates for the correction of the inertial outputs. The selection of the radio navigation aid stations necessary for the generation of the Kalman filter measurements is accomplished either automatically, or manually through a pilot selected input frequency. Author

A85-14828#
OMEGA NAVIGATION SYSTEM POSITION-FIX ACCURACY ASSESSMENT
P. M. CREAMER, R. R. GUPTA (Analytic Sciences Corp., Reading, MA), and P. B. MORRIS (U.S. Coast Guard, Navigation Science Div., Washington, DC) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 32-40. refs

A baseline assessment is provided for the worldwide hyperbolic position-fix accuracy of the OMEGA Navigation System. The assessment is performed by evaluating the fix errors obtained using a single-frequency, hyperbolic fix algorithm, and the Morris/Swanson propagation correction prediction model. Position-fix statistical measures for computed for each monitor site and LOP pair available in 5 years of phase-difference data selected from the OMEGA MASTERFILE. The worldwide distributions of position-fix measures are then displayed for two selected OMEGA fix-geometry criteria: GDOP less than 10, and best-available GDOP at each site. Author

A85-14829#
THE GEOSTAR SATELLITE NAVIGATION AND COMMUNICATIONS SYSTEM
G. K. ONEILL (Geostar Corp., Princeton, NJ) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 50-54.
The design and performance parameters of the Geostar communications and navigation satellite, scheduled for launch in 1987, are described. The Geostar system comprises a ground station equipped with redundant computers, data bases, and a digitized terrain map, the space segment, and portable transceivers. Two-way digital links will employ spread spectrum, packet switching, TDMA, and code DMA techniques. Coding will furnish communication security and billing. The system will be capable of carrying 55 million messages/hr, serving a population of 50 million transceivers, each costing $450 (1984). A constellation of three Geostar satellites could provide 2-7 m location/altitude accuracy for aircraft. Other services will include position fixing, directional guidance for air, land, and marine vehicles, terrain warnings, two-way messages between transceivers, emergency SAR signals, and data base connections from remote locations. M.S.K.

A85-14830#
ARTIFICIAL INTELLIGENCE APPLIED TO THE INERTIAL NAVIGATION SYSTEM PERFORMANCE AND MAINTENANCE IMPROVEMENT
C. A. BEDOYA and K. J. KELLER (McDonnell Aircraft Co., St. Louis, MO) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 55-61.
(Contract F33616-82-C-1904)
Test results and performance and design features of an inertial navigation system-fault analysis and management system (INS-FAAMS) for implementing artificial intelligence (AI) in fighter aircraft avionics are outlined. Development objectives of INS-FAAMS were to enhance the availability and accuracy of INS and demonstrate AI expert system capabilities. INS failures were studied and found to be intermittent, induced by an incorrect procedure, or due to nonduplicable conditions. The expert system AI data base was defined through field maintenance data, identification of key failure paths, and simulation testing with regards different mission profiles. A blackboard architecture was selected and comprised three divisions, permanent knowledge and current hypothesis, knowledge source demons searching for an antecedent to become true, and a priority-based scheduler. Tests have revealed the INS-FAAMS effectiveness at identifying problems for maintenance or isolating them when possible. M.S.K.

A85-14832#
SUBOPTIMAL FILTERING FOR AIDED GPS NAVIGATION
D. C. MOSSMAN, J. H. BOCHEM, D. G. CALDWELL (Sperry Corp., Sperry Flight Systems, Phoenix, AZ), and W. T. HIGGINS, JR. (Arizona State University, Tempe, AZ) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 73-81.
A navigational algorithm which includes features of both an empirical complementary filter and an optimal Kalman filter is defined for implementation in a GPS receiver. The Kalman filter formalism is modified to eliminate cross-coupling terms and a prefilter which assumes velocity gains is defined. The prefilter is superposed on the suboptimal filter and the system is expanded to solve for errors. The system performance was tested with a simulation of an aircraft on a round the world racetrack and by mounting receiver equipment in a mobile van. Satisfactory results were obtained in 1/30th of the computational time required by an optimized Kalman filter. M.S.K.

A85-14833#
A FEASIBILITY STUDY OF A VLF RADIO COMPASS FOR ARCTIC NAVIGATION
D. PETROV, J. LAMONTAGNE, and J. LAGANIERE (Aviation Electric, Ltd.; Allied Corp., Montreal, Canada) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 87-94. refs
Because of the erratic behavior of magnetic compasses in the arctic and long settling times of gyrocompasses in the vicinity of the north pole, the feasibility of a very low frequency (VLF) radiocompass in these regions has been studied. The operation of this instrument is explained by defining in spherical trigonometry the loci of points which subtend a constant angle with respect to two fixed references. Results of VLF radio direction finding in the arctic are discussed. It is shown that vehicle heading can be determined with an accuracy better than 2 deg. Author

A85-14834#
CLOCK COASTING AND ALTIMETER ERROR ANALYSIS FOR GPS
N. KNABLE and R. M. KALAFUS (U.S. Department of Transportation, Transportation Systems Center, Cambridge, MA) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 109-114.
The Global Positioning System can serve as a primary navigation system for users with equipment that can continue to provide a navigation fix during system outages caused by satellite failure. The use of an altimeter or very stable clock to continue the nav fix is shown to be a practical solution. There is a need to reduce the cost of these aids. Author

A85-14835#
INTEGRATED GLOBAL NAVIGATION AND SURVEILLANCE SYSTEM
R. P. CROW IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 115-122.
System design and performance features of an Integrated Global Navigation and Surveillance System (IGNASS) are discussed. IGNASS would combine ground and space-based networks to provide three-dimensional aircraft location, precise area navigation, collision avoidance data, two-way data links between aircraft, and multi-runway landing guidance. The ground links would transmit interrogation codes to aircraft via satellite link. Multiple satellite reply receptions and relays would provide the locations/heading data for ATC functions. Existing ground stations would provide back-up. It is shown that equipment redundancy permits integration of the navigation and surveillance functions while meeting FAA directives to keep the systems separate. A constellation of 20 satellites in GEO are needed, each featuring 19 beams aimed at the earth. The on-board power, data processing, and ground back-up system requirements are outlined. M.S.K.

A85-14836#
THE USE OF PSEUDO-SATELLITES (PLS) FOR IMPROVING GPS PERFORMANCE
D. KLEIN (Intermetrics, Inc., Cambridge, MA) and B. W. PARKINSON (Stanford University, Stanford, CA) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 123-128. refs
A combination of a differential GPS transmitter with a GPS-like ranging signal synchronized with the GPS is described as a means of producing pseudo-satellites (PLs) to ameliorate dilution of precision (DOP) events due to poor geometry. Up to four areas of poor geometry will occur at any one time. Siting a PL station, which would mimic GPS signals and thus allow automated determination of GPS signal bias by local users, near an area

exposed to periodic poor coverage geometry is shown to eliminate the occurrence of DOP in navigational signals. A simulation revealed that the PLs would also enhance vertical positioning data. Studies have indicated that the PL signals should be either 1575 MHz with 100 microsec pulses, or a 1560 or 1590 MHz continuous signal. M.S.K.

A85-14837#
SOME CONCEPTS FOR IMPROVING NON-PRECISION APPROACH GUIDANCE THROUGH USE OF ON-BOARD DATA BASES
E. O. FRYE (Rockwell International Corp., Cedar Rapids, IA) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 129-137. refs

Measures which might be taken to augment existing and planned navigational aids to provide total approach control performance were examined in terms of simulations using a data base on numerous existing airports and associated nav-aid equipment. New equipment must be sufficiently accurate to guide an aircraft to a touchdown to within 30 ft laterally and -200 to +1000 ft longitudinally with a 3 deg glideslope for the last 5 mi in the air. A survey was performed of the existing VOR/DME ILS and MLS systems at FAA certified airports. Simulated landings were flown onto the airstrips, revealing that a 200 ft ceiling is acceptable for a safe approach. Various enhancements were studied for the cockpit and avionics displays. It was found that an on-board data base containing both instrumental and visual scene landmarks for terminal approach was a valuable aid. Displaying the data graphically on a screen or HUD further augmented its value. The data could be stored at the airports and radioed for real-time display in the cockpit. M.S.K.

A85-14838#
C/A CODE RECEIVERS FOR PRECISE POSITIONING APPLICATIONS
J. ASHJAEE, R. ESCHENBACH, and R. HELKEY (Trimble Navigation, Mountain View, CA) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 138-143. refs

Many positioning applications require more accuracy than has been reported from a C/A code receiver, but they cannot affort the cost of a P code set with dual L band channels. Two Global Positioning System (GPS) receivers have been developed - one for time and frequency monitoring, and one for position location. Because of the requirements of the time and frequency product, the accuracy of the C/A code was investigated. Data are presented which show a positioning accuracy (both relative and absolute) much better than that which is generally thought to be available using a C/A code receiver. This improvement is seen in both short term (.25 sec), and long term (1 day) measurements. Using this enhanced accuracy, data are presented which support the case for the use of C/A code receivers in precise relative as well as absolute positioning applications. Author

A85-14839#
ON THE DEVELOPMENT OF A DATA BASE FOR THE NAVSTAR GPS PHASE IIB USER EQUIPMENT DT&E (OR) FIELD TESTING
J. BESER (Intermetrics, Inc., Huntington Beach, CA) and B. J. SPROSEN (RAF, Global Positioning System Joint Program Office, Los Angeles, CA) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 144-154.

The user segment GPS test program is described, together with the data base, the processing and analyses performed to validate the equipment performance and the results available to a prospective equipment developer. The prototype user equipment was tailored to the needs of the host vehicles, e.g., fighters, helicopters, and people. The tests examined GPS signal acquisition time, navigation performance, alignment capabilities, mission applications, human factors design, reliability, availability and maintainability, multipath propagation effects, and interoperability of the receivers and support equipment. The tests are being run on the desert and open seas. The data base covers the mission configuration, test structure, equipment, individual unit performances, and test results. Potential bidders for production equipment agreements access the results data base on-line or from archives through menu-driven screens, except when classified data are transmitted. M.S.K.

A85-14840#
TI 4100 NAVSTAR NAVIGATOR TEST RESULTS
D. HENSON and B. MONTGOMERY (Texas Instruments, Inc., Lewisville, TX) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 155-163.

Test results with the TI 4100 GPS signal receiver/processor for navigation are reported. The transportable unit has an antenna that can be mounted up to 200 ft away and connected by cable, two 16 character alphanumeric displays, and a 20 key keyboard for input. The TI 4100 can track up to four GPS satellites simultaneously using L1 and L2 frequencies. A relative navigation mode permits references to other navigational aid data when less than four GPS satellites are in sight. Tests run in three satellite, three satellite time-bias-rate hold, and two satellite altitude and time-bias-rate hold modes yielded accuracies within 15 m and velocities closer than 0.2 m/sec. M.S.K.

A85-14841#
LOW COST GPS RECEIVER SIGNAL PROCESSING
G. F. SAGE (Navigation Technology, Inc., Cool, CA) IN: Institute of Navigation, Annual Meeting, 40th, Cambridge, MA, June 25-28, 1984 . Washington, DC, Institute of Navigation, 1984, p. 164-169.

Design goals for signal processors for the mobile terrestrial GPS receivers are defined, noting the design constraints of low-cost, high reliability and performance. A software approach has been taken to simplify the hardware requirements. An A/D converter samples the output of a single 175.42 MHz IF channel. Multiplex features of the receiver reduce hardware biases, delays, and internal interference. An 8-bit processor guides all internal functions, including signal acquisition, bit synchronization, code tracking, and pseudo-range calculations. The latter two functions are controlled by ROM-based software. M.S.K.

A85-15169
IMPROVEMENTS IN COMPUTING FLIGHT PATHS AND FLIGHT TIMES FOR AIR TRAFFIC CONTROL
H. VISSCHER and W. VAN BLOKLAND (ATC Systems Bureau, Netherlands) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, Sept. 1984, p. 152-157.

The accuracy levels and factors introducing errors into estimated time over (ETO) calculations of aircraft flying past reporting points (RP) in the Netherlands air system were examined. The RPs provide ATC with data for deciding if a conflict situation could arise. The study covered 542 aircraft for a 6 mo period for 10-15 intervals. Differences between ETO and actual passage over were calculated. Large extremes were found and attributed to unreliable wind data, flight path deviations and performance decrements in flight management computers. Improved ETO predictions and flight path adherence could be attained with better radar position updates and a better data base on the actual, rather than advertized, performance of modern aircraft in various flights phases. The latter measure is feasible due to standardized aircraft operating procedures, which were noted to be assiduously followed. M.S.K.

A85-15523
MODERN AVIATION ELECTRONICS
A. HELFRICK Englewood Cliffs, NJ, Prentice-Hall, Inc., 1984, 319 p.

An advanced text in aviation electronics is presented. The general subjects discussed include: frequency synthesizers, communications, low-frequency navigation systems, very high frequency navigation systems, rho-theta navigation, landing systems, surveillance systems, and indicators. C.D.

A85-15658
THE DESIGN OF AN ON-BOARD LOOK-AHEAD-SIMULATION FOR APPROACH
J. RIEPE (Braunschweig, Technische Universitaet, Brunswick, West Germany) IN: Simulation in engineering sciences: Applications to the automatic control of mechanical and energy systems; Proceedings of the International Symposium, Nantes, France, May 9-11, 1983 . Amsterdam and New York, North-Holland, 1983, p. 285-290.
A prospective flight guidance system which would repetitively simulate an approach path, based on waypoint input data, for cockpit display as a guide for the pilot is described. The pilot inputs control forces to bring the aircraft along the displayed flight path, while ATC can furnish messages of new conditions such as wind speed changes. The display response to changing command inputs should take at most 100 msec, with trajectory updates proceeding at a rate of 10/sec. Pilot attention to the CRT should not require more than 5 sec viewing time, implying full approach path, with a symbol of the aircraft proceeding along that path, be repeated at least every 2 sec. Separation of the running simulation and ATC and control systems inputs to the pilot can be achieved with a parallel computer architecture. A prototype system has been used with a flight simulator and has achieved the required simulation rapidity for display, and software techniques for meeting update criteria are being developed. M.S.K.

A85-15687
THE MAIN CHARACTERISTICS OF A SYNTHETIC-APERTURE RADAR IN THE CASE OF ARBITRARY MOTION OF THE FLIGHT VEHICLE [OSNOVNYE KHARAKTERISTIKI RSA PRI PROIZVOL'NOM DVIZHENII LETATEL'NOGO APPARATA]
IA. S. ITSKHOKI, N. A. SAZONOV, and E. F. TOLSTOV Radiotekhnika i Elektronika (ISSN 0033-8494), vol. 29, Nov. 1984, p. 2164-2172. In Russian. refs
The effect of phase fluctuations on the azimuth resolution and accuracy of a synthetic-aperture radar is evaluated for rectilinear flight and the sidelooking regime. Arbitrary flight trajectories and observation angle are assumed, and the evaluation is carried out according to the modulus of the output-signal function. L.M.

N85-12006# Joint Publications Research Service, Arlington, Va.
NEW AIRPORT GROUND TRAFFIC CONTROL SYSTEM PLANNED
G. GRISHAYEVA *In its* USSR Rept.: Transportation (JPRS-UTR-84-029) p 9-11 4 Oct. 1984 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 5 Jul. 1984 p 3
Avail: NTIS HC A06/MF A01
Flights under ICAO category 3 weather conditions require the use of technically more improved lighting and radar facilities. Recessed green lights situated at the centerline at 15-meter intervals in straight sections of taxiways and at intervals of 7.5 meters on curves produce a beam of light readily visible to pilots because they are installed in a bored cylindrical opening in the taxiways concrete. Scanning radar enables the ground controller in the airport tower to see both the runways and the taxiways as well as the aircraft and special vehicles on them. A graphic panel of the taxiway lighting system produces a true picture of the signal lighting. A diagram of the airport is situated next to the radar scope. In case of any malfunction, the controller is warned and the nature and location of the malfunction is indicated. A.R.H.

N85-12007# Joint Publications Research Service, Arlington, Va.
START-2 ATC SYSTEM INSTALLATION PROGRESSES AT LENINGRAD
V. SENIN *In its* USSR Rept.: Transportation (JPRS-UTR-84-028) p 12-13 4 Oct. 1984 Transl. into ENGLISH from Pravda (Moscow), 6 Jul. 1984 p 6
Avail: NTIS HC A06/MF A01
The technical re-equipment of Pulkovo Airport is continuing: a third runway is operating, and an experimental automated system for refueling aircraft is being built. The air traffic control service also is being filled with electronic technology. The widely known Start system now controls the movements of 36 airliners simultaneously. In the summer flight period, Pulkovo handles up to 200 arriving aircraft and the same number of departing aircraft. It is difficult for the air traffic control service: so many arriving and departing aircraft must be accommodated, they must be separated by air corridors and directed to follow a closely controlled course. The Start-2 system permits traffic control in the area of two or three airports and controls movements of up to 100 aircraft simultaneously. The system collects, processes, and represents full data on the aircraft from takeoff to departure from the ATC area. The system can photograph and record on tape the movement of aircraft in the approach and landing zones. A.R.H.

N85-12047 Bundesanstalt fuer Flugsicherung, Frankfurt am Main (West Germany).
ACTIVITIES REPORT IN AIR TRAFFIC CONTROL Annual Report, 1983 [JAHRESBERICHT, 1983]
Jun. 1984 45 p In GERMAN
Avail: Issuing Activity
The organization of civil aviation in the Federal Republic of Germany is described. Developments in air traffic security, navigational aids, radar engineering, information transfer and data processing are discussed. Author (ESA)

N85-12048# Martin Marietta Aerospace, Washington, D.C. Air Traffic Control Div.
SYSTEM ENGINEERING AND INTEGRATION CONTRACT FOR IMPLEMENTATION OF THE NATIONAL AIRSPACE SYSTEM PLAN, VOLUME 1, SECTIONS 1.0-4.0, 6.0 NAS Plan Audit Report
Aug. 1984 209 p
(Contract DTFA01-84-C-00017)
(AD-A145763; ATC-84-0026-VOL-1) Avail: NTIS HC A10/MF A01 CSCL 09B
When the National Airspace System (NAS) Plan for Facilities, Equipment, and Associated Development was released by the FAA in December 1981, the agency was facing a problem of potentially crisis proportions--that of meeting increasing airspace system demand with dated and deteriorating facilities. At that time, the FAA already had some viable ongoing modernization projects in various stages of planning and development. It was, however, overdue to the extent that airspace system facilities were already being stressed toward capacity, and demanded labor-intensive efforts to sustain aging equipment operation. Consequently, NAS modernization is now faced with over a decade of design, development, replacement, and upgrade activities aggravated by an urgency of completion and an intolerance to error or compromise to safety. The purpose of our audit was to verify the overall goals and objectives of the NAS Plan from the standpoint of technical validity and feasibility, system safety, user benefits, methods, costs, and schedule. In essence, the audit was intended to task and answer the following questions: are the goals and objectives appropriate to satisfy the requirements of both users and operators of the NAS through the year 2000 and beyond; are the planned modernization projects not only technically feasible but valid to satisfy the NAS goals and objectives; will system safety be enhanced through implementation of the modernization projects and uncompromised during the transition to them. GRA

N85-12049# Aeronautical Research Labs., Melbourne (Australia).
OBSERVATIONS OF LIGHTWEIGHT DOPPLER SYSTEM ACCURACY
I. V. LLOYD May 1984 27 p
(AD-A145968; ARL/SYS-TM-70) Avail: NTIS HC A03/MF A01 CSCL 17G
Data on the accuracy of the Lightweight Doppler Navigation System (LDNS) fitted to a Royal Australia Air Force UH-1H helicopter were gathered as a by-product of an experiment on the TACTERM navigation system. The observed accuracy was found to be close to 1% of distance travelled, a figure generally considered to be representative of modern Doppler navigation systems. The dominant source of LDNS position error was magnetic

compass error which in turn appeared to be dominated by spatial and temporal variations in the local magnetical field. GRA

N85-12883# Committee on Science and Technology (U. S. House).
AIRCRAFT NAVIGATION AND LANDING TECHNOLOGY: STATUS OF IMPLEMENTATION
Washington GPO 1984 202 p Hearing before the Subcomm. on Transportation, Aviation and Mater. of the Comm. on Sci. and Technol., 98th Congr., 2nd Sess., No. 109, 24 Jul. 1984
(GPO-38-615) Avail: Subcommittee on Transportation, Aviation and Materials

The background and current status of the Microwave Landing System (MLS); market environment; operational considerations; and the Non-Federal Systems and Airway's Improvement Program were discussed. B.G.

N85-13115# Joint Publications Research Service, Arlington, Va.
ACCOUNTING FOR ERROR STOCHASTICITY IN TERMINAL HOMING OF AIRCRAFT Abstract Only
P. I. KUZNETSOV, L. A. PCELINTSEV, and Y. S. SABYNIN *In its* USSR Rept.: Electron. and Elec. Eng. (JPRS-UEE-84-010) p 75 28 Aug. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Tekhn. Kibernetika (Moscow), no. 1, Jan. - Feb. 1984 p 213-216
Avail: NTIS HC A06/MF A01

The energy efficiency terminal homing of an aircraft is improved by correcting for the instantaneous missed hit error while accounting for the stochasticity of the latter. The problem of such a corrective control is formulated on the basis of a diffusion process as its model. The optimum strategy is defined in terms of the homing cost function and the Boltz criterion. The corresponding generalized Stefan boundary value problem with indeterminate boundary is solved by uniquely satisfying the Bellman equation. The condition of smooth splicing is established, which yields the necessary unique set of prolongations of autonomous flight. Prolongation may be based, typically, on the fuel reserve. Solution of the Bellman equation for this problem can be facilitated by the method of backward induction in time. Flight control curves were plotted and the payoff of corrective action based on error stochasticity was evaluated for various typical sets of parameter values. R.J.F.

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A85-13503#
MAGNA ANALYSIS OF THE T-38 AIRCRAFT STUDENT CANOPY - RESPONSE TO IN-FLIGHT AERODYNAMIC PRESSURE LOADS
J. L. HART (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 12 p. refs
(AIAA PAPER 84-2390)

The response of the T-38 aircraft student canopy to in-flight aerodynamic pressure loads are determined using the MAGNA (Materially and Geometrically Nonlinear Analysis) finite element computer program. In-flight static pressures measured at 103 positions on the surface of the T-38 student canopy are used to produce a continuous definition of pressure on the surface of the canopy model. The equivalent stress on the surface of the canopy as well as forces and moments along the perimeter are determined. The results presented show that in terms of mechanical failure or rupture of the T-38 student canopy, the combined effects of the aerodynamic loads and internal cockpit pressures experienced in flight produce relatively low levels of stress and low forces and moments. The data acquisition system and analytical tools used in this study make possible for the first time analytically based designs of patterns for protechnic cutting of transparent parts and optimized designs of transparency edge attachments and canopy jettisoning hardware. This analysis demonstrates a unique analytical capability for studying the structural response of transparent crew enclosures to aerodynamic pressure loads. Author

A85-13508#
TECHNIQUES TO REDUCE EXHAUST GAS INGESTION FOR VECTORED-THRUST V/STOVL AIRCRAFT
T. A. KAEMMING and K. C. SMITH (McDonnell Aircraft Co., Engineering Technology Div., St. Louis, MO) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p.
(AIAA PAPER 84-2398)

A series of water flow visualization tests simulating VTOL operation were conducted on a scale model of the McDonnell Douglas Model 279-3, an advanced supersonic fighter/attack V/STOVL aircraft. Vertical thrust is provided by a four nozzle, vectored thrust turbofan engine similar to the AV-8B. Using a unique, low cost test technique, near field exhaust gas flow phenomena were studied, and techniques were evaluated to minimize exhaust gas ingestion. Aircraft design changes and flow control devices were identified which virtually eliminate ingestion. Author

A85-13510#
CANARD/TAIL COMPARISON FOR AN ADVANCED VARIABLE-SWEEP-WING FIGHTER
J. P. LANDFIELD and D. RAJKOVIC (Grumman Aerospace Corp., Bethpage, NY) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p. Research supported by the Grumman Aerospace Corp. refs
(AIAA PAPER 84-2401)

Comparative evaluations have been conducted of longitudinal stability and control characteristics, trimmed drag-due-to-lift, minimum nosewheel lift-off speed, and carrier approach speed performance, for wing-canard and wing-horizontal stabilizer configurations of an advanced naval attack aircraft incorporating vectorable two-dimensional nozzles. The canard configuration is noted to offer trim wing lift and vectored thrust with upload, resulting in a vehicle that is 3-4 percent lighter than the conventional configuration when sized for equal carrier approach speed. O.C.

A85-13516#
MAINTENANCE IMPACT OF CURRENT LOADS RECORDING METHODOLOGY ON CRACK-GROWTH BASED INDIVIDUAL AIRCRAFT TRACKING
R. M. ENGLE, JR. (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) and T. F. CHRISTIAN, JR. (USAF, Damage Tolerance Analysis Laboratory, Robins AFB, GA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p. refs
(AIAA PAPER 84-2410)

The Air Force is currently changing the individual aircraft tracking system from one based on classical fatigue analysis to one based on fracture mechanics and crack growth. However, most current loads monitoring devices remain those which were installed under the fatigue based tracking programs. Consequently, the parameters which are being recorded are the same as those used in the previous tracking methodology. An evaluation, both analytical and experimental, has been conducted to determine the impact of using this existing data base to track individual aircraft on a crack growth basis. The basic conclusions are that the transition to the crack-growth based tracking system should not result in any major problems in maintenance scheduling and that any discrepancies which may occur should err on the side of safety. Author

A85-13519#
TRANSATMOSPHERIC VEHICLES - A CHALLENGE FOR THE NEXT CENTURY
S. A. TREMAINE (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) and J. B. ARNETT AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p.
(AIAA PAPER 84-2414)

The U.S. Air Force Systems Command's Aeronautical Systems Division has begun to investigate the Transatmospheric Vehicle (TAV) concept, which is seen as a global range military aircraft, operating from conventional airfields, whose hypersonic speed cruise regime would be at the upper reaches of the atmosphere. Attention is given to the difficulties inherent in the TAV design's reconciliation of aerothermodynamically highly stressed outer skin surfaces and cryogenic fuel tankage. Both airbreathing and rocket propulsion concepts are under consideration, as are exotic fuels and oxidizers possessing higher energy densities. One such fuel, metastable helium, would yield six times the propulsive efficiency of current cryogenic fuels. O.C.

A85-13520#
FLEXIBILITY FOR THE NEXT CENTURY - P3I AND B-1B
R. H. GULCHER (Rockwell International Corp., Los Angeles, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 5 p.
(AIAA PAPER 84-2415)

In order for new, high performance aircraft to perform adequately over the long service lives that are essential for cost effectiveness, 'preplaned product improvement' (P3I) design practices have been instituted. Attention is presently given to the application of P3I design and development principles to th B-1B strategic penetrator bomber, which must retain its effectiveness and mission versatility until well into the 21st century. Analyses of possible B-1B utilization in alternative roles and missions have indicated high potential effectiveness for reasonable investments in configurational modifications. This flexibility is exhibited not only in weapons carriage (both internal and external), but in digital avionics and ECMs and software control for mission modification. O.C.

A85-13521#
FUTURE TRANSPORT AIRCRAFT DESIGN CHALLENGES
R. H. LANGE (Lockheed-Georgia Co., Marietta, GA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 10 p. refs
(AIAA PAPER 84-2416)

This paper presents the results of preliminary design system studies of long-range strategic-airlift aircraft, continuous-patrol aircraft, and other strategic-systems aircraft. Included in the aircraft design concepts are advanced technologies such as filamentary composites and metal-matrix materials, advanced turboprop and turbofan propulsion, laminar-flow control, and advanced flight-control systems. The challenges for application of these technologies in the design process are described. The integrated effect of advanced technologies on range, time on station, and operating costs are presented for several aircraft design concepts. Aircraft design parameters include Mach numbers from 0.3 to 0.8, ranges up to 6500 nautical miles, endurance times up to 48 hours, and payloads up to 331,000 pounds. Author

A85-13537#
INTEGRATED TECHNOLOGIES AND THE TRANSPORT AIRCRAFT OF THE FUTURE
R. VANT RIET and W. T. LEWERENZ (Douglas Aircraft Co., Long Beach, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 12 p.
(AIAA PAPER 84-2447)

New and advanced technologies which can be implemented in next-generation aircraft to provide cost-effective incentives for the purchase of operation of the equipment are surveyed. Advanced turbofans, although offering increased fuel efficiency, will not reach the SFC levels projected for propfans in pusher or tractor configurations or unducted fans. Problems persist, however, in efficient extraction of bleed air to power the cabin environmental control system. Aerodynamic concepts which reduce drag and deserve consideration in new designs include supercritical airfoils, winglets, high aspect ratios, adaptive wings, two-surface canards, three-surface aircraft, and laminar flow control. Greater use will be made of Al-Li alloys, advanced polymers, metal-matrix composites, and superplastic and diffusion bonding techniques for structural components. Secondary power may be extracted by using the engine shaft power to turn generators. The key problem is integrating the technologies in a manner that will significantly reduce the direct operating costs of new aircraft. M.S.K.

A85-13538#
A SYSTEM APPROACH FOR DESIGNING A CRASHWORTHY HELICOPTER USING PROGRAM KRASH
M. W. VOTAW and J. K. SEN (Hughes Helicopters, Inc., Culver City, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 27 p. refs
(Contract DAAK51-83-C-0039)
(AIAA PAPER 84-2448)

An approach to simplify the problem of designing a helicopter to withstand severe crash impacts is presented. It is based on a systems analysis that includes considerations of design requirements, structural characteristics, occupant limitations, weight increases, and flight characteristics. A recommended chronology of design events is proposed that includes the formulation of: (1) a simple KRASH model, (2) a detailed KRASH model, (3) weight impact relationships on a component basis, and (4) the total aircraft weight impact. As crashworthiness limits are extended, weight increases may be incurred because of the wider range of helicopter sink speeds and impact conditions imposed. The KRASH program and the systems approach to crashworthiness methodology establishes a design to meet crash requirements and a means of assessing weight increases. Author

A85-13539#
PRELIMINARY AIRCRAFT DESIGN AND THE LANDING GEAR TURNOVER ANGLE CRITERION
H. H. PERRY (U.S. Navy, Naval Air Systems Command, Washington, DC) and J. J. SCHNEIDER (Boeing Vertol Co., Philadelphia, PA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 10 p.
(AIAA PAPER 84-2449)

During the preliminary design process of a new aircraft, the landing gear arrangement as affected by the operational requirements and/or design criteria is critical with potentially far-reaching effects. Historically, fixed-wing aircraft have received initial attention in this area and military specifications have, for approximately fifty years, defined requirements for turnover angle. However, until the Army's recent AMCP 706-202 Specification, rotary-wing aircraft turnover angle rquirements were never fully defined and understanding of shipboard requirements needed development. This paper describes the development of a real turnover angle criterion which is proposed for both shipboard and land-based rotary-wing aircraft. This criterion is also recommended for fixed-wing airplane specifications. Author

A85-13541#
FATIGUE SUBSTANTIATION OF THE SH-60B STABILATOR BY TEST
R. L. HOLT, D. O. ADAMS, and J. H. SCHNEIDER (Sikorsky Aircraft, Stratford, CT) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 15 p.
(AIAA PAPER 84-2452)

The design features, test program, and performance envelope of the foldable stabilator for the tail pylon of the Seahawk helicopter are described. The 14.33 ft span stabilator has a 34.5 in. constant chord, three-piece assembly, Kevlar and Al skins, steel-reinforced Al spars, and one lug attachment to the pylon with an elastomeric bushing to move the bending mode away from the dominant rotor frequencies. Dynamic fatigue tests with accelerated loads yielded low and high frequency load damage data and permitted calculations with Miner's cumulative damage law to characterize replacement intervals. The primary flight load input is main rotor downwash in level flight. Computerized monitoring of gages enabled tracking the appearance and propagation of lug cracks. The lug coupons have a design life of 10,000 flight hours. M.S.K.

A85-13546#
ADVANCED CONCEPTS IN COMBAT AUTOMATION
J. K. RAMAGE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and L. N. LYDICK (General Dynamics Corp., Fort Worth, TX) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 14 p.
(AIAA PAPER 84-2458)

Phase II automated maneuvering attack system (AMAS) development for the advanced fighter technology integration (AFTI) for the F-16 fighter is summarized. Emphasis is placed on the attack sensor integration, coupling of the flight and fire control systems, the implications of weapons integration, considerations relevant to the pilot-vehicle interactions, and concepts involved in vehicle automation. Automation is being enhanced to reduce the pilot workload and errors, improve pilot performance and increase the pilot-vehicle capabilities. Block diagrams are provided of the functional interfaces and multimode control law structure. The AFTI/F-16 is intended for tactical combat air-ground attack situations. The system is being extended through definition of curvilinear flight programs to partially automate the attack, weapons delivery and egress modes. M.S.K.

A85-13547*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
IMPACT OF FLIGHT SYSTEMS INTEGRATION ON FUTURE AIRCRAFT DESIGN
R. V. HOOD, S. M. DOLLYHIGH, and J. R. NEWSOM (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p. refs
(AIAA PAPER 84-2459)

Integrations trends in aircraft are discussed with an eye to manifestations in future aircraft designs through interdisciplinary technology integration. Current practices use software changes or small hardware fixes to solve problems late in the design process, e.g., low static stability to upgrade fuel efficiency. A total energy control system has been devised to integrate autopilot and autothrottle functions, thereby eliminating hardware, reducing the software, pilot workload, and cost, and improving flight efficiency and performance. Integrated active controls offer reduced weight and larger payloads for transport aircraft. The introduction of vectored thrust may eliminate horizontal and vertical stabilizers, and location of the thrust at the vehicle center of gravity can provide vertical takeoff and landing capabilities. It is suggested that further efforts will open a new discipline, aeroservoelasticity, and tests will become multidisciplinary, involving controls, aerodynamics, propulsion and structures. M.S.K.

A85-13550#
BOEING 737-300 FLIGHT TEST PROGRESS REPORT
W. A. ADAIR and J. C. MCROBERTS (Boeing Commercial Airplane Co., Seattle, WA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p.
(AIAA PAPER 84-2464)

Design features of the 737-300, a larger version of the 737-200 transport aircraft, and highlights of the flight test program are outlined. A high degree of commonality in components, procedures, and handling qualities and controls for the two aircraft permits pilots rated on one to be rated on the other. Tools and parts used on one can also be used on the other. The CFM56-3 engines provide 20 percent improvement in SFC over current low bypass ratio engines and meet new noise standards. Extensive use was made of composites for the control surfaces and a FMC computer was made standard. Nearly 60 hr of simulator flight were accumulated before actual flight tests, which were handled at base and remote sights with data taken at all sites telemetered to a main interactive computer system. The flight tests were carried out with two aircraft and revealed problems with a high stall speed, tail contact on takeoff and pilot control responsiveness dissatisfaction which were easily solved. The aircraft have successfully logged 60 flight hours/mo of tests and the basic configurations have been certified. M.S.K.

A85-13551*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
ROTOR SYSTEMS RESEARCH AIRCRAFT AIRPLANE CONFIGURATION FLIGHT-TEST RESULTS
W. D. PAINTER (NASA, Flight Research Center, Edwards, CA) and R. E. ERICKSON (NASA, Ames Research Center, Moffett Field, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 11 p. refs
(AIAA PAPER 84-2465)

The Rotor Systems Research Aircraft (RSRA) has been undergoing ground and flight tests by Ames Research Center since late 1979, primarily as a compound aircraft. The purpose was to train pilots and to check out and develop the design flight envelope established by the Sikorsky Aircraft Company. This paper reviews the preparation and flight test of the RSRA in the airplane, or fixed-wing, configuration and discusses the results of that test. Author

A85-13553*#
JOINED-WING RESEARCH AIRPLANE FEASIBILITY STUDY
J. WOLKOVITCH (ACA Industries, Inc., Torrance, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 14 p. refs
(Contract NAS2-11725)
(AIAA PAPER 84-2471)

The joined wing is a new type of aircraft configuration which employs tandem wings arranged to form diamond shapes in plan view and front view. Wind-tunnel tests and finite-element structural analyses have shown that the joined wing provides the following advantages over a comparable wing-plus-tail system; lighter weight and higher stiffness, higher span-efficiency factor, higher trimmed maximum lift coefficient, lower wave drag, plus built-in direct lift and direct sideforce control capability. To verify these advantages at full scale a manned research airplane is required. A study has therefore been performed of the feasibility of constructing such an airplane, using the fuselage and engines of the existing NAA AD-1 oblique-wing airplane. Cost and schedule constraints favored converting the AD-1 rather than constructing a totally new airframe. By removing the outboard wing panels the configuration can simulate wings joined at 60, 80, or 100 percent of span. For maximum versatility the aircraft has alternative control surfaces (such as ailerons and elevators on the front and/or rear wings), and a removeable canard to explore canard/joined-wing interactions at high-lift conditions. Design, performance, and flying qualities are discussed. Author

A85-13554#
LOW COST DEMONSTRATORS FOR MATURING TECHNOLOGIES
G. ROSENTHAL, S. A. POWERS (Fairchild Republic Co., Farmingdale, NY), A. W. BALDWIN, and D. L. CARTER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 26 p.
(Contract F33615-83-C-3017)
(AIAA PAPER 84-2472)

Attention is given to the R&D program management and economics consequences of the use of a novel flight vehicle demonstrator concept which allows modular reconfiguration of an airframe and cockpit-bearing 'core vehicle'. A central fuselage box structure is used which incorporates the cockpit and landing gear; alternative wings, strakes, empenages and engine nacelles are attached to this core structure for flight testing and evaluation.

Both development time and money are projected to be substantially reduced by this approach. O.C.

A85-13558#
FATIGUE EVALUATION OF HELICOPTER DYNAMIC COMPONENTS USED IN LOGGING OPERATIONS
J. R. HOOVER (Boeing Vertol Co., Philadelphia, PA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 35 p. refs
(AIAA PAPER 84-2482)

The fatigue evaluation of helicopter logging requires a number of elements that are key to that operation. These elements are: (1) a flight profile which accurately describes the operation; (2) S-N curves which are accurate in the low and intermediate cycle range; (3) flight loads which portray the proper flight attitudes, accelerations, airspeed, rates of climb and descent, and other pertinent aircraft parameters; and (4) the ability to analyze long data records to develop load histograms for life calculations. Each of these areas are discussed in greater detail. Specifically, those modifications made to improve on previously used techniques are presented using the results of an in-flight strain survey conducted with a Columbia helicopter at an actual logging site. This testing was performed earlier this year under an experimental authorization. The logging was not for revenue, but simulated actual conditions to the degree possible for that site. Author

A85-13559*# Hughes Helicopters, Culver City, Calif.
HIGHER HARMONIC CONTROL FOR ROTARY WING AIRCRAFT
B. P. GUPTA, A. H. LOGAN, and E. R. WOOD (Hughes Helicopters, Inc., Culver City, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 25 p. Research supported by Hughes Helicopters, Inc., and U.S. Army.
(Contract NAS1-16266)
(AIAA PAPER 84-2484)

Higher Harmonic Control reduces helicopter airframe vibration through the exercise of rotor blade pitch control at frequencies that are higher harmonics of rotor rotation. Analysis wind tunnel tests and flight tests of this technology with an OH-6A helicopter have led to vibration reduction levels of the order of more than 80 percent. Blade feathering capability at rotor speed harmonics other than the first also promises the improvement of such rotor characteristics as acoustics, aerodynamic efficiency and ground resonance. O.C.

A85-13569*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FLIGHT TEST TECHNIQUES FOR VALIDATING SIMULATED NUCLEAR ELECTROMAGNETIC PULSE AIRCRAFT RESPONSES
R. M. WINEBARGER and W. R. NEELY, JR. (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p.
(AIAA PAPER 84-2498)

An attempt has been made to determine the effects of nuclear EM pulses (NEMPs) on aircraft systems, using a highly instrumented NASA F-106B to document the simulated NEMP environment at the Kirtland Air Force Base's Vertically Polarized Dipole test facility. Several test positions were selected so that aircraft orientation relative to the test facility would be the same in flight as when on the stationary dielectric stand, in order to validate the dielectric stand's use in flight configuration simulations. Attention is given to the flight test portions of the documentation program. O.C.

A85-13572*# National Aeronautics and Space Administration, Washington, D. C.
AERONAUTICAL TECHNOLOGY 2000 - A PROJECTION OF ADVANCED VEHICLE CONCEPTS
C. C. ROSEN, III (NASA, Office of Aeronautics and Space Technology, Washington, DC), R. J. BURGER (National Research Council, Washington, DC), and A. SIGALLA (Boeing Commercial Airplane Co., Seattle, WA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 18 p.
(AIAA PAPER 84-2501)

At the request of NASA and under the aegis of the National Research Council, representatives from industry, academic institutions and government have participated in a workshop to consider opportunities for the exploitation of aircraft technology in such fields as aerodynamics, materials, structures, guidance, navigation and control, human factors, propulsion, computers and data processing, and systems integration. Attention is given to the advanced vehicle concepts that have emerged for possible year-2000 implementation, which encompass such diverse aircraft types as supersonic transports, hypersonic airliners, missiles, and interceptors, transatmospheric vehicles, next-generation space shuttles, subsonic transports and attack aircraft, advanced helicopter, tilt-rotor VTOL configurations, and solar- and microwave beam-powered extremely high altitude aircraft. O.C.

A85-13573*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SOME FIGHTER AIRCRAFT TRENDS
M. L. SPEARMAN (NASA, Langley Research Center, Aeronautical Systems Office, Hampton, VA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 12 p. refs
(AIAA PAPER 84-2503)

Some basic trends in fighter aircraft are traced from the post World War II era. Beginning with the first operational jet fighter, the P-80, the characteristics of subsequent fighter aircraft are examined in terms of performance, mission capability, effectiveness, and cost. Characteristics presented include such items as power loading, wing loading, maximum speed, rate of climb, turn rate, weight and weight distribution, cost and cost distribution. In some cases, the characteristics of U.S.S.R. aircraft are included for comparison. The trends indicate some of the rationale for certain fighter designs and indicate some likely characteristics to be sought in future fighter aircraft designs. Author

A85-13574#
FUTURE AIR FORCE TACTICAL AIRLIFTER CONSIDERATIONS
R. C. LECROY and D. M. RYLE, JR. (Lockheed-Georgia Co., Marietta, GA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p.
(AIAA PAPER 84-2504)

This paper reviews, from a Lockheed perspective, requirements considerations for future tactical transport aircraft. The changing tactical airlifter environment which is being driven by new and evolving military operational doctrine, more intensive threat environments, service equipping trends and supportability requirements is discussed and implications for future tactical transports are presented. The future airlifter needs will dictate exceptional takeoff, landing and ground performance, unprecedented survivability, automated systems to lessen an enormously high pilot work load, outstanding systems reliability, and combat damage repairability. Generic technologies necessary to meet these future challenges are discussed. Author

A85-13575#
LARGE AIRCRAFT, REQUIREMENTS AND CAPABILITIES
J. CHUPRUN, JR. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 11 p. refs
(AIAA PAPER 84-2505)

The focus of attention is on large aircraft. An historical review of the growth in aircraft size is made. For the largest aircraft over time, correlations on their physical dimensions, mass properties, and design characteristics are summarized. The requirements that drive aircraft size are identified. A simplified methodology is developed which relates payload and fuel fraction to gross weight. The capabilities of some selected large aircraft extracted from Air Force design studies are presented. Identification of the missions and requirements that drive aircraft size forms the framework from which future large aircraft can be postulated. Author

A85-13577#
THE AERODYNAMICS OF THREE-SURFACE AIRPLANES
E. R. KENDALL (Gates Learjet Corp., Wichita, KS) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 8 p. refs
(AIAA PAPER 84-2508)

Application of the classical Prandtly-Munk theory to a modern three-surface airplane produces a proof that the induced drag due to trim can be zero at any longitudinal c.g. location. Potential induced drag savings are about 7 percent relative to the conventional tail-aft design and between 15 percent and 20 percent relative to the two-surface canard-wing configuration. Author

A85-13585#
THE DESIGN EVOLUTION OF AN ADVANCED COMPOSITE TRANSLATING COWL
B. V. MURACH (Martin Marietta Aerospace, Baltimore, MD) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p.
(AIAA PAPER 84-2523)

Over the course of the last 20 years many improvements have been made in the design of aircraft structures. This paper describes the particular weight reduction, cost reduction, and productivity improvements that were made to the family of GE CF6 engine thrust reverser translating cowls. Redesigning a proven lightweight aluminum transcowl utilizing advanced composite materials proved to be a very demanding and complex undertaking. More stringent design requirements, unforeseen manufacturing difficulties, escalating costs, and reduced material mechanical property allowables all entered into the series of trade studies which eventually culminated into the extremely efficient CF6-80C2 engine translating cowl. Author

A85-13588#
THE VALUE OF WIND TUNNEL TESTS IN STUDENT DESIGN PROJECTS
J. F. MARCHMAN, III (Virginia Polytechnic Institute and State University, Blacksburg, VA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p.
(AIAA PAPER 84-2529)

The present investigation is concerned with the value of wind tunnel testing for students in Aerospace Engineering Design classes, taking into account two cases in which design groups made use of a subsonic wind tunnel available at Virginia Tech. One of these cases is related to a design project which won first place in a design competition sponsored by the Soaring Society of America for a self-launched sport sailplane. The other case is connected with a competition for an 'Advanced Technology Turbofan Executive Aircraft'. In both cases the student groups built a scale model aircraft and tested it in the Virginia Tech 6 x 6 foot Stability Wind Tunnel. After an evaluation of the various factors involved, it is concluded that wind tunnel testing as part of a student design course will be counter-productive and the students' time would be much better spent refining their designs on the basis of available analytical techniques. G.R.

A85-13589#
HOT GAS INGESTION AND THE SPEED NEEDED TO AVOID INGESTION FOR TRANSPORT TYPE STO/VL AND STOL CONFIGURATIONS
R. E. KUHN AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 25 p. Research supported by the Rockwell International Corp. refs
(AIAA PAPER 84-2530)

Recent studies of the flow fields around STO-VL aircraft operating in ground effect give new insight into the mechanisms of hot gas ingestion at low forward speeds. This paper uses this information and other published data on hot gas ingestion to identify the key design and operational parameters involved in minimizing inlet temperature rise in hover and in reducing the minimum speed at which the aircraft can be operated in ground effect without ingestion. Author

A85-13590#
HELICOPTER AIRFRAME VARIABLE TUNE VIBRATION ABSORBER
P. W. VON HARDENBERG and C. NIEBANCK (Sikorsky Aircraft, Stratford, CT) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 29 p. refs
(AIAA PAPER 84-2531)

This paper describes a unique helicopter airframe-mounted vibration absorber. It is a tuneable mass-spring absorber with a natural frequency that is automatically controlled. The concept embodies two opposed bifilar pendular mounted masses, acting under controllable spring forces. Internal compression springs were initially position set by an open loop hydraulic servo electronically operated by rotor rpm. Other aircraft requirements and applications include consideration of a self-adaptive configuration using a limited authority closed outer loop control design. The basic absorber has been proven to be highly reliable. It is weight effective for wide range NR applications. Author

A85-13591#
DESIGN AND DEVELOPMENT OF A DYNAMICALLY SCALED MODEL AH-64 MAIN ROTOR
F. K. STRAUB, R. A. JOHNSTON, R. E. HEAD (Hughes Helicopters, Inc., Culver City, CA), and H. L. KELLEY (U.S. Army, Research and Technology Laboratories, Hampton, VA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 22 p. Army-supported research. refs
(AIAA PAPER 84-2532)

The AH-64 Apache Advanced Attack Helicopter (AAH) has recently been put into production. Under contract an American aerospace company developed a 27 percent dynamically Mach scaled model of the AH-64 main rotor. The present investigation is concerned with the scaling requirements and the design of the model rotor hub and blades, as well as the instrumentation provided with them. The model rotor hub has been tested in the Langley V/STOL tunnel using the General Rotor Model System (GRMS). The main part of the investigation deals with the dynamic analysis of the model rotor and its integration with the GRMS. Attention is given to the basic scaling requirements for model rotor performance testing, the AH-64 main rotor geometry, and aspects of aerodynamic stability. G.R.

A85-13680#
FURTHER INVESTIGATION OF THE COUPLED FLAPPING AND TORSION DYNAMICS OF HELICOPTER ROTOR BLADES
A. ROSEN and Z. BEIGLEMAN (Technion - Israel Institute of Technology, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 23-30.

The nature of the coupling between the flapping and torsion dynamics of helicopter rotor blades is investigated. By examining the case of hovering it is shown that usually the flapping dynamics and torsion dynamics are well separated. Based on this fact is is possible to simplify the coupled flapping-torsion equations which determine the tip path plane dynamics. The simplified model is used in order to calculate the modes, roots and time response of the tip path plane. These calculations are compared with the results which are obtained by using the complete model. It is shown that the simplified model is appropriate for mechanics of flight purposes. Author

A85-13697#
CORRELATION OF GLOBAL AND LOCAL AERODYNAMIC PROPERTIES IN FLIGHT
A. BERTELRUD (Flygtekniska Forsoksanstalten, Bromma, Sweden) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 197-207. Research sponsored by the Forsvaret Materielverk. refs

In the paper it is described how local aerodynamic properties are reliably and accurately measured in stationary flight as well as during maneuvers. The local results are integrated to yield global results in terms of drag, lift and moments for comparison with design conditions, and the relation to stability derivatives is also discussed. Also a strap-on system for problem-solving in flight is described. This type of system defines local flow characteristics in important regions of the vehicle, and is then used to detect unexpected features. Author

A85-13701#
PERIODIC OPTIMAL CRUISE OF AN ATMOSPHERIC VEHICLE
J. L. SPEYER, D. DANNEMILLER, and D. WALKER (Texas, University, Austin, TX) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 245-255. refs
(Contract NSF ECS-79-18246)

Since the steady state cruise path of an idealized point mass model of an atmospheric vehicle operating in the hypersonic flight regime is dynamically not fuel minimizing, closed periodic paths are numerically determined. By application of second order conditions for local optimality, a periodic extremal path for a flat earth is shown to be locally minimizing and produces an improvement in fuel usage of 4.2 percent over the steady state cruise path. Application of these second variational conditions to extremal paths for the spherical earth failed. Nevertheless, these paths produce improved fuel performance over the associated steady state cruise path. Author

A85-13895*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
THE X-29 FLIGHT-RESEARCH PROGRAM
T. W. PUTNAM (NASA, Flight Research Center, Edwards, CA) AIAA Student Journal (ISSN 0001-1452), vol. 22, Fall 1984, p. 2-12, 39. refs

The X-29 experimental aircraft, which is a technology integration and evaluation platform for such features as static longitudinal instability, sweptforward wings and three-surface longitudinal control, offers an opportunity to validate the entire aircrft design process through careful correlation and comparison of flight test results with wind tunnel results and design predictions. Attention is presently given to the design features of the aircraft, which encompass supercritical airfoils, digital flight control, and aeroelastically tailored composite wings, as well as to the flight test program that was formulated to investigate the interactions and relative merits of these design features, in light of data gathered by carefully positioned sensors. O.C.

A85-13899
SAAB-FAIRCHILD 340 - OPERATOR'S ANALYSIS
J. CLOSTERMANN Interavia (ISSN 0020-5168), vol. 39, Oct. 1984, p. 1109-1113.

An evaluation is made of the performance capabilities and flying qualities of the SAAB-Fairchild 340 commuter aircraft, which is powered by two 1630-hp turboprop engines. The cockpit flight deck optionally incorporates multifunction displays. Attention is given to the features and operating qualities of the aircraft's hydraulic, pneumatic and electrical systems, weight changes during flight, range/payload relationships, and limiting speeds. O.C.

A85-13919
ADVANCED TACTICAL FIGHTER
J. MOXON and G. WARWICK Flight International (ISSN 0015-3710), vol. 126, Oct. 20, 1984, p. 1048, 1049; 1055, 1056; 1060, 1061.

Full scale development of the U.S. Air Force's Advanced Tactical Fighter (ATF), which must provide air superiority capabilities until at least 2025, will probably begin in 1988 upon the selection of a single contractor. The ATF will have a range 50-100 percent greater than that of the F-15, and although controlled by a single pilot, will be able to engage multiple enemy fighters simultaneously beyond visual range. Innovative, high performance technologies that will be integrated into the ATF encompass aerodynamic surfaces that adapt under automated control to different flight regimes and mission tasks, integrated avionics, low observability engine inlets and exhausts, digital flight control, automated weapons deployment during combat, and interactive cockpit display graphics. O.C.

A85-13965#
PROJECTED ADVANTAGE OF AN OBLIQUE WING DESIGN ON A FIGHTER MISSION
C. D. WILER and S. N. WHITE (Rockwell International Corp., North American Aircraft Operations, El Segundo, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p.
(AIAA PAPER 84-2474)

A review of performance aerodynamics is presented which leads to the conclusion that variable wing geometry is an efficient method of satisfying multidesign point mission requirements. Of the two variable geometry approaches, the oblique wing is identified as having potential advantages over symmetric-sweep designs on fighter missions with subsonic loiter and supersonic dash requirements. A design comparison study is reported which showed a 17 percent improvement in takeoff weight for the oblique wing, or a 29 percent mission performance advantage at the same gross weight. Author

A85-14011#
B-1B - FLEXIBLE, SURVIVABLE PENETRATOR
T. VAN KEUREN (USAF, Washington, DC) Aerospace America (ISSN 0740-722X), vol. 22, Nov. 1984, p. 50-53.

The B-1B strategic bomber variant has only 10 percent of the radar cross section, and therefore detectability by an enemy, which characterized its precursor, the B-1A. This degree of stealth was achieved through a complete redesign of the engine inlets to hide the compressor faces. The use of radar emission-absorbing surface materials has also substantially contributed to low observability. The ALQ-161 defensive electronics system of the B-1B counters early warning systems and long range interceptor aircraft radar once inside enemy territory. It is expected that the combination of terrain-following penetration cruise altitudes and nuclear hardness with defensive electronics and low radar cross section will render the B-1B extremely difficult to intercept well into the 1990s. O.C.

A85-14013#

FACELIFT GIVES B-52 NEW LEASE ON LIFE

G. M. MCVEIGH (USAF, Washington, DC) and J. M. GRAYBEAL (Analytic Services, Inc., Arlington, VA) Aerospace America (ISSN 0740-722X), vol. 22, Nov. 1984, p. 62-65.

The current B-52 force consists of 264 aircraft (168 G and 96 H variants); all are scheduled to undergo the Offensive Avionics System (OAS) modification, and all except 69 of the G variants will be modified to carry Air Launched Cruise Missiles (ALCMs) externally. OAS is a state-of-the-art digital navigation/stores management system that includes a highly accurate dual inertial navigation system. Besides the ALCMs, Short Range Attack Missiles, conventional and nuclear gravity bombs, and the Harpoon antiship missile, will be incorporated. The forthcoming use of the B-1B as a manned penetrating bomber will allow the B-52 to be dedicated to all-standoff range weapons delivery missions. O.C.

A85-14015#

DESIGNING A PERSONAL AIRCRAFT - THE MOONEY 201

R. DEMEIS Aerospace America (ISSN 0740-722X), vol. 22, Nov. 1984, p. 70-73.

Lessons concerning the problems most likely encountered in the course of personal (up to six passengers, top speed of 200 mph) aircraft design, development and certification are derived from the specific case of the Mooney 201 aircraft, of which almost 1500 have been built. Attention is given to persistent efforts at achieving simplicity of manufacture and maintenance, even at the expense of weight and aerodynamic performance. This, and such other attitudinal characteristics of general aviation engineers as resistance to the incorporation of technical innovations into new design efforts, are noted to constitute a markedly different industrial climate from that found among large aircraft manufacturers with primarily military and corporate customers. O.C.

A85-14016#

THE ADVANCED TACTICAL FIGHTER - DESIGN GOALS AND TECHNICAL CHALLENGES

A. C. PICCIRILLO (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) Aerospace America (ISSN 0740-722X), vol. 22, Nov. 1984, p. 74-79.

The technologies and configurational possibilities that have emerged as candidates for integration into the U.S. Air Force's Advanced Tactical Fighter (ATF) are discussed with respect to developmental pacing and prospective performance improvement over air superiority fighters that the ATF will replace in the mid-1990s. Under a Joint Advanced Fighter Engine program which recognizes the schedule incompatibilities of concurrent engine and airframe development, the search for appropriate powerplant designs will begin ahead of the rest of the ATF's development effort. ATF is noted to require a several-fold improvement in both system reliability and sortie generation rates over current aircraft, together with rapid deployment to, and redeployment from, unprepared sites. Operation and support costs reductions are identified as the preeminent design challenge for the ATF. O.C.

A85-14046

HELICOPTER VIBRATIONS - A TECHNOLOGICAL PERSPECTIVE

R. G. LOEWY (Rensselaer Polytechnic Institute, Troy, NY) American Helicopter Society, Journal (ISSN 0002-8711), vol. 29, Oct. 1984, p. 4-30. refs

Oscillatory motion of the nonrotating portion of the airframe has been a matter of serious concern from the earliest days of rotorcraft development. Considerable progress has been made over the years in designing helicopters which have lower vibration levels and operate at higher altitudes and forward speeds. However, helicopter vibrations remain a difficult problem. The present investigation provides insights into the reasons why it is difficult to predict fixed airframe vibrations and to reduce them. Fixed airframe, steady vibrations of helicopters are considered, taking into account those excited by rotors. Attention is given to the fuselage, the rotor blade, vibration control devices, and the schematic of a rotor active-isolation system. G.R.

A85-14048

ACAP CRASHWORTHINESS ANALYSIS BY KRASH

B. L. CARNELL and M. PRAMANIK (Sikorsky Aircraft, Stratford, CT) American Helicopter Society, Journal (ISSN 0002-8711), vol. 29, Oct. 1984, p. 38-42.

The KRASH Computer Program was used to analyze the crashworthiness of the Army/Sikorsky Advanced Composite Airframe Program (ACAP) helicopter. A mathematical model of the ACAP airframe, landing gear, and crushable fuselage understructure was constructed, consisting of masses, beams, and springs. Crash impacts of this model at the two design level impact velocities and several roll and pitch angles were simulated. A typical sequence of events, including landing gear stroking, fuselage contact, and subsequent understructure crushing that occur as the crash impact energy is dissipated, is described. The results of these simulated impacts, including the maximum load factors, the landing gear honeycomb strut and fuselage understructure crushing, and the stroking of the seats are summarized. The use of the predicted load factors in subsequent NASTRAN analyses of the airframe structure is described. It was shown that the ACAP structure meets the crashworthiness requirement of maintaining living space and, with the crashworthy seats, protects the occupants from injurious headward accelerations. Author

A85-14750

THE RISKS OF RESEARCH AND DEVELOPMENT FLYING

P. G. PUGH (Ministry of Defence, Directorate of Engine Technology, London, England) Aerospace (UK) (ISSN 0305-0831), vol. 11, Nov. 1984, p. 21-28.

The risks involved in R&D flying and the problems associated with its' management have been analyzed. The analysis comprises the outcome of 116 post-war research programs and 28 post-war development programs involving specially built or adapted aircraft. Flights begin at the safest condition and work from there in steps of speed, altitude, g or whatever are the pertinent variables. Analysis of results obtained in the first flights and their comparison with previous predictions enables a new set of predictions to be made with corresponding certainty. Results covering the average rate of loss per flight have been considered, along with a statistical study of the results in which variability, mean value and frequency distribution are calculated. It has been shown that risk is smallest for transport aircraft and is increased by combat capability and rocket propulsion. Although the risk of loss of aircraft for development programs is greater than for research programs, the much smaller scale of the latter means that the risk per flying hour is greater. M.D.

A85-14856#

DRONES AND RPVS - TECHNOLOGIES, SYSTEMS AND TRENDS

G. HARMS Dornier-Post (English Edition) (ISSN 0012-5563), no. 3, 1984, p. 39-44.

Unmanned flight vehicles, (RPV's and drones) for effective operational possibilities for supporting, supplementing and replacing more complex manned aircraft and guided missiles, are examined. Drones, used in target simulation, have requirements which include extremely low-level flight at high speed, pop-up maneuvers and formation flights. In terms of development and deployment, aspects such as sufficient on-board computer intelligence and jamming-resistant data transmission channels are needed. These systems and their characteristics, based on reconnaissance, electronic warfare and combat missions are covered in detail. Drones and RPV's are especially useful in target presentation and reconnaissance and cost effective when evaluated in terms of mission results. M.D.

A85-15074

CFO IS NEARING A NEW PLATEAU

D. J. HOLT Aerospace Engineering (ISSN 0736-2536), vol. 4, Nov.-Dec. 1984, p. 22-28.

One of the approximations of the Navier-Stokes equations utilizing panels to represent the aircraft geometry and designated as PAN AIR is presented in the framework of computational fluid dynamics (CFD). PAN AIR is currently being adapted to transonic flow using a new concept of a rectangular grid of points in physical space which is independent of the surface geometry. The grid is used to evaluate certain volume integrals used with fast Fourier transformations. The new variation of PAN AIR was successfully applied to two-dimensional airfoils. NASA Ames research to solve the nonlinear viscous forms of Navier-Stokes equations, using a computational mesh of grid points and solving all governing equations within each volume formed by the grid, is discussed, noting the Numerical Simulation (NAS) program. The need for a large-capacity computer (10 to the 9th calculations per second and 2.4 x 10 to the 8th word memory) for such calculations is argued. L.T.

A85-15593
PAH-2 - THE GERMAN/FRENCH CONNECTION
S. WARTENBERG Vertiflite (ISSN 0042-4455), vol. 30, Nov.-Dec. 1984, p. 34-37.

The PAH-2 antitank helicopter, designed by West Germany and France, and scheduled to go into service by 1991, is studied. The aircraft will have a 13-meter diameter hingeless composite main rotor, two 900 kW engines and a takeoff weight of 10,000 to 11,000 lbs. The aircraft's crashworthiness is determined to be within 90 percent of MIL Standard 1290. The West German version of the PAH-2 will be armed with eight HOT missiles and up to four Stinger missiles. The two French versions are the antitank helicopter and an escort helicopter, with all versions having at least 80 percent commonality. The aircraft is a combination of graphite/epoxy and Kevlar and aluminum parts and will have correctional mechanical controls with helmet-mounted electronic displays. Test flights should begin in 1987. L.T.

A85-15596
EH-101 - AGUSTA AND WESTLAND JOIN FORCES
S. WARTENBERG Vertiflite (ISSN 0042-4455), vol. 30, Nov.-Dec. 1984, p. 60-64.

EH-101, a naval/utility/commercial helicopter, being developed jointly by Great Britain and Italy, is studied. The EH-101 will be a five-bladed main rotor helicopter with three engines rated at 1600 shp each, 31,500 lbs maximum gross weight, 160 knot cruise speed and a 500 n.m. range with 30 passengers. The British naval version will be a replacement for the current Sea King and will be designed to perform antisubmarine warfare missions, surveillance, target tracking, antisurface vessel warfare, amphibious operations and search and rescue. The aircraft is scheduled to make its first flight in late 1986, with deliveries in 1990. L.T.

A85-15630#
DESIGN AND FABRICATION OF CRASHWORTHY COMPOSITE EXTERNAL FUEL TANKS
J. V. DAINES (Fiber Science, Inc., Salt Lake City, UT) IN: Reinforced Plastics/Composites Institute, Annual Conference, 38th, Houston, TX, February 7-11, 1983, Preprints . New York, Society of the Plastics Industry, Inc., 1984, p. 12-A-1 to 12-A-6.

The conventional, metallic material fuel tanks used by helicopters and fighter aircraft have performed poorly when tested to military crashworthiness specifications. Attention is presently given to the development of composite external fuel tanks which will enhance aircraft and personnel survivability in the event of lightning or ballistic strike, crash impact, or external fire due to fuel leakage. Test results are assessed. O.C.

A85-15642
EH.101 - EUROPE'S 'FIXED-WING' HELICOPTER
G. WARWICK Flight International (ISSN 0015-3710), vol. 126, Nov. 3, 1984, p. 1175-1178.

Attention is given to the design features and performance capabilities of the EH.101 civil-military helicopter, which was undertaken as a British-Italian joint venture. Three versions are under concurrent development: a naval antisubmarine/antiship weapons platform, a 30-seat passenger transport for offshore oil rig support and commuter operations, and a military/utility cargo transport with loading ramp. The EH.101 is noted to offer significant improvements in helicopter safety, with its three engines, high power margins, damage-tolerant structure, and fail-safe rotorhead design. The entire dynamic system, comprising engines, transmissions, and rotors, are held in common by the three versions. Airframe differences are confined to the rear fuselage, which must fold in the naval variant. O.C.

A85-15882
APPLICATION OF THE FINITE ELEMENT TECHNIQUE TO AERODYNAMIC PROBLEMS OF AIRCRAFT
M. HASHIMOTO (Mitsui Engineering and Shipbuilding Co., Ltd., Okayama, Japan), S. SUZUKI (Toyota Central Research and Development Laboratories, Inc., Nagakute, Aichi, Japan), and K. NAKAMURA (Nissan Motor Co., Ltd., Yokosuka, Kanagawa, Japan) Computers and Structures (ISSN 0045-7949), vol. 19, no. 1-2, 1984, p. 57-69. refs

Finite element techniques combined with the collocation method are formulated and applied to obtain numerical solutions for the integral equation which determines the airload acting on the wings, body and other components of an aircraft. The aerodynamic interaction problems of wings and a body are studied by a finite element method based on Morino's method (1974, 1975). Examples include the steady airloads over cross wings with or without a fillet, and a wing-lifting body combination. The lifting surface problems are solved for the airloads by the finite element technique employing triangular or quadrilateral elements, where the conditions that the shape functions must satisfy are emphasized. Examples include not only the steady airload over a rectangular wing with partial-span flap, but also the unsteady airload over a rectangular wing oscillating in the first bending mode. Author

N85-12050# Aeronautical Research Labs., Melbourne (Australia).
THE IN-FLIGHT ESTIMATION AND INDICATION OF CUMULATIVE FATIGUE DAMAGE TO HELICOPTER GEARS
K. F. FRASER Mar. 1984 113 p refs
(ARL-AERO-PROP-REPORT-164; AR-003-013) Avail: NTIS HC A06/MF A01

The safe fatigue life of helicopter transmission components made if in service load data together with transmission fatigue data, represented as the number of cycles of failure as a function of tooth load, were estimated. Instrumentation was developed to provide in flight estimation and indication of the proportion of safe fatigue life expended for critical gears in single or twin engine helicopter transmission systems. Basic transmission load data in the form of totalized times spent in a number of contiguous torque bands are continually updated and stored during flight. The basic load data together with values of life expenditure for critical gears for the current flight are printed out after flight. This technique opens the way towards fatigue life monitoring of individual transmissions. The special demands of the life estimating system and in particular the very significant effects of errors in mean torque estimation are assessed. E.A.K.

N85-12051# National Aerospace Lab., Tokyo (Japan).
AN EXPERIMENTAL STUDY ON THE INDUCED NORMAL FORCE ON TAIL-FINS DUE TO WING-TAIL INTERFERENCE
M. SHIROUZU, K. SAGA, Y. SHIBATO, and T. AKIMOTO May 1984 20 p refs In JAPANESE; ENGLISH summary
(NAL-TR-814; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

The normal force on the tail fins induced by aerodynamic load on front fins was studied. The magnitude of the induced normal force was obtained experimentally from a wind tunnel test of two stage rocket models with both front and tail fin, with either front or tail fin, and without any fin. The variation of the induced normal force with bank angle difference between front and tail fin was also obtained from wind tunnel tests of a roll controllable rocket model. The results are compared with predictions based on the strip theory. This simplified theory gives approximate magnitude and Mach number dependence of the induced normal force, however, it is not sufficient for precise prediction. E.A.K.

N85-12052# Air Force Flight Test Center, Edwards AFB, Calif.
60,000 POUND CAPACITY EXTRACTION SYSTEM Final Report, Nov. 1982 - Jun. 1984
M. R. WUEST and M. A. LOPEZ Aug. 1984 97 p
(AD-A145841; AD-E001746; AFFTC-TR-84-19) Avail: NTIS HC A05/MF A01 CSCL 15G

This LAPES (Low Altitude Parachute Extraction System) test program was conducted to determine the suitability of proposed extraction parachute subsystems to safely and reliably extract platform airdrop loads weighing from 31,500 to 60,000 pounds. The following extraction parachutes were evaluated in single and cluster of two configurations: 35-foot diameter single slot (ss), 44-foot diameter ribbon (R), 40-feet diameter R, and 35-foot diameter R. Twenty-seven tests were conducted during this test program. A modified HC-130H aircraft was used as the drop aircraft except for the first test where a C-141 was used. The aircraft flew at 130 knots indicated airspeed and at pressure altitudes of 2,280 to 5,000 feet. The load weights ranged from 12,880 to 42,000 pounds. Test results indicated that a cluster of two 35 foot diameter R extraction parachutes and a 15 foot diameter drogue parachute was the most suitable combination to extract a load of 60,000 pounds. GRA

N85-12053# Systems Control Technology, Inc., Palo Alto, Calif.
NONLINEAR SYSTEM IDENTIFICATION METHODOLOGY DEVELOPMENT BASED ON F-4S FLIGHT TEST DATA ANALYSIS Final Report
J. H. VINCENT, S. N. FRANKLIN, U. H. RABIN, and T. L. TRANKLE Dec. 1983 179 p
(Contract N00421-81-C-0289; N00014-78-C-0641)
(AD-A146289) Avail: NTIS HC A09/MF A01 CSCL 14B

The Naval Air Test Center (NATC) and Systems Control Technology, Inc. (SCT) have worked jointly to develop an advanced flight test data processing technique that supports an integrated flight testing procedure (i.e., extraction of test data for multiple test requirements from common flight conditions). This data processing technique is commonly referred to as system (or parameter) identification. Realization of this goal for an integrated flight testing procedure is dependent on the ability to identify nonlinear aerodynamic characteristics and propulsion system performance from flight test data. The identified models can be used to define performance, stability and control, and unaugmented airframe dynamic characteristics of the aircraft being evaluated. The need for improved modeling of aircraft aerodynamic characteristic has been, and continues to be apparent in numerous areas of technical and operational importance. Four such areas are: (1) flying quality military specification compliance testing, (2) training simulations, (3) design methods for specification of aircraft characteristics, and (4) the development of mission profiles that make optimum use of the airplane's capabilities. In general, there is a need for an improved understanding of an airplane's aerodynamic characteristics to support design improvements for increased cost effectiveness, expanded mission flexibility and enhanced operational safety. GRA

N85-12054# Illinois Univ., Urbana. Urbana Dept. of Aeronautical and Astronautical Engineering.
STOCHASTIC MOTOR BLADE DYNAMICS Final Report, Dec. 1977 - Jun. 1984
Y. K. LIN and J. E. PRUSSING Jul. 1984 11 p
(Contract DAAG29-81-K-0072; DAAG29-78-G-0039)
(AD-A146312; AAE-84-3; UILU-ENG-84-0503; ARO-15193.9-EG; ARO-17830-5-EG) Avail: NTIS HC A02/MF A01 CSCL 01C

The results of a theoretical investigation into the effects of atmospheric turbulence on the dynamical behavior of helicopter rotor blades are reported. Turbulence is found to destabilize the uncoupled flapping and coupled flapping-torsional motions; however, it stabilizes the coupled flapping-lagging motion by effectively increasing the damping in the least stable lead-lag mode. When a motion is stable, turbulence contributes to random fluctuation from the average system response. Under a trim condition, which suppresses the first harmonics in flapping, the effect of turbulence, as measured by the standard deviation of system response, is of the same order of magnitude as the second harmonics in the deterministic (i.e., an idealized turbulence-free) solution. Author (GRA)

N85-12055# Aeronautical Research Labs., Melbourne (Australia).
ESTIMATION OF HELICOPTER PERFORMANCE USING A PROGRAM BASED ON BLADE ELEMENT ANALYSIS
A. M. ARNEY Jul. 1984 88 p
(AD-A146341; ARL/AERO-TM-365) Avail: NTIS HC A05/MF A01 CSCL 01B

A convenient method of predicting helicopter performance is presented, which is applicable up to speeds corresponding to an advance ratio of 0.3, for any conventional helicopter (i.e., single main rotor) with flapping blades. This method uses a computer program, POLAR, which is based on a blade-element analysis assuming uniform induced flow. Program POLAR can be employed for most steady flight conditions and is not subject to limitations imposed by the use of performance tables and charts. Details of blade operating conditions may be estimated at specified points on the rotor disc. The structure of the program and examples of its use are given. Comparisons of estimates obtained using POLAR, with other performance methods are also included. Author (GRA)

N85-12884*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLIGHT AND WIND-TUNNEL COMPARISONS OF THE INLET-AIRFRAME INTERACTION OF THE F-15 AIRPLANE
L. D. WEBB, D. ANDRIYICH-VARDA, and S. A. WHITMORE Nov. 1984 35 p refs
(NASA-TP-2374; H-1175; NAS 1.60:2374) Avail: NTIS HC A03/MF A01 CSCL 01C

The design of inlets and nozzles and their interactions with the airplane which may account for a large percentage of the total drag of modern high performance aircraft is discussed. The inlet/airframe interactions program and the flight tests conducted is described. Inlet drag and lift data from a 7.5% wind-tunnel model are compared with data from an F-15 airplane with instrumentation to match the model. Pressure coefficient variations with variable cowl angles, capture ratios, examples of flow interactions and angles of attack are for Mach numbers of 0.6, 0.9, 1.2, and 1.5 are presented. E.A.K.

N85-12885*# Ohio Univ., Athens. Avionics Engineering Center.
REALISTIC LOCALIZER COURSES FOR AIRCRAFT INSTRUMENT LANDING SIMULATORS Final Report
T. A. MURPHY Hampton, Va. NASA. Langley Research Center May 1984 78 p refs
(Contract NAS1-17368)
(NASA-CR-172333; NAS 1.26:172333; OU/AEC/EER-66-1)
Avail: NTIS HC A05/MF A01 CSCL 01C

The realistic instrument landing simulator (ILS) course structures for use in aircraft simulators are described. Software developed for data conversion and translation of ILS course structure measurements and calcomp plots of the courses provided are described. A method of implementing the ILS course structure data in existing aircraft simulators is outlined. A cockpit used in the lab to review the digitized ILS course structures is displayed. E.A.K.

N85-12886# Societe Nationale Industrielle Aerospatiale, Suresnes (France). Lab. Central.
MODERN STRUCTURAL MATERIALS. PRESENT SITUATION AND EVOLUTION PROSPECTS [LES MATERIAUX STRUCTURAUX MODERNES SITUATION ACTUELLES ET PERSPECTIVES D'EVOLUTION]
G. HILAIRE 14 Aug. 1984 60 p In FRENCH Presented at Semaine Aeron. G.I.F.A.S., Madrid, 12-15 Jun. 1984
(SNIAS-842-551-101) Avail: NTIS HC A04/MF A01

The properties of light alloys, composites, steels and titanium alloys used in aircraft construction are reviewed. The mechanical properties, including tensile strength, modulus and fatigue

resistance, and the economic factors are compared. It is shown that the finished products of carbon reinforced plastic materials have costs of the same order as those manufactured with light alloys. The prospects of aluminum, lithium alloys, powder metallurgy and metallic matrix composites are discussed. The applications of new materials in aircraft, helicopters and engines are examined.
Author (ESA)

N85-12887*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INITIAL FEASIBILITY GROUND TEST OF A PROPOSED PHOTOGRAMMETRIC SYSTEM FOR MEASURING THE SHAPES OF ICE ACCRETIONS ON HELICOPTER ROTOR BLADES DURING FORWARD FLIGHT Final Report, 1 Oct. - 31 Dec. 1983
R. L. PALKO (Calspan Field Services, Inc., Arnold Air Force Station, Tenn.), P. L. CASSADY (Calspan Field Services, Inc., Arnold Air Force Station, Tenn.), R. C. MCKNIGHT, and R. J. FREEDMAN Aug. 1984 45 p
(NASA-TM-87391; NAS 1.15:87391; AD-A146051; AEDC-TR-84-10) Avail: NTIS HC A03/MF A01 CSCL 01C
A ground test was accomplished to determine if a combination of standard photographic system parameters could be chosen that would allow stereophotographs to be made of the main rotor of a UH-1H helicopter in forward flight. The photographs would be used to measure the shape of ice accretions on the rotor in forward flight. During the ground test, 83 photographic pairs were obtained at three camera shutter speeds for a range of ambient light conditions from dark to complete daylight. Twenty-seven of these photographic pairs were evaluated on the AEDC analytical stereocompiler for readability. The test showed that quality photographs could be taken using standard equipment with shutter speeds of 1/30 and 1/60 sec for up to three hours per day. The test also showed that the addition of a specifically designed control circuit for synchronization at 1/500-sec shutter speed would allow testing for the complete day for most winter days. GRA

N85-12888# Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Versuchs- und Forschungsanlage.
GRAPHICS SOFTWARE FOR THE DISPLAY OF BODY DEFORMATION MOTION [GRAPHISCHE SOFTWARE ZUR DARSTELLUNG DER DEFORMATIONSBEWEGUNG EINES KOERPERS]
G. MANDANIS 6 Jan. 1983 76 p In GERMAN
(FW-FO-1640) Avail: NTIS HC A05/MF A01
Three programs for graphic display of the characteristic mode of aircraft structures were elaborated. They are interactive and affect geometrical data; deformation structure; and alternative nodal line display, respectively. The system can also be used for the display of objects other than aircraft. Author (ESA)

N85-13460# Joint Publications Research Service, Arlington, Va.
EFFECTIVENESS OF AGRICULTURAL AVIATION
V. V. KUZKIN *In its* USSR Rept.: Life Sci.: Biomed. and Behavioral Sci. (JPRS-UBB-84-026) p 21-26 5 Dec. 1984 Transl. into ENGLISH from Zashchita Rast. (Moscow), no. 8, Aug. 1984 p 2-4
Avail: NTIS HC A08
The growth in the volume of aviation chemical work which is accompanied by an improvement in qualitative indicators, an improvement in the productivity of flights, economize on material expenditures and the introduction of new technological methods and agricultural apparatuses was examined. Flight organization is improved and ties between aviation enterprises and soviets of agroindustrial associations, are strengthened. More progressive methods and highly productive apparatuses are more widely employed. The most important indicator of effectiveness of agricultural aviation is the use of flights, which is related to the maximum tolerated load of chemicals on the flying apparatus and indirectly related to the expenditure norm per hectare and to the duration of the flight. The increase of productivity by decreasing flight time by curtailing the hop from the airport to the designated plot is emphasized. Productivity of aircraft is affected by the configurations of fields, the agricultural equipment, technology, and the time the chemicals are loaded. E.A.K.

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A85-13652
AIR FLOW AND PARTICLE TRAJECTORIES AROUND AIRCRAFT FUSELAGES. II - MEASUREMENTS
W. D. KING, D. E. TURVEY, D. WILLIAMS, and D. J. LLEWELLYN (Commonwealth Scientific and Industrial Research Organization, Cloud Physics Laboratory, Sydney, Australia) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 1, March 1984, p. 14-21. refs
Measurements have been made of airflow velocities and cloud liquid water contents from selected positions around the fuselage of an F-27 aircraft. The airflow measurements away from the propeller inflow region are in reasonable agreement with those previously calculated. The liquid water measurements were made using two CSIRO hot-wire probes, one of which could be positioned at distances of 15-60 cm from the fuselage. Results of these comparisons showed that the enhancement factors previously calculated appear quite reasonable and that corrections can consequently be made to allow for sampling errors caused by fuselage-related flow distortions. The comparisons also show that there are additional sampling errors as large as 10 percent which depend on position of the probe relative to the wings and propellers. For the F-27 these additional effects decrease substantially with increasing aircraft speed. Author

A85-13971#
DOPPLER EFFECT AND ITS INFLUENCE ON LOW-ALTITUDE CW ALTIMETERS
Y.-Y. SUN (Chung Shan Institute of Science and Technology, Lungtan, Republic of China) Chinese Institute of Engineers, Journal (ISSN 0253-3839), vol. 7, July 1984, p. 221-224. refs
A general expression for the Doppler effect in relation to three coordinate frames moving with respect to each other is presented and applied to a radar and an altimeter. The influence of Doppler frequency shift on low-altitude continuous wave altimeters is shown. C.D.

A85-14009#
THIN PLASMA PANELS SQUEEZE INTO CRAMMED AIRCRAFT
E. J. LERNER Aerospace America (ISSN 0740-722X), vol. 22, Nov. 1984, p. 28, 30.
The 'plasma panels' that have been chosen for a number of computer graphics display functions aboard the E4-B flying command center, which will carry national command personnel during a nuclear war, operate on principles similar to those of neon signs. By comparison with conventional CRTs, plasma panels have great compactness in depth and can be as little as an inch thick; they also offer good brightness and resolution. Among the problems they present are high sensitivity to pressure changes, such as would be incurred during cabin depressurization, and restriction to red and amber display character colors, which are normally reserved for cockpit warning signals. O.C.

A85-14017#
THE AUTOMATED COCKPIT IMPROVES HANDS-OFF PERFORMANCE
E. J. LERNER Aerospace America (ISSN 0740-722X), vol. 22, Nov. 1984, p. 80-83.
The 757/767 airliner's automated cockpit is the control center for an interlocked computer system that manages all aspects of flight. This all-digital design is held by its creators to be able to

yield fuel savings of 2-5 percent, while reducing crew size, lowering maintenance costs, and prolonging MTBF. The Flight Management System computer network functions encompass flight control, engine indicator, sensor, and display subsystems. The most vital electronic components of the system, which are the Flight Control Computer, internal reference system, altimeter, and Instrument Landing System, are triply redundant. Attention is presently given to the cockpit Display of Traffic Information system, which shows the pilot, on a map-like CRT display, the positions and courses of other aircraft in the vicinity. O.C.

A85-14457* Bendix Corp., Southfield, Mich.
NEW RESULTS IN FAULT LATENCY MODELLING
J. G. MCGOUGH, F. L. SWERN (Bendix Corp., Southfield, MI), and S. BAVUSO (NASA, Langley Research Center, Hampton, VA) IN: EASCON '83; Proceedings of the Sixteenth Annual Electronics and Aerospace Conference and Exposition, Washington, DC, September 19-21, 1983 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 299-306.

The test design and results from assessment of the performance of the self-test program and the extent of fault latency in a redundant flight control system (FCS) are reported. Assembly language programming generated gate-level faults directed to every avionics component. Details of the fault-simulation software are described, noting the input needed to match the five control-surface parameters managed by the FCS. Most faults were immediately detected, and component-level faults, occurring at pins, were more easily noted than gate-level faults. The results indicated that a 200-word self-test program is sufficient to obtain a fault coverage of 85 percent. Minor hardware changes are required to reach levels over 90 percent. M.S.K.

A85-15594
TADS/PNVS - THE KEEN EYES OF THE HUNTER
J. OHARA Vertiflite (ISSN 0042-4455), vol. 30, Nov.-Dec. 1984, p. 43-45.

The Target Acquisition Designation Sight/Pilot Night Vision Sensor (TADS/PNVS) designed for the AH-64 Apache aircraft is discussed. The system incorporates two separate units: the TADS, used primarily by the co-pilot gunner, consists of the Day sensor, which includes the Day TV, direct view optics, laser rangefinder/designator and laser spot tracker, and the Night Sensor which contains a Forward Looking Infrared (FLIR) Sensor for target acquisition. The PNVS, operated by the pilot independently of TADS, includes an FLIR sensor which is boresighted to his line of sight by the use of electro-optical head-tracking system. Further production of the TADS/PNVS systems is planned for Navy's Helicopter Night Vision System program. The production line is scheduled for a maximum rate of 12 units per month to be reached in 1986. L.T.

N85-12056# Systems Associates, Long Beach, Calif. Resource Management Systems Div.
COMMAND FLIGHT PATH DISPLAY. PHASE I AND II: APPENDIX F Final Technical Report
Sep. 1983 271 p
(Contract F33615-79-C-3618)
(AD-A145858; SAI-83-01; SAI-S-82-03) Avail: NTIS HC A12/MF A01 CSCL 01D

Contained in this appendix are the various plots generated during data reduction. Parameters plotted include Altitude (flight plan and actual vs. distance*), Lateral Deviation (horizontal distance from flight plan path vs. distance), and Velocity (flight plan, actual, and CFPD velocity indicator vs. distance). Flight test cases involving the modified Charlie pattern were segmented into Routes, each plot containing two consecutive Routes. A chart is included indicating the relative location of these Routes. GRA

N85-12889*# McDonnell-Douglas Corp., Long Beach, Calif.
SYSTEM STATUS DISPLAY INFORMATION
L. G. SUMMERS and J. B. ERICKSON 17 Oct. 1984 73 p refs
(Contract NAS1-16202)
(NASA-CR-172347; NAS 1.26:172347; MDC-J2616) Avail: NTIS HC A04/MF A01 CSCL 01D

The system Status Display is an electronic display system which provides the flight crew with enhanced capabilities for monitoring and managing aircraft systems. Guidelines for the design of the electronic system displays were established. The technical approach involved the application of a system engineering approach to the design of candidate displays and the evaluation of a Hernative concepts by part-task simulation. The system engineering and selection of candidate displays are covered. B.G.

07

AIRCRAFT PROPULSION AND POWER

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

A85-13506#
DESIGN DEVELOPMENT AND OPTIMIZATION CRITERIA CONSIDERATIONS FOR A TANDEM FAN MEDIUM SPEED V/STOL PROPULSION CONCEPT
M. V. RICCIUS (LTV Aerospace and Defense Co., Dallas, TX) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p.
(AIAA PAPER 84-2395)

In a tandem fan VTOL propulsion system, the two fans positioned coaxially in each nacelle are directly driven by the core engine. This four-fan system, in addition to obviating fan reduction gearing, employs relatively small diameter fans and therefore reduces aircraft drag, size, and weight. Attention is presently given to multimission aircraft sizing criteria, alternative methods for one engine-inoperative landing operations, hover control modulation requirements, and design options for drive system failure isolation. O.C.

A85-13526#
ADVANCES IN EJECTOR THRUST AUGMENTATION
P. M. BEVILAQUA (Rockwell International Corp., Columbus, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 16 p. refs
(AIAA PAPER 84-2425)

The state of the art in ejector technology development is surveyed. An ejector comprises a shroud around a normal jet exhaust entraining air in the exhaust flow and thus augmenting thrust. The principle of thrust augmentation has been modeled quantitatively, while difficulties have been encountered in expanding quasi-one-dimensional models of the flowfield to higher dimensions that account for elliptic and interacting regions of turbulent and rotational flow. The effectiveness of several modeling approaches is discussed, as are configurations for hypermixing jet nozzles and wing sections. Test results with the early XV-4A, XC-8A, XFV-120 and the NASA-DeHavilland augmentor-equipped aircraft are outlined, together with planned trials with an ejector-equipped modified F-16. The ejector is intended for implementation on V/STOL aircraft. A persistent problem which will be studied with the modified F-16 is the reduction of ram drag during conversion from hover. M.S.K.

A85-13527#
DEVELOPMENT OF THE AV-8B PROPULSION SYSTEM
R. S. CLARK and S. K. VASTA (McDonnell Aircraft Co., St. Louis, MO) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 13 p.
(AIAA PAPER 84-2426)

Design and performance features of the light attack V/STOL AV-8B jet are described, with an emphasis on the propulsion system (PS). The PS has bifurcated main inlets set flush to the fuselage ahead of the wing. The F402 turbofan engine with four rotatable, fixed geometry nozzles supplies hover and forward flight thrust. Strakes on the gunpods and a retractable fence on the front of the gunpods furnish positive pressure and help offset the aerodynamic suckdown force. The inlet lip contour chosen was a 2:1 quarter ellipse with a 7.5 deg inlet plane droop. The engine is equipped with a digital control system optimized for combat conditions. Test results from all phases of component development are provided, noting that validation trials for the engine and control system are scheduled for 1985. M.S.K.

A85-13536#
PROPULSION TECHNOLOGY PROJECTIONS FOR COMMERCIAL AIRCRAFT
C. REID and P. H. KUTSCHENREUTER (General Electric Co., Cincinnati, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 10 p. refs
(AIAA PAPER 84-2446)

Technologies offering fuel savings for propulsion systems of transport aircraft in the mid-1990s to early 2000s are discussed. Attention is centered on SFC and direct operating costs (DOC), with the goals being Mach 0.8 flight at 35,000 ft with an SFC of 0.5 lb fuel/hr per lb of payload. Natural laminar flow would be needed on the engine nacelles. Engine weight reduction can be obtained through increased flow/unit frontal area, optimized blade and disk rim speeds, reduced numbers of stages, blades and vanes, and integrated components made of, e.g., 700 deg composites, Ti-Al alloys, high temperature Ti, TiSiC metal matrix composites, carbon-carbon composites, ceramics, and power metallurgy turbine parts. The goals could be reached with very high bypass ratio turbofans or gearless fans or counterrotating unducted fan jets. It is noted that engine costs may supercede SFC as the deciding factor in aircraft costs. M.S.K.

A85-13542#
ENGINE CONTROL CONSIDERATIONS FOR MULTIFUNCTION NOZZLES
R. S. BEITLER (General Electric Co., Cincinnati, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p.
(AIAA PAPER 84-2454)

One of the innovations being developed for the next generation of fighter aircraft engines is the multifunction exhaust nozzle which combines the variable area capability of current nozzles with new thrust vectoring/spoiling/reversing capabilities. These new capabilities will be used to supplement the normal aerodynamic flight control elements and to provide more rapid thrust response in flight and after landing. This paper discusses the control of such nozzles. The engine performance control features of current fighter engine exhaust nozzle controls must be retained and integrated with the new directional thrust control features. A typical multifunction nozzle is described, and design considerations relative to its control are discussed. Author

A85-13543#
SINGLE EXPANSION RAMP NOZZLE DEVELOPMENT STATUS
D. J. DUSA and W. H. WOOTEN (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 8 p. refs
(AIAA PAPER 84-2455)

Design features and test results with the ADEN (Augmented Deflector Exhaust Nozzle) self-cooling, two-dimensional, thrust vectoring nozzle on the F404 engine are reported. The ADEN is targeted for use on V/STOL aircraft and is part of a single expansion ramp nozzle. The throat area is controlled by a variable geometry convergent-divergent upper flap assembly, thereby controlling the internal expansion area ratio in response to a range of operating pressure ratios. Downward diversion of the jet during a V/STOL maneuver is accomplished with a rotating deflector mounted outside the nozzle. Vectoring capabilities also aid in-flight maneuvering. Fan duct bypass air provides nozzle cooling. Altitude chamber tests accumulated 56 hr of data on cooling, aerodynamic performance, and mechanical operations at various Mach flow numbers and nozzle pressure loadings up to 48 psi. Installation of the ADEN on the X-29A is recommended. M.S.K.

A85-13544#
DEVELOPMENT OF A PNEUMATIC THRUST DEFLECTING NOZZLE
M. J. HARRIS (David Taylor Naval Ship Research and Development Center, Aviation and Surface Effects Dept., Bethesda, MD) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p. refs
(AIAA PAPER 84-2456)

The concept of a pneumatic thrust deflecting nozzle was demonstrated in a series of static investigations. Pneumatic thrust deflection is achieved by blowing a thin jet tangentially across a small curved deflecting surface incorporated into the nozzle of a turbojet engine. Exhaust from the turbojet flows with the tangentially blown jet around the deflecting surface. The angle of thrust deflection is controlled by varying the momentum of the tangential blowing. Thrust deflection through 60 deg was achieved when the thrust of a small turbojet simulator or a J402-CA-400 turbojet engine was deflected pneumatically. A pneumatic thrust deflecting nozzle is a mechanically simple system capable of a wide range of thrust deflection. This system can provide a high performance aircraft with increased maneuverability, heavy lift capability, or short takeoff and landing capability. Author

A85-13545#
WIND TUNNEL EVALUATION OF ADVANCED EXHAUST NOZZLES FOR STOL TACTICAL AIRCRAFT
J. G. DOONAN (Grumman Aerospace Corp., Bethpage, NY) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 17 p. refs
(Contract F33615-79-C-3009)
(AIAA PAPER 84-2457)

Results from a wind tunnel test program to evaluate the low speed aeropropulsive performances of four advanced nozzle configurations designed to enhance STOL capabilities are described. The configurations included lightweight vectoring axisymmetric, asymmetric load balanced exhaust, high aspect ratio (HAR) single expansion ramp and reversing single expansion ram nozzles. All trials were performed using the same 1/8 scale model advanced tactical fighter on a sting. Dry power landing and afterburning takeoff modes were examined with thrust vector angles up to 60 and 30 deg, respectively. Highest lift enhancement was obtained from the HAR configuration, which also introduced nose-down pitching moments. Thrust vectoring significantly reduced the necessary takeoff and touchdown velocities through increased lift coefficients. M.S.K.

A85-13557#
THE AH-64A NITROGEN INERTING SYSTEM
T. C. KNIGHT and J. E. RITTER (Hughes Helicopters, Inc., Culver City, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 24 p. refs
(AIAA PAPER 84-2480)

Fuel fires and explosions are the most critical problems on all military aircraft. In addition to the dangers of flammable liquid near hot metal, they must withstand the direct strikes of high explosive incendiary rounds. To counter this, pressurized inert gas, reticulated plastic foam in the fuel tanks, and chemical extinguishing systems have been studied or used. Unfortunately, these methods either consume supplies, impose a weight penalty, or rob vital fuel space. The on-board Nitrogen Inerting Unit (NIU) is a small, light, continuously operating system that establishes and maintains an oxygen concentration below 12 percent in the air space of the fuel tank. This concentration will not support combustion, and the explosive threat is eliminated. Presently the AH-64A, 'Apache', is the only attack helicopter with this system. Author

A85-13561#
EVALUATION AND CORRECTION OF THE ADVERSE EFFECTS OF (I) INLET TURBULENCE AND (II) RAIN INGESTION ON HIGH BYPASS ENGINES
R. E. RUSSELL and I. W. VICTOR (General Electric Co., Cincinnati, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 12 p.
(AIAA PAPER 84-2486)

In order to eliminate the deleterious effects of adverse atmospheric conditions on high bypass turbofan engines during ground tests, a turbulence control structure surrounding the engine inlet has been developed which controls free turbulence and winds. In addition, a test rig has been designed and implemented which can simulate the quantity, size and distribution of rain droplets ingested by the engine inlet. Diagnostic tests conducted with a CF6-50 turbofan have demonstrated that water droplets have passed through both the fan and low pressure compressor. Since there was insufficient moisture during light rain conditions to saturate the low pressure compressor's discharge air, evaporative cooling of the water impinging on the compressor inlet temperature sensor coil caused it to respond with an opening of the compressor's variable stator blades, thereby deteriorating the high speed stall margin. O.C.

A85-13563#
INSTALLED ENGINE PERFORMANCE IN DUST-LADEN ATMOSPHERE
W. TABAKOFF and A. HAMED (Cincinnati, University, Cincinnati, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 11 p. refs
(Contract DAAG29-82-K-0029)
(AIAA PAPER 84-2488)

Aircraft engines operating in areas where the atmosphere is polluted with small solid particles are subjected to erosion damage and consequently, their performance deteriorates. This paper presents the results of an investigation of the solid particles dynamics through a helicopter engine with inlet particle separator. The nonseparated particle trajectories were determined through the five stage axial flow compressor. The results are presented to show the particle distribution throughout the compressor and the intensity of the particle blade impacts at the various stages. Author

A85-13571#
DETERMINATION OF AIRCRAFT PROPULSIVE EFFICIENCY AND DRAG USING STEADY STATE MEASUREMENTS AND LOCK'S PROPELLER MODEL
G. BENNETT (Mississippi State University, Mississippi State, MS) and M. SABZEHPARVAR AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p. Research supported by the Mississippi State University. refs
(AIAA PAPER 84-2500)

The development of a propeller model for the accurate prediction of thrust and shaft power has rendered aircraft performance parameter identification in light of steady state flight test data feasible. A parameter identification technique employing gradient search is presently used in an analysis of simulated flight test data. Gradient research requires relatively simple instrumentation to measure the rate of climb and shaft power, together with other routine measurements which are within the means of general aviation aircraft manufacturers. O.C.

A85-13576#
NEAR-TERM APPLICATION OF MODERN PROPULSION TECHNOLOGY TO A TACTICAL TRANSPORT
D. M. RYLE, JR. (Lockheed-Georgia Co., Marietta, GA), F. W. PERKINS (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT), and J. L. EDDY (General Electric Co., Cincinnati, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 10 p.
(AIAA PAPER 84-2506)

Emerging requirements for new tactical transport aircraft are reviewed, with particular emphasis on new battlefield scenarios. Two types of aircraft are visualized: the tactical assault and tactical support airlifters. Two C-130 derivatives are reviewed, in some detail, that are capable of providing a low-cost solution to these requirements. These aircraft incorporate modern propulsion technology to enhance field length and payload-range. A major part of this paper discusses the configuration and performance of the GE34 engines and the Hamilton Standard counter-rotating propellers. Author

A85-13581#
DESIGN FOR MILITARY AIRCRAFT ON-BOARD INERT GAS GENERATION SYSTEMS
A. F. GRENICH, F. F. TOLLE, G. S. GLENN, and W. J. YAGLE (Boeing Military Airplane Co., Seattle, WA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 13 p. USAF-sponsored research. refs
(AIAA PAPER 84-2518)

On-board inert gas generation systems (OBIGGS) offer aircraft fuel tank inerting without the logistics problems associated with other fuel tank inerting concepts. The OBIGGS concept uses air separation modules which convert suitably conditioned supply air into a nitrogen rich gas for inerting. Satisfactory performance of these modules has been verified experimentally by conducting simulated flight tests; development of complete flight qualified systems has been completed for the AH-64A helicopter and is feasible for larger aircraft in the near future. In addition to the air separation modules a complete OBIGGS requires equipment to condition the supply air, pressure regulators, valves, tubing and related hardware and possibly a compressor and tank for inert gas storage. Since an OBIGGS imposes both weight and bleed air penalties on the aircraft, it is essential to optimize the system for the aircraft and missions of interest. Design guidelines are presented for the system sizing and trade-off studies necessary for system optimization. Author

A85-13627*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE ROLE OF MODERN CONTROL THEORY IN THE DESIGN OF CONTROLS FOR AIRCRAFT TURBINE ENGINES
W. MERRILL, B. LEHTINEN, and J. ZELLER (NASA, Lewis Research Center, Cleveland, OH) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Nov.-Dec. 1984, p. 652-661. Previously cited in issue 11, p. 1707, Accession no. A82-26526. refs

A85-13630*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IDENTIFICATION OF MULTIVARIABLE HIGH-PERFORMANCE TURBOFAN ENGINE DYNAMICS FROM CLOSED-LOOP DATA
W. MERRILL (NASA, Lewis Research Center, Aerodynamics and Engine Systems Div., Cleveland, OH) (Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 1, p. 427-434) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Nov.-Dec. 1984, p. 677-683. Previously cited in issue 06, p. 723, Accession no. A84-18582. refs

A85-13714*# Washington Univ., Seattle.
BLADE TIP GEOMETRY - A FACTOR IN ABRADING SINTERED SEAL MATERIAL
J. WOLAK, A. F. EMERY, S. ETEMAD, and S. R. CHOI (Washington, University, Seattle, WA) ASME, Transactions, Journal of Tribology (ISSN 0742-4787), vol. 106, Oct. 1984, p. 527-533. NASA-sponsored research. refs

Experimental results are presented for the case of titanium blade tip specimens of various geometrical configurations rubbing at 100 m/s against specimens of nickel-chromium sintered powder metal seal material, the latter being fed toward the rotating blades at an incursion rate of 0.0254 mm/s. Blade tips in the form of orthogonal cutting tools with about 85 deg negative rake angles exhibited desirable abrading capabilities, as measured by the tear-free appearance of the grooves they generated in the seal material, little wear of blade tips, low forces of interaction and low seal densification. Similar results have been obtained for blade specimens with tips of small radius of curvature, as well as for square-ended and slanted blade tips that are plasma-sprayed with abrasive particles. The relationship between the size of these particles and their abrading effectiveness is considered. Author

A85-13953*# General Electric Co., Cincinnati, Ohio.
COMPARISON OF SCALED MODEL DATA TO FULL SIZE ENERGY EFFICIENT ENGINE TEST RESULTS
S. P. LAVIN, P. Y. HO (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH), and R. CHAMBERLIN (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 15 p. refs
(Contract NAS3-20643)
(AIAA PAPER 84-2281)

Acoustic tests of a subscale fan and a subscale mixer nozzle were conducted in anechoic chambers over a variety of operating conditions. The subscale fan test was an investigation into the effects of vane/blade ratio and spacing on fan generated noise. A turbulence control structure (TCS) was used to simulate the 'turbulence-free' condition in flight. The subscale mixer nozzle test investigated the acoustic properties of several different forced mixer designs. A tertiary flow was utilized on the mixer model to simulate the forward velocity effects on the jet. The results were scaled up to full size conditions and compared with measured engine data. The comparisons showed good agreement between the component scaled model results and the full scale engine data. Author

A85-13954*# General Electric Co., Cincinnati, Ohio.
MEASUREMENT AND PREDICTION OF ENERGY EFFICIENT ENGINE NOISE
S. P. LAVIN, P. Y. HO (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH), and R. CHAMBERLIN (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs
(AIAA PAPER 84-2284)

The NASA/GE Energy Efficient Engine (E3) static noise levels were measured in an acoustic arena on the Integrated Core and Low Spool Test System. These measured levels were scaled to the appropriate size to power four study aircraft and were projected to flight for evaluation of noise levels relative to FAR36, Stage III limits. As a result of these evaluations, it is predicted that the NASA/GE E3 engine with a wide spacing cut-on blade/vane ratio fan and a forced mixer nozzle can meet FAR36 Stage III limits with sufficient design margin. Author

A85-14010#
THRUST REVERSING TOO COMPLEX FOR COMPUTERS
J. J. HARFORD Aerospace America (ISSN 0740-722X), vol. 22, Nov. 1984, p. 30-33.

Viscous flow effects in the turning and separated internal flows of target and cascade type thrust reversers, which are used in airliner low and high bypass turbofans, respectively, have not as yet been adequately modeled by computational simulation. Flow visualization methods have therefore had to be used in wind tunnel simulations aimed at establishing reversed exhaust plume patterns that prevent exhaust gas reingestion by engine inlets, together with the raising up of ground debris that may cause structural damage and interference with wing and empennage flow patterns. O.C.

A85-14049
ADAPTIVE FUEL CONTROL FOR HELICOPTER APPLICATIONS
J. J. HOWLETT (Sikorsky Aircraft, Stratford, CT), T. MORRISON, and R. D. ZAGRANSKI (Chandler Evans, Inc., West Hartford, CT) American Helicopter Society, Journal (ISSN 0002-8711), vol. 29, Oct. 1984, p. 43-54.

A United States Army-sponsored computer-aided study of a twin engine helicopter is being conducted to develop new engine control strategies for microprocessor-based fuel control systems. Some of these concepts are classically adaptive in that the control modifies itself on-line to deal with engine deterioration, surge or failure. In addition, the permanent control concepts are inherently adaptive in that helicopter capability is enhanced over a wide range of operating situations. For example, engine power recovery is improved with rotor speed derivative control which allows increased transient load factors and improved handling qualities in maneuvering flight. Fuel consumption is minimized in cruise by seeking out the optimum rotor speed. Rotor drive train torsional damping is increased by utilizing the fast combustion power of the engine to counter output shaft resonance. Studies indicate that very few hardware modifications are required, therefore, a substantial payback may be achieved by implementing these new control features into the software of current generation microprocessor-based fuel control systems. Author

A85-14275
ELECTRIC POWER SYSTEMS IN AIRCRAFT - COMMENTS TO THE STANDARD GOST 19705-74 [ELEKTROENERGIESYSTEME IN FLUGZEUGEN - ERLAEUTERUNGEN ZUM STANDARD GOST 19705-74]
W.-D. KROHS (Interflug Gesellschaft fuer Internationalen Flugverkehr mbH, Berlin, East Germany) and J. GRUENHEID Technisch-oekonomische Information der zivilen Luftfahrt (ISSN 0232-5012), no. 4, 1984, p. 117-121. In German.

The employment of electric power has become an important factor in the operation of modern aircraft. During a long stay of the aircraft on the ground, it is desirable to supply to the aircraft electric energy from ground-based equipment. Such an approach makes it possible to avoid an excessive use of onboard generators and a depletion of electric energy in onboard storage devices. In connection with the efficient conduction of the various operations in which the onboard aircraft power system is involved, it is important that the involved equipment is standardized. For the Soviet aircraft industry, the required specifications are defined in the Standard GOST 19705-74 1. There is no equivalent GDR-Standard. A description is given of the most important specifications of GOST 19705-74; and the 'GOST 19705-74/Group E 02/UDK 629.7.064.5(083.74) Electric Energy-Supply Systems for Aircraft and Helicopters. Requirements regarding the quality of electric energy' are divided into 15 parts. Attention is also given to three supplements to GOST. G.R.

A85-14801
A STATISTICAL ANALYSIS OF THE FATIGUE STRENGTH CHARACTERISTICS OF TURBOMACHINE BLADES [STATISTICHESKII ANALIZ KHARAKTERISTIK SOPROTIVLENIIA USTALOSTI LOPATOK TURBOMASHIN]
B. F. BALASHOV, V. P. KHARKOV, and Z. KH. IUROVSKII (Tsentral'nyi Nauchno-Issledovatel'skii Institut Aviatsionnogo Motorostroeniia, Moscow, USSR) Problemy Prochnosti (ISSN 0556-171X), Oct. 1984, p. 15-19. In Russian.

The fatigue life and the endurance limit of titanium alloy steel, and nickel alloy blades of the compressors and turbines of aircraft gas-turbine engines are investigated statistically. An analysis of the results of a computer simulation of fatigue tests shows that the values of fatigue life and endurance limit based on small samples do not provide sufficiently reliable estimates of the dispersion characteristics of the fatigue strength for low values of the fatigue curve index (-b2 less than 10). Results are presented for blades of EI961 steel, VT8, VT9, VT3-1 titanium alloys, and ZhS6K, ZhS6U, and EI437B nickel alloys. V.L.

A85-14855#
RELIABLE TURBOPROP ENGINES
Dornier-Post (English Edition) (ISSN 0012-5563), no. 3, 1984, p. 8-12.

The Garrett TPE 331 turboprop engine selected for the Dornier 228 aircraft, for its reliability and technological and operational advantages is discussed. The fixed-shaft design has the following advantages over a free-shaft engine: easier installation on the airframe, a more compact size, lighter weight and less fuel burned for a given amount of power. The high propulsion efficiency provides high ram recovery and exhaust jet thrust. Low operational costs and ease of maintenance are among the engine's other advantages. The TPE 331-5 engine has a removal rate of only one removal per 12,500 hours and a network of service centers making support work and training, easily accessible worldwide. M.D.

A85-15350#
THE FUEL PROPERTY/FLAME RADIATION RELATIONSHIP FOR GAS TURBINE COMBUSTORS
J. A. CLARK (Ohio State University, Columbus, OH) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1828-1830.

Clark (1982) has asserted that flame radiation is linearly related to hydrogen content and nonlinearly related to aromaticity. On the other hand, Naegeli et al. (1982) have argued that flame radiation is linearly related to both fuel properties. The present investigation has the objective to examine the recent Naegeli et al. data to learn whether or not there is support for the nonlinearity argument. It is found that the radiation flux data from the study conducted by Naegeli et al. are excellently correlated with two distinct fitting parameters which involve fuel hydrogen and fuel aromaticity. One of the parameters is linearly dependent on polycyclic aromaticity while the second parameter has a nonlinear dependence. It is concluded that more radiation flux data from fuels whose polycyclic aromaticity is either very low or very high are needed to determine which fitting parameter is more correct. G.R.

A85-15820
THE FUNDAMENTALS OF THE AUTOMATED DESIGN OF ENGINES FOR FLIGHT VEHICLES [OSNOVY AVTOMATIZIROVANNOGO PROEKTIROVANIIA DVIGATELEI LETATEL'NYKH APPARATOV]
D. V. KHRONIN, V. I. BAULIN, IU. P. KIRPIKIN, and M. K. LEONTEV Moscow, Izdatel'stvo Mashinostroenie, 1984, 184 p. In Russian. refs

Fundamental concepts and definitions regarding the considered topic are discussed, taking into account the causes of the intensive development of computer aided design (CAD) procedures, the effectiveness of CAD systems, basic trends of CAD development, details regarding specific operational aspects, and questions concerning the utilization of CAD methods in applications related to the design of the engines of flight vehicles. The scientific basis of CAD methods and problems concerning their application are considered along with the technical means emloyed by CAD methods, the architecture of the system of interacting components, the computational network, general software for the computer system, specialized software for the CAD procedures, the information needed for the implentation of CAD methods related to the design of the engines of flight vehicles, and details concerning a number of CAD methods. Attention is given to a system for the automatic matching of the characteristics of engine and aircraft, and an automated system for the study of the dynamics of aircraft engines. G.R.

A85-15822
FLIGHT TESTS OF SPECIAL POWERPLANT EQUIPMENT AND SYSTEMS FOR FIXED-WING AIRCRAFT AND HELICOPTERS [LETNYE ISPYTANIIA SPETSIAL'NYKH USTROISTV I SISTEM SILOVYKH USTANOVOK SAMOLETOV I VERTOLETOV]
G. P. DOLGOLENKO, V. T. DEDESH, A. P. LENT, A. M. BOTSKOVSKII, S. P. SHCHERBAKOV, A. G. TIKHOMIROV, N. S. TROFIMOV, IU. F. ERSHOV, V. F. IANISHEVSKII, V. A. KOTEREV et al. Moscow, Izdatel'stvo Mashinostroenie, 1984, 128 p. In Russian. refs

The several types of flight tests used to judge the performance of aircraft propulsion systems in the USSR are described, with particular emphasis on the gas-turbine engine. Criteria are given for determining the operational characteristics of automatic control systems for ignition, lubrication, fuel intake and fire protection in the power plants of several fixed-wing aircraft and helicopters. A series of pen and ink drawings and schematic diagrams are used to illustrate the test criteria. I.H.

A85-15832#
LIQUID-FUELED RAMJETS
PH. GAZIN (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Lecture Series on Ramjet and Ramrocket Propulsion Systems for Missiles, 136th, Monterey, CA, London, England, and Munich, West Germany, Sept. 1984) ONERA, TP, no. 1984-112, 1984, 21 p. refs
(ONERA, TP NO. 1984-112)

An evaluation is made of the design features and performance levels that typify the state-of-the-art in liquid-fueled ramjets for guided missile applications. Recently developed ramjet propulsion systems offer such unique characteristics as the combination of long range with variable-altitude and variable-speed capabilities. Attention is given to the performance characteristics associated with various inlet, combustor, fuel chemistry, and fuel-feed system alternatives. Emphasis is given to the purely aerodynamic shaping of combustor swirl flows which yield exceptional energy efficiency. O.C.

A85-15842#
DYNAMIC BEHAVIOR OF A PROPFAN [COMPORTEMENT DYNAMIQUE D'UN 'PROP-FAN']
J. M. BESSON (SocieteNational Industrielle Aerospatiale, Division Helicopteres, Marignane, Bouches-du-Rhone, France) and D. PETOT (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Symposium on Aerodynamics and Acoustics of Propellers, Toronto, Canada, Oct. 1-4, 1984) ONERA, TP, no. 1984-122, 1984, 18 p. In French. refs
(ONERA, TP NO. 1984-122)

The dynamic behavior of a 1-m-diameter 12-blade propfan model is investigated analytically and experimentally. Both the propfan and its individual blades are analyzed using two versions of a simplified beam model and the finite-element codes ASTRONEFF and SAMCEF, considering blades of Dural alloy, CFRP, and foam-filled CFRP. The modeling techniques are illustrated, and results are presented in graphs and tables. The single-blade findings are compared with the results with the results of wind-tunnel tests performed at the ONERA Mondane S1 facility, and the errors of the models are found ot be of the order 10 percent. The ASTRONEF procedure is shown to be best adapted to the foam-filled ribbed CFRP blade to be used in the actual propfan model. Preliminary computations of the aerodynamics and static deformation of the propfan are also presented. T.K.

A85-15958#
AERO ENGINE COMPONENTS IN COMPOSITE MATERIALS - 20 YEARS' EXPERIENCE
A. THOMPSON (Bristol Composite Materials Engineering, Ltd., Bristol, England) IN: Reinforced Plastics/Composites Institute, Annual Conference, 39th, Houston, TX, January 16-19, 1984, Preprints . New York, Society of the Plastics Industry, Inc., 1984, p. 11-A-1 to 11-A-8.

An evaluation is made of the extent to which the aerospace industry has taken advantage of composite materials' weight, corrosion, maintenance and cost reduction possibilities over the last 20 years. The cases explored encompass engine casings, fan blades, toroidal and bypass ducts, compressor blade assemblies, and sound attenuation panels. The most important factor in all such cases which led to the selection of composite materials was cost minimization for the given values of required lightness, fatigue resistance, and ease of complex shape manufacture. O.C.

N85-12057 Cincinnati Univ., Ohio.
PERFORMANCE DETERIORATION OF CASCADES EXPOSED TO SOLID PARTICLES Ph.D. Thesis
C. BALAN 1984 169 p
Avail: Univ. Microfilms Order No. DA8413691

The performace degradation in turbomachinery exposed to solid particle ingestion was studied. The erosive nature of the solid particles ingested leads to changes in the rotor/stator blade profiles and their surface roughness. These changes in the blade shapes and roughness alters the blade surface boundary layer development and the performance of the turbomachines. An experimental investigation was concluded on two dimensional NACA 65(10)10 compressor airfoil cascades. Thsese cascades were made of 6061-T6 aluminum alloy and were exposed to 165 microns quartz sand in a specially built cascade erosion tunnel. Two types of cascades were investigated, namely accelerating and diffusing. The erosion of the blades, and the performance of the erodes cascades were studied. The theoretical analysis of the performance deterioration consists of predicting the blade erosion and the loss mechanisms in the cascades. The computation of the particle trajectories using compressible inviscid flow field through the cascade, yields the particle impact locations along the blade surfaces. Then the experimental correlations for surface quality and erosion based on the flat plate data are applied at every impact location. Dissert. Abstr.

N85-12058 Cornell Univ., Ithaca, N.Y.
UNSTEADY AERODYNAMIC RESPONSE OF CASCADES AND TURBOROTORS Ph.D. Thesis
V. G. MENGLE 1984 255 p
Avail: Univ. Microfilms Order No. DA8415387

The unsteady aerodynamic forces due to arbitrary transient motions of the blades in an axial turborotor are studied by using linearized cascade theory. The mathematical techniques in single airfoil theory are extended to cascaded airfoils. Approximate expressions are obtained for the indicial and the oscillatory forces essential to applications in aeroelastic problems. Pade Approximants based on the Maclaurin series of the transformed responses are constructed next for various solidities. These describe the transient responses as the sums of terms exponentially decaying with time. The time-constants for such transient processes are shown to depend on the zeros of a certain hypergeometric function. In staggered cascades, the inverse Fourier transforms of the standard harmonic coefficients, unlike the case in isolated airfoil, prove to be complex. They correspond to the response of indicial motions in which the amplitudes on adjacent blades differ by a complex factor. These responses, termed here as the Generalized Cascade indicial Function, are calculated for various cascade parameters using rational approximants with complex coefficients for the standard harmonic coefficients.
Dissert. Abstr.

N85-12059*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Engineering Div.
MATERIALS FOR ADVANCED TURBINE ENGINES. PROJECT 2: RENE 150 DIRECTIONALLY SOLIDIFIED SUPERALLOY TURBINE BLADES, VOLUME 2 Final Report
G. J. DEBOER Feb. 1982 39 p 2 Vol.
(Contract NAS3-20074)
(NASA-CR-167993; NAS 1.26:167993; R82AEB540-VOL-2)
Avail: NTIS HC A03/MF A01 CSCL 21E

The results of the engine testing of Rene 150 Stage 1 high pressure turbine blades in CF6-50 core and fan engines are presented. The core engine test was conducted for 233 hours with a variety of test cycles, and the fan engine test was conducted for 1000 C cycles. Post-test analysis of the core engine test data confirmed the suitability of the Rene 150 HPT blade for fan engine testing. Post-test evaluation and analysis of the fan engine test blades included visual and dimensional inspection as well as metallographic examination of selected blades. The Rene 150 HPT blade met the target goal of this project by demonstrating increased metal temperature capability; however, the post-test analysis revealed several areas that would have to be addressed in designing a long-life Rene 150 CF6-50 HPT blade. R.S.F.

N85-12060# Douglas Aircraft Co., Inc., Long Beach, Calif.
A COMPARATIVE EVALUATION OF EMADS (ENGINE MONITORING AND DISPLAY SYSTEM) AND CONVENTIONAL ENGINE INSTRUMENTS
D. A. PO-CHEDLEY Sep. 1981 98 p
(AD-A145901; MDC-J2330) Avail: NTIS HC A05/MF A01
CSCL 21E

A study was conducted to assess the performance benefits associated with the use of the General Electric Engine Monitoring and Display System (EMADS). An experiment was designed to compare pilot performance using both EMADS and conventional engine instruments. Data was collected from eight DC-10 qualified pilots having an average of over 13,000 hours of flight experience. The flight task for each of the sixteen test trials consisted of engine startup, manual takeoff, and climbout to 5,000 feet in a fixed base simulator. In addition, a number of predefined engine related fault conditions were introduced at various points during the simulation, with the pilots being instructed to execute the appropriate corrective action. For each of the fault monitoring tasks, performance (reaction time) with EMADS was as good or better than that resulting from the use of conventional instruments. Subjective input obtained from the pilots indicated a clear preference for EMADS. Recommendations are made regarding future research activity. GRA

N85-12061# United Technologies Research Center, East Hartford, Conn.
BASIC STUDY OF BLADED DISK STRUCTURAL RESPONSE Final Report, Sep. 1979 - Jan. 1984
A. V. SRINIVASAN and D. G. CUTTS Nov. 1983 250 p
(Contract F33615-79-C-2054)
(AD-A146226; R83-914806-48; AFWAL-TR-83-2075) Avail:
NTIS HC A11/MF A01 CSCL 01C

Vibration induced fatigue failure of rotor blades is of continuing concern to the designer of aircraft engines. The emphasis on improved engine performance under the necessary constraints of minimum weight and satisfactory life requires that vibration levels in all rotor blades be kept low. Further, certain important design considerations of rotor blades require a thorough understanding of the aeromechanical characteristics of bladed disk assemblies. These design considerations include: (1) blade life prediction which uses vibration amplitudes in its calculations, (2) setting allowable frequency margins which need to be justified on the basis of the intensity of resonant stresses at integral order speeds, and (3) prediction of susceptibility of the component to aeroelastic instabilities. The dynamic response of a shrouded fan was characterized over a range of speeds by subjecting the assembly to forced vibration in vacuum in a spin rig and to distortion induced vibration in an aerodynamic rig. The characterization was established by analysis of blade strain response data obtained when the assembly was driven by predetermined standing or traveling wave forcing through piezoelectric crystal drive elements attached to the blades, by means of an aerodynamic distortion screen and by exit guide vanes. Both tuned and mistuned configurations of the assembly were tested. In addition, the relative motion at shroud interfaces was measured using optical sensors for various input conditions. The vibratory motions were of a microslip type with no evidence of stick-slip type of motion.
GRA

N85-12062# Rolls-Royce Ltd., Derby (England).
PROPULSION
J. A. BORRADAILE 1 Aug. 1984 42 p
(PNR-90208) Avail: NTIS HC A03/MF A01

The history of the jet engine for civil aircraft from the Whittle jet of the 1940's to high bypass ratio turbofans is described. Engine functioning, and environmental influences on engine design, including fuel prices, noise, and the pressures for longer engine lives on wing are discussed. Author (ESA)

N85-12063# Rolls-Royce Ltd., Derby (England).
CYCLIC ENDURANCE TESTING OF THE RB211-22B CAST HP TURBINE BLADE
J. S. PONSFORD and G. K. WADDINGTON 1 May 1984 13 p
(PNR-90210) Avail: NTIS HC A02/MF A01

A cyclic endurance program to prove the design of a cast, directionally solidified high pressure turbine blade was developed to simulate the total in-flight service life of the blade. Definition of the endurance cycles, automation used in running the cyclic tests, and modifications incorporated to ensure that testing was kept representative of the service environment are discussed. Results demonstrate that the design objective (10,000 hr) can be achieved in airline service. Author (ESA)

N85-12891*# Dayton Univ., Ohio.
TURBINE BLADE DAMPING STUDY, INTRODUCTION
In its Turbine Blade Damping Study 79 p Nov. 1984 refs
Avail: NTIS HC A09/MF A01 CSCL 21E

Turbine Blade damping studies are reported. The analytical and experimenal definition of the performance parameters of turbine blade platform friction dampers were studied. The UDRI VAX 11/780 digital computer system experimental studies and a high speed spin pit utilized under a subcontracted effort wee analyzed.. The first turbine stage of the high pressure fuel turbopump (HPFTP) of the space shuttle main engine (SSME), which has exprienced blade fatigue problems are examined. EAK

N85-12899# Elektroschmelzwerk Kenpten G.m.b.H., Munich (West Germany).
DEVELOPMENT AND FABRICATION OF REFRACTORY BODIES FOR GAS TURBINE ENGINES Final Report, Apr. 1983
K. HUNOLD, W. GRELLNER, A. LIPP, and K. REINMUTH Bonn Bundesministerium fuer Forschung und Technologie Sep. 1984 75 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-84-180; ISSN-0340-7608) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 16

Applying hot isostatic pressing (HIP) techniques, dense bodies were manufactured from SiC and SiC/Si3 N4 mixtures with and without sintering aids. The correlation between strength and microstructure of hot-pressed silicon carbide (HPSIC) with different aluminum additions was investigated. The material properties of HIPSIC and standard-SiC were compared. The conditions of diffusion bonding of SiC parts were elaborated. Author (ESA)

08

AIRCRAFT STABILITY AND CONTROL

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

A85-13533#
DEVELOPMENT OF A 3-D INTERACTIVE GRAPHICS FLIGHT PATH ANALYSIS PROGRAM FOR THE T-38 AIRCRAFT
A. E. DAUGHERTY, T. P. BOYETT, T. J. JOHNSON, and E. G. HERNANDEZ (USAF, San Antonio Air Logistics Center, Kelly AFB, TX) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p. refs
(AIAA PAPER 84-2439)

This paper discusses the development and use of an interactive flight path analysis computer system for the Northrop T-38 trainer aircraft. This system is a non-linearized six degree of freedom simulation of the T-38 aircraft utilized in performance analyses and mishap investigations for the United States Air Force. The aircraft, performance data requirements, simulation program, and the in-house computer system are outlined. Author

A85-13534#
WRIGHT BROTHERS LECTURESHIP IN AERONAUTICS - HANDLING QUALITIES AND PILOT EVALUATION
R. P. HARPER, JR. (*Calspan Corp., Buffalo, NY*) *and* G. E. COOPER (G.E. Cooper Associates, Saratoga, CA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 18 p. refs
(AIAA PAPER 84-2442)

The dynamic system and constituent elements of the process of evaluating aircraft handling qualities are explored with an emphasis on simulation, evaluation through experiment, and historical progress. The dynamics of any aircraft are limited by the pilot's abilities as a controller. The pilot is limited by the flight envelope of the aircraft and the ergonomics of the control effectors. The system is therefore a closed loop. In simulators, a pilot's reactions to real-world events are modified by two situations: moving base simulations introduce attenuation and washout dynamics into motion feedbacks; fixed base simulators eliminate motion feedback altogether. The history of flight and test pilot reporting is traced from the Wright Brothers experiments, showing the negative flight stabilities and poor flight data in the early years of the aircraft industry. Handling qualities improved with the quality of flight test recording equipment, documentation standards, and servo-mechanisms for in-flight simulators. Finally, the interactive roles of aircraft engineers and pilot-evaluators in judging flying qualities in simulators are discussed. M.S.K.

A85-13548*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FLIGHT CRITICAL SYSTEM DESIGN GUIDELINES AND VALIDATION METHODS
H. M. HOLT, A. O. LUPTON, and D. G. HOLDEN (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 11 p. refs
(AIAA PAPER 84-2461)

Efforts being expended at NASA-Langley to define a validation methodology, techniques for comparing advanced systems concepts, and design guidelines for characterizing fault tolerant digital avionics are described with an emphasis on the capabilities of AIRLAB, an environmentally controlled laboratory. AIRLAB has VAX 11/750 and 11/780 computers with an aggregate of 22 Mb memory and over 650 Mb storage, interconnected at 256 kbaud. An additional computer is programmed to emulate digital devices. Ongoing work is easily accessed at user stations by either chronological or key word indexing. The CARE III program aids in analyzing the capabilities of test systems to recover from faults. An additional code, the semi-Markov unreliability program (SURE) generates upper and lower reliability bounds. The AIRLAB facility is mainly dedicated to research on designs of digital flight-critical systems which must have acceptable reliability before incorporation into aircraft control systems. The digital systems would be too costly to submit to a full battery of flight tests and must be initially examined with the AIRLAB simulation capabilities. M.S.K.

A85-13549#
A SYSTEM APPROACH TO FLIGHT CONTROL RELIABILITY AND MAINTAINABILITY
P. R. CHANDLER and D. P. RUBERTUS (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p. refs
(AIAA PAPER 84-2463)

This paper describes a system approach to designing extremely high reliability and maintainability into a Flight Control System (FCS) thru exploiting reconfiguration and graceful degradation via a weapon system effectiveness index. The problem is discussed in detail and specific objectives are identified. Critical issues explored to determine the potential applicability and limits of reconfiguration and graceful degradation to an ATF class application. Goals are defined and an approach is presented that has the potential to meet the goals. Included is a detailed discussion of requirements for performance, availability, and cost. A method is given for determining the aircraft control effector structure through a performance index. A strategy for performing the reconfiguration is identified and discussed, and an architecture that exploits the strategy is briefly presented. Author

A85-13564#
INTEGRATED MODULAR FLIGHT CONTROL - COSTS AND BENEFITS
D. G. BAILEY (Honeywell Systems and Research Center, Minneapolis, MN) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p.
(AIAA PAPER 84-2490)

It is noted that modular flight control subsystems can be produced that are compatible with two-level maintenance, thereby increasing mobility and eliminating shop test stations, adapters, personnel, and test documentations. Such integrated modular avionics concepts as functional integration and shared resources, modular packaging, and effective built-in tests, are applicable at the subsystem level. Modular flight control subsystems have been produced that have on-board fault isolation capability for the case of a line-replaceable unit. O.C.

A85-13565#
FLIGHT CONTROL TECHNOLOGY FOR CURRENT/FUTURE TRANSPORT AIRCRAFT
R. A. PATTERSON (Rockwell International Corp., Collins Air Transport Div., Cedar Rapids, IA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 5 p.
(AIAA PAPER 84-2491)

The presently anticipated developments in airliner flight control technology will be based on weight and volume reductions of electronics units accomplishing conventional functions while integrating novel functions. Among these novel additions will be sensors for Microwave Landing Systems, Global Positioning Systems, and data links. Both shop- and onboard-maintenance technique refinements are also anticipated. Higher bandwidth data buses and superior critical function performance will reduce cable and wire weights while providing augmentation control, which also reduces the weight associated with structure and stability elements. O.C.

A85-13566#
INTEGRATED FLIGHT/FIRE/PROPULSION CONTROLS
C. E. KNOX and D. W. MEYER (General Electric Co., Binghamton, NY) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 6 p.
(AIAA PAPER 84-2493)

A critical element of the effort to design next-generation tactical fighter aircraft is the design of integrated fire, flight and propulsion controls (IFFPCs). An attempt is presently made to sum up the state-of-the-art in this technology and the further development initiatives required to achieve performance requirements for 1990s aircraft. The hardware of these IFFPCs will be entirely digital, and fault tolerance will be both redundant and reconfigurable. The degree of control complexity achieved will require command arbitration and fault-induced reconfiguration, in conjunction with total vehicle management system functions. O.C.

A85-13567#
FUTURE REQUIREMENTS FOR INTEGRATED FLIGHT CONTROLS
A. D. STERN (Allied Bendix Aerospace, Flight Systems Div., Teterboro, NJ) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p. refs
(AIAA PAPER 84-2494)

The development of integrated aircraft control systems (IACS) for further tactical aircraft should be performed in a top-down fashion. Criteria influencing the IACS design break-down into five major areas: (1) functional performance; (2) crew workload; (3) fault tolerance; (4) advanced architectures; and (5) sustainability. Each of these areas plus their supporting technologies are discussed. Author

A85-13631*# Rensselaer Polytechnic Inst., Troy, N. Y.
NONLINEAR MODEL SIMPLIFICATION IN FLIGHT CONTROL SYSTEM DESIGN
A. A. DESROCHERS (Rensselaer Polytchnic Institute, Troy, NY) and R. Y. AL-JAAR Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Nov.-Dec. 1984, p. 684-689. Previously cited in issue 10, p. 1352, Accession no. A84-25505. refs
(Contract NAG1-171)

A85-13633#
MULTI-INPUT/MULTI-OUTPUT CONTROLLER DESIGN FOR LONGITUDINAL DECOUPLED AIRCRAFT MOTION
J. L. SPEYER, J. E. WHITE, R. DOUGLAS, and D. G. HULL (Texas, University, Austin, TX) (Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers, p. 378-389) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Nov.-Dec. 1984, p. 695-702. Research supported by the General Dynamics Corp. Previously cited in issue 21, p. 3625, Accession no. A81-44123. refs

A85-13681#
YF16-CCV MULTIVARIABLE FLIGHT CONTROL DESIGN WITH UNCERTAIN PARAMETERS
I. HOROWITZ (Weizmann Institute of Science, Rehovot, Israel; Colorado, University, Boulder, CO), Z. KOPELMAN (Israel Aircraft Industries, Ltd., Lod; Weizmann Institute of Science, Rehovot, Israel; Colorado, University, Boulder, CO), O. YANIV, and L. NEUMANN (Weizmann Institute of Science, Rehovot, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 31-36. refs
(Contract AF-AFOSR-80-0213; AF-AFOSR-82-063)

The considered flight control problem is basically a multiple-input-output (MIO) feedback problem with an uncertain plant. Horowitz (1979) has developed a 'quantitative synthesis' technique for the MIO problem with significant plant uncertainty. 'Quantitative synthesis' involves a case in which there are bounds on the plant uncertainty, and tolerances on the acceptable response. The considered objective involves the finding of

compensations guaranteeing the performance tolerances over the plant uncertainty. Attention is given to a summary of the MIO quantitative synthesis technique, the necessary conditions for the use of the MIO synthesis technique, the direct side force mode, the vertical translation mode, and the 5 x 5 nonlinear mode.
G.R.

A85-13691#
A MODELLING APPROACH FOR AUTOPILOT DESIGN OF A ROLLING MISSILE
O. GOLAN and M. JODORKOVSKY (Rafael Armament Development Authority, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 153-159.

A modeling approach suitable for autopilot design of a rolling missile is proposed. The model exhibits a hierarchical coupling structure of the steering equations when slow turning rates of the maneuvering plane are assumed. The structure enables the design of the maneuvering control independent of the maneuvering plane rotation control. A design example based on the model, showed an excellent maintenance of magnitude and direction of the required maneuver in a high rate rolling missile. Author

A85-14050
ROTOR BLADE FLAP-LAG STABILITY AND RESPONSE IN FORWARD FLIGHT IN TURBULENT FLOWS
J. E. PRUSSING, Y. K. LIN (Illinois, University, Urbana, IL), and T. N. SHIAU American Helicopter Society, Journal (ISSN 0002-8711), vol. 29, Oct. 1984, p. 81-87. refs
(Contract DAAG29-81-K-0072)

The effect of random air turbulence on the coupled flap-lag motion of a helicopter rotor blade in forward flight is investigated. By assuming white noise turbulence and applying a special case of the stochastic averaging procedure, equations are developed which describe the stochastic first and second moments of the perturbations in flap and lead-lag angles due to turbulence. Numerical results for stability in forward flight illustrate that turbulence has a stabilizing effect, compared to the deterministic (no-turblence) case. Results for the steady state responses of the perturbations in forward flight indicate that the average response of the blade is not significantly affected by turbulence. In contrast, the random fluctuations away from the average response exhibit significant values due to the effects of turbulence. The turbulence levels assumed correspond to typical values for natural atmospheric turbulence. Author

A85-14636
THE DYNAMICS OF TAKEOFF AND LANDING OF AIRCRAFT [DINAMIKA VZLETA I POSADKI SAMOLETOV]
M. G. KOTIK Moscow, Izdatel'stvo Mashinostroenie, 1984, 257 p. In Russian. refs

A description is given of the basic concepts and definitions regarding the considered topic, taking into account a graphical representation of the various sections of the trajectory of an aircraft during takeoff and landing, the flight trajectory during a missed landing procedure, a classification of takeoffs and landings, and a nomenclature of takeoff and landing speeds. Equations regarding the motion of the aircraft in a general form are considered along with the concept of the load factor, equations of motion with load factor, concepts based on energy considerations, the determination of the characteristics of the takeoff run, methods for the determination of the characteristics of the part of the takeoff when the aircraft is airborne, analytical methods for the determination of the trajectory characteristics, the calculation of ascent characteristics by means of a method based on energy considerations, and the analytical calculation of the characteristics of the initial climb with the aid of equations involving the load factor. G.R.

A85-15657
THE MODELLING AND CONTROL OF RC HELICOPTER
K. FURUTA, Y. OHYAMA, and O. YAMANO (Tokyo Institute of Technology, Tokyo, Japan) IN: Simulation in engineering sciences: Applications to the automatic control of mechanical and energy systems; Proceedings of the International Symposium, Nantes, France, May 9-11, 1983 . Amsterdam and New York, North-Holland, 1983, p. 279-284. refs

A mathematical model of an RC helicopter in hovering is derived assuming that the type of the main rotor hub is elastic see-saw-flapping type and that the direction of the total main rotor thrust approximately coincides with that of normal line of tip path plane. The dynamics of two kinds of sensor, rate gyro and inclinometer are investigated. Finally those reliability and validity are confirmed by using simple gimbal equipment. Author

A85-15716
DYNAMICS OF SPATIAL MOTION OF AN AEROPLANE WITH DEFORMABLE CONTROLS
Z. DZYGADLO and A. KRZYZANOWSKI Journal of Technical Physics (ISSN 0324-8313), vol. 24, no. 3, 1983, p. 339-365. refs

The translational motion of an airplane with deformable controls and moving ponderable control surfaces is investigated analytically, extending the model of Dzygadlo and Boldak (1983) and Dzygadlo and Krzyzanowski (1982). The nonlinear equations of motion are derived, taking the elasticity and damping of the aileron, elevator, and rudder controls into account, and a Runge-Kutta-Gill program written in ALGOL is developed for their numerical evaluation. Results for the Iskra TS-II jet trainer are presented in graphs and briefly characterized. T.K.

A85-15718
ANALYSIS OF LONGITUDINAL NATURAL VIBRATIONS OF AN AEROPLANE WITH MOVING DEFORMABLE CONTROL SURFACES
Z. DZYGADLO and J. BLASZCZYK Journal of Technical Physics (ISSN 0324-8313), vol. 24, no. 4, 1983, p. 481-498. refs

The vibrational behavior of a deformable airplane is investigated analytically, extending the three-stage-synthesis methodology (involving finite elements, superelements, and higher-order superelements) of Dzygadlo an Blaszczyk (1977, 1978, and 1981) to the case of moving deformable ailerons and elevators. The equations of motion for the deformable assemblies are derived; boundary and coupling conditions are applied; the equations of motion for the rigid assemblies are reviewed; and dynamic and kinematic coupling conditions are developed to obtain the equation of frequency and the natural modes. The results of numerical computations using a computer algorithm written in ALGOL are presented in graphs and tables for a hypothetical airplane and an actual jet trainer aircraft. The method is shown to converge rapidly and provide correct dynamic analyses. It is found that the effect of moving control surfaces can be disregarded in preliminary appraisals of the vibration frequency of main assemblies, while 140-150 degrees of freedom are sufficient to determine about 20 frequencies when the effect is taken into account. T.K.

A85-15719
A MODEL FOR THE ANALYSIS OF DYNAMIC PROPERTIES OF A HELICOPTER ROTOR BLADE WITH VARIOUS BOUNDARY CONDITIONS
W. SOBIERAJ Journal of Technical Physics (ISSN 0324-8313), vol. 24, no. 4, 1983, p. 499-509. refs

The coupled flexural-torsional vibrations of a deformable helicopter rotor blade are investigated analytically, applying the displacement finite-element method (with one-dimensional discretization) of Dzygadlo and Sobieraj (1977 and 1980) to a number of possible boundary conditions, which are confined to the inner end section of the blade by introducing a number of simplifications. Configurations analyzed include elastic clamping, flapping hinge, feathering hinge, elastic constraint against torsion in the blade-angle controls, and compensation of vertical oscillations. The applicability of the analytical model to a computer algorithm is indicated, and diagrams are provided. T.K.

A85-15720
DYNAMICS OF NON-AUTONOMOUS SPATIAL MOTION OF AN AEROPLANE WITH FIXED CONTROL SYSTEMS
Z. DZYGADLO and A. KRZYZANOWSKI Journal of Technical Physics (ISSN 0324-8313), vol. 24, no. 4, 1983, p. 511-536. refs
The effect of a pulsed external force on the translational motion of a rigid airplane is investigated analytically. A complete set of nonlinear equations is derived; a Runge-Kutta-Gill algorithm is developed for its numerical integration; and results are presented graphically for different numbers and strengths of pulses (as due to gun firings) and different points of attachment to the aircraft structure. Consideration is also given to the effect of altitude and velocity, and it is found that a given series of pulses has a smaller effect at high speed and low altitude. T.K.

A85-15847#
ACTIVE CONTROL OF BUFFETING ON A MODERN TRANSPORT-AIRCRAFT WING CONFIGURATION IN A WIND TUNNEL [CONTROLE ACTIF DU TREMBLEMENT SUR UNE CONFIGURATION D'AILE D'AVION DE TRANSPORT MODERNE EN SOUFFLERIE]
R. DESTUYNDER (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Symposium on Active Control Systems: Review, Evaluation and Projections, 65th, Toronto, Canada, Oct. 15-18, 1984) ONERA, TP, no. 1984-131, 1984, 11 p. In French.
(ONERA, TP NO. 1984-131)
The results of tests performed in the ONERA Modane S1 wind tunnel at Mach numbers 0.50, 0.78, and 0.82 on a large half-model civil transport aircraft having a supercritical wing with three flaperons actively controlled to damp the structural response to buffeting are presented in diagrams and graphs and discussed. The control system operates the two innermost flaperons separately to respond to the two main eigenmodes of the structure (at 14 and 42 Hz). It is found that structural strain and airframe motion are significantly reduced in both subsonic and transonic regimes without affecting the flight mechanics of the aircraft. T.K.

N85-12064 Virginia Polytechnic Inst. and State Univ., Blacksburg.
NUMERICAL SIMULATION OF THE SUBSONIC WING-ROCK PHENOMENON Ph.D. Thesis
P. A. KONSTADINOPOULOS 1984 142 p
Avail: Univ. Microfilms Order No. DA8417825
A method to calculate unsteady, incompressible, inviscid, three-dimensional flows around arbitrary planforms, is coupled with the equation of motion for a slender wing rolling about an axis parallel to its midspan. This one degree of freedom motion can simulate the wing-rock phenomenon. The basic mechanism, the cause and the parameters affecting this nonlinear motion was studied. The model is a flat plate delta wing with 80 degrees leading edge sweep and leading edge separation is considered. A mathematical simulation of wing rock suggests that roll damping, which is positive at low angles of attack, changes sign as the angle of attack increases. The rolling moment coefficient is separated into restoring and damping terms, and the contribution of each was studied. It is found that during wing rock the linear term of the restoring part grows at large roll angles which limits the motion to an oscillation of finite amplitude and at small roll angles the linear term of the damping part dominates and drives the wing away from the equilibrium position. Dissert. Abstr.

N85-12900*# Information and Control Systems, Inc., Hampton, Va.
FLIGHT TESTS OF THE DIGITAL INTEGRATED AUTOMATIC LANDING SYSTEM (DIALS) Final Report
N. HALYO Washington NASA Dec. 1984 127 p refs
(Contract NAS1-16158)
(NASA-CR-3859; NAS 1.26:3859; TR-683106) Avail: NTIS HC A07/MF A01 CSCL 01C
The design, development, implementation and flight tests of the Digital Integrated Automatic Landing System (DIALS) are discussed. The system was implemented and flight tested on the Transport Systems Research Vehicle (TSRV), a Boeing 737-100. The design uses modern optimal control methods. The direct digital design obtained uses a 10 Hz rate for the sampling of sensors and the control commands. The basic structure of the control law consists of a steady state Kalman filter followed by a control gain matrix. The sensor information used includes Microwave Landing System (MLS) position, attitude, calibrated airspeed, and body accelerations. The phases of the final approach considered are localized and steep glideslope capture (which may be performed simultaneously or independently), localizer and glideslope track, crab/decrab, and flare to touchdown. The system can capture, track, and flare from conventional, as well as steep, glideslopes ranging from 2.5 deg to 5.5 deg. All of the modes of the control law including the Kalman filters were implemented on the TSRV flight computers which use fixed point arithmetic with 16 bit words. The implementation considerations are described as well as an analysis of the flight test results. R.J.F.

N85-12901*# United Technologies Research Center, East Hartford, Conn.
HIGH-TEMPERATURE OPTICALLY ACTIVATED GAAS POWER SWITCHING FOR AIRCRAFT DIGITAL ELECTRONIC CONTROL
J. M. BERAK, D. H. GRANTHAM, J. L. SWINDAL, J. F. BLACK, and L. B. ALLEN May 1983 201 p refs
(Contract NAS3-22535)
(NASA-CR-174711; NAS 1.26:174711; UTRC-R83-925312-25)
Avail: NTIS HC A10/MF A01 CSCL 01C
Gallium arsenide high-temperature devices were fabricated and assembled into an optically activated pulse-width-modulated power control for a torque motor typical of the kinds used in jet engine actuators. A bipolar heterojunction phototransistor with gallium aluminum arsenide emitter/window, a gallium arsenide junction field-effect power transistor and a gallium arsenide transient protection diode were designed and fabricated. A high-temperature fiber optic/phototransistor coupling scheme was implemented. The devices assembled into the demonstrator were successfully tested at 250 C, proving the feasibility of actuator-located switching of control power using optical signals transmitted by fibers. Assessments of the efficiency and technical merits were made for extension of this high-temperature technology to local conversion of optical power to electrical power and its control at levels useful for driving actuators. Optical power sources included in the comparisons were an infrared light-emitting diode, an injection laser diode, tungsten-halogen lamps and arc lamps. Optical-to-electrical power conversion was limited to photovoltaics located at the actuator. Impedance matching of the photovoltaic array to the load was considered over the full temperature range, -55 C to 260 C. Loss of photovoltaic efficiency at higher temperatures was taken into account. Serious losses in efficiency are: (1) in the optical source and the cooling which they may require in the assumed 125 C ambient, (2) in the decreased conversion efficiency of the gallium arsenide photovoltaic at 260 C, and (3) in impedance matching. Practical systems require improvements in these areas. Author

09

RESEARCH AND SUPPORT FACILITIES (AIR)

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

A85-15581
VISUAL SIMULATION TAKES FLIGHT
J. B. TUCKER High Technology (ISSN 0277-2981), vol. 4, Dec. 1984, p. 34-43, 46, 47.
Computer-generated imagery (CGI) has been developed to improve the realism of a simulated landing. The flight simulators

consist of an exact replica of the cockpit and a minicomputer, programmed to the aircraft's characteristics, which processes the control signals from the cockpit. The illusion of continuous flight is created by the computer while flight conditions are programmed by an instructor station. The advantages of simulation have been shown to include standardization of training, fewer injuries, increased training time unhampered by weather conditions and airport traffic and cost reduction. Training a pilot on a real 747 costs about $7000 an hour while a 747 simulator costs only $600 an hour. The two CGI systems, commercial and military, have been studied and compared. Simulations for commercial aviation markets are less expensive and are driven by microprocessors. In the military market, the visual simulation systems provide more realism, training effectiveness and more detail. The three main components of a CGI system include a software database that defines the visual environment, a hardware image generator and a display system. Techniques such as scene management, in which three dimensional objects are modeled, have been examined. Although the detail and resolution provided by these systems are adequate for high-altitude flight, studies have shown that more realism is needed for low-altitude flight. Compact area-of-interest (AOI) displays mounted on the trainees' helmets are also discussed. M.D.

A85-15846#
ULTRA LIGHT WALL WIND TUNNEL
O. PAPIRNYK and J. P. CHEVALLIER (Supersonic Tunnel Association, Semi-Annual Meeting, 62nd, Goettingen, West Germany, Oct. 10, 11, 1984) ONERA, TP, no. 1984-129, 1984, 8 p.
(ONERA, TP NO. 1984-129)

In order to improve the test conditions in a free jet wind-tunnel, the assumed influence of the vortices in the mixing layer is reduced in a small pilot facility by using a ultra light wall made of a highly porous fine mesh screen. Longitudinally stretched down to the diffusor and filled by pressure difference due to the ejector effect, this screen dramatically reduces the level of all the components of the speed fluctuations. Questions remain concerning transposition to a full-size facility, the real boundary conditions for wall interference effect and sound transmission. Author

N85-12067# Army Construction Engineering Research Lab., Champaign, Ill.
DEVELOPMENT OF A PAVEMENT MAINTENANCE MANAGEMENT SYSTEM. VOLUME 10: SUMMARY OF DEVELOPMENT FROM 1974 THROUGH 1983 Final Report
M. Y. SHAHIN and T. D. JAMES Tyndall AFB, Fla. AFESC Jul. 1984 36 p
(AD-A146035; CERL-TR-C-76; AFESC/ESL-TR-83-55-VOL-10)
Avail: NTIS HC A03/MF A01 CSCL 01E

This report documents and summarizes the development of the pavement maintenance management system from 1974 through 1983. The most important aspects of the development are discussed, step by step. These are: development of the Pavement Condition Index, development of maintenance and repair (M&R) guidelines, validation of the M&R guidelines, development of initial prediction models, development of consequence system programs, development of final prediction models, and adoption of the PAVER pavement management system. GRA

N85-12068# Drexel Univ., Philadelphia, Pa. Dept. of Civil Engineering.
MATERIALS FOR EMERGENCY REPAIR OF RUNWAYS Interim Report, 1 Oct. 1983 - 31 Mar. 1984
S. POPOVICS 30 Apr. 1984 148 p
(Contract AF-AFOSR-0245-83)
(AD-A146139; REPT-001129-1; AFOSR-84-0693TR) Avail: NTIS HC A07/MF A01 CSCL 11B

The purpose of the investigation here was to test four inorganic cementing materials, and screen out from further investigation those that are obviously unsuitable for the fulfillment of the requirements for emergency repair of concrete runways under war conditions. The four materials are SET-45 cold formula; SET-45 hot formula; Aluminum phosphate (AIP cement; and Jet cement. In addition, a 50/50 blend of the SET-45 cold and hot formulas was investigated, and a portland cement of Type III was tested for the sake of comparison. The SET-45 formulas and the AIP cement are based on magnesium oxide. The Jet cement is a modified portland cement. A combination of mechanical testing and physicochemical examinations was used. The mechanical testing concentrated on the early strength developing capabilities of the cements under room temperature. GRA

N85-12069# Army Construction Engineering Research Lab., Champaign, Ill.
DEVELOPMENT OF A PAVEMENT MAINTENANCE MANAGEMENT SYSTEM. VOLUME 9: DEVELOPMENT OF AIRFIELD PAVEMENT PERFORMANCE PREDICTION MODELS Final Report, Jan. 1980 - Sep. 1983
M. Y. SHAHIN, G. R. NELSON, J. M. BECKER, and S. D. KOHN Tyndall AFB, Fla. Air Force Engineering and Sciences Center May 1984 203 p
(Contract AF PROJ. 2054)
(AD-A146150; CERL-TR-C-76-VOL-9; AFESC/ESL-TR-83-45)
Avail: NTIS HC A10/MF A01 CSCL 01E

Extensive data were collected from 327 airfield pavement features at 12 U.S. Air Force bases. The data, which provided a wide range of information on designs, materials, traffic, and climate, were used to develop PCI and key distress prediction models for both asphalt-concrete and jointed-concrete-surfaced pavements. Four satisfactory models were developed for predicting PCI for PCC and AC/PCC pavements, corner breaks in PCC pavements, and reflection cracking in AC/PCC pavements. Additional data were collected from 101 airfield pavement features at five of the Air Force bases originally surveyed to evaluate the four prediction models. The evaluation showed that the PCI prediction models are satisfactory. The reflection cracking model also provided reasonable prediction of eight pavement features. However, verification of the corner break model showed that it has a high standard deviation of prediction. Evaluation of the models for each of the five bases showed that predictions for some of the bases were much better than others, possibly because some of the material properties, climatic factors, and traffic conditions in certain bases were not well represented in the overall model. Thus, it was concluded that localized modeling could provide much more accurate predictions. GRA

N85-12902# Federal Aviation Administration, Atlantic City, N.J.
CLOSELY SPACED INDEPENDENT PARALLEL RUNWAY SIMULATION Final Report
D. L. BUCKANIN, R. C. GUISHARD, and L. E. PAUL Oct. 1984 72 p refs
(DOT/FAA/CT-84/45) Avail: NTIS HC A04/MF A01

Closely spaced independent parallel runway operations under instrument meteorological conditions were simulated to determine: (1) the impact of reduced runway spacings on the air traffic controller's ability to detect and resolve potential conflicts; and (2) the surveillance sensor accuracy and update rates needed to support closer runway separation. The environment was configured to simulate a terminal radar control room conducting independent parallel runway operations. Sixteen full performance level field controllers participated in the simulation; final and local control positions were manned by Technical Center controllers. Six experimental conditions were simulated involving 48 1 hour data gathering experimental runs conducted over a 4 week period. It is indicated that safe operations can be conducted at 3,400 feet runway separation provided a surveillance radar of at least a 2 second update rate and 2 milliradian accuracy is used. It is anticipated that some increase in penetrations of the no transgression zone may result from this reduction. E.A.K.

N85-12903*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.
THE PRELIMINARY CHECKOUT, EVALUATION AND CALIBRATION OF A 3-COMPONENT FORCE MEASUREMENT SYSTEM FOR CALIBRATING PROPULSION SIMULATORS FOR WIND TUNNEL MODELS Final Report
W. A. SCOTT Sep. 1984 180 p refs
(Contract NCC2-100)
(NASA-CR-174113; NAS 1.26:174113; KU-FRL-510-1) Avail: NTIS HC A09/MF A01 CSCL 14B

The propulsion simulator calibration laboratory (PSCL) in which calibrations can be performed to determine the gross thrust and airflow of propulsion simulators installed in wind tunnel models is described. The preliminary checkout, evaluation and calibration of the PSCL's 3 component force measurement system is reported. Methods and equipment were developed for the alignment and calibration of the force measurement system. The initial alignment of the system demonstrated the need for more efficient means of aligning system's components. The use of precision alignment jigs increases both the speed and accuracy with which the system is aligned. The calibration of the force measurement system shows that the methods and equipment for this procedure can be successful. E.A.K.

N85-12904# Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Versuchs- und Forschunsanlage.
INVESTIGATION FOR THE IMPROVEMENT OF THE TRANSONIC TUNNEL WORKING SECTION OF THE EMMEN FEDERAL AIRCRAFT WORKS (SWITZERLAND) [UNTERSUCHUNG ZUR VERBESSERUNG DER TRANSONIC-KANAL-MESSSTRECKE DES EIDGENOESSISCHES FLUGZWERKE, EMMEN]
G. CAPITAINE 20 Oct. 1983 75 p refs In GERMAN
(FW-FO-1681) Avail: NTIS HC A04/MF A01

Wall interference correction in transonic wind tunnels for three dimensional models is treated. Slotted measuring section configurations and their effects on the flow conditions in empty tunnels and on models were investigated. Main characteristics for Mach numbers 0.65 M 1.0 are : axial pressure gradient 0.002; drag coefficient 0.0002; standard deviation of Mach number distribution 0.002 and angle of attack = - 2 deg. Author (ESA)

N85-13461# Joint Publications Research Service, Arlington, Va.
OPERATION OF AVIATION SUPPORT BASES
E. K. GASANOV *In its* USSR Rept.: Life Sci.: Biomed. and Behavioral Sci. (JPRS-UBB-84-026) p 27-28 5 Dec. 1984 Transl. into ENGLISH from Zashchita Rast. (Moscow), no. 8, Aug. 1984 p 4
Avail: NTIS HC A08

A progressive method of group basing of crews was introduced which allows the improvement of the effectiveness and quality of aviation chemical operation. A school of progressive experience was established. In 1965 crews from aviation enterprises treated 906,000 hectares, in 1983 the figure was over 1.5 million hectares. The fleet of airplanes increased insignificantly, this increase was caused by the increase in labor productivity. In the region serviced by the enterprise nine support bases were created. The distance between any one of them and the farthest sowing area was not more than 10 to 16 kilometers. Each base has an airport, a parking site for aircraft provision of emergency electrical energy, storehouses, production and housing facilities and a dispatcher's point with the necessary means of communication. E.A.K.

11

CHEMISTRY AND MATERIALS

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

A85-12722#
CONTROL OF THE PROPERTIES OF CARBON FIBER-REINFORCED PLASTICS
R. G. WHITE and T. A. PALMER (Southampton, University, Southampton, England) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1662-1669. Previously cited in issue 14, p. 1986, Accession no. A83-32790. refs

A85-14111
CERTIFICATION OF KEVLAR ON PRIMARY STRUCTURE SAAB/FAIRCHILD SF-340 AIRCRAFT
M. LEVY and K. GRUBE (Fairchild Republic Co., Farmingdale, NY) IN: Testing, evaluation and quality control of composites; Proceedings of the International Conference, Guildford, Surrey, England, September 13, 14, 1983 . Sevenoaks, Kent, England, Butterworth Scientific, Ltd., 1983, p. 145-158. refs

The Kevlar fiber-reinforced portions of the SF-340 commuter airliner's control surfaces have been designed to withstand flight loads in light of both static and durability/damage considerations. Coupon, component, subcomponent and full scale tests have been conducted in order to characterize the composite, with respect not only to static and fatigue loadings but also freeze/thaw cycles, moisture absorption, and impact damage/residual strength. A maximum moisture gain of 4 percent is expected in Kevlar 49 laminates for 120 F and 98 percent relative humidity conditions. O.C.

A85-14167
DEVELOPMENT OF RESINS FOR DAMAGE TOLERANT COMPOSITES - A SYSTEMATIC APPROACH
J. DIAMANT and R. J. MOULTON (Hexcel Corp., Dublin, CA) SAMPE Quarterly (ISSN 0036-0821), vol. 16, Oct. 1984, p. 13-21. refs

A systematic nonempirical screening approach has been used to develop improved resin matrices for damage tolerant composites. The approach involves the use of a state-of-the-art baseline resin, TGMDA/DDS, as a model for the behavior of the continuous matrix phase and its modifier. The principles thus derived are then evaluated and applied to other matrix and modifier constituents. It is shown that the fracture toughness of rubber-modified TGMDA/DDS resins increases with the nitrile content and molecular weight of the rubber. The ultimate tensile strain and strength increase with the rubber-matrix reactivity. The fracture toughness can also be increased by modifying the matrix with tough thermoplastics if phase separation with good interfacial bonding is achievable. V.L.

A85-15166
METALLISED FABRICS, THEIR PROPERTIES AND TECHNICAL APPLICATIONS
H. EBNETH (Bayer AG, Leverkusen, West Germany) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, Sept. 1984, p. 131-134.

The material properties and applications of metallized fabrics, which reflect and shield from EM waves, are outlined. The fabrics are made of synthetic organic fibers or natural fibers with additives of carbon, ceramic, and/or glass fibers coated with Ni or other metals. Coatings of Ni of at least 10 g/sq m are suitable as passive radar reflectors on lifeboats. A 300 ft search altitude has been shown sufficient for sighting liferafts at 7 n mi distance. The cloths can be used to shield objects or persons in the presence of microwave beams. Aircraft composite structures have been protected from lightning by giving them a skin of graphite filament yarn and aluminum separated by an aramid which prevents formation of aluminum carbide. Coating the outside, graphite layer with Ni and polyurethane raises the resistance to 100 kA, sufficient for military standards. M.S.K.

A85-15579
DAMPING OF COMPOSITE MATERIALS
S. V. HOA and P. OUELLETTE (Concordia University, Montreal, Canada) Polymer Composites (ISSN 0272-8397), vol. 5, Oct. 1984, p. 334-338; Discussion, p. 338. refs

A rule of mixture for the prediction of the loss factor of hybrid laminates of graphite/epoxy and Kevlar/epoxy composite materials is developed. The theoretical values agree reasonably with the experimental values for ten samples. An optimal laminate having the modulus of aluminum and twice the loss factor of graphite/epoxy laminates is achieved. Author

A85-15580
THE APPLICATION OF ENDLESS-FIBER REINFORCED POLYMERS
G. MENGES and J. MINTE (Institut fuer Kunststoffverarbeitung, Aachen, West Germany) Polymer Composites (ISSN 0272-8397), vol. 5, Oct. 1984, p. 347-351; Discussion, p. 352. refs

The lightness, corrosion resistance, low thermal expansion coefficient, and high specific modulus of elasticity of such advanced composites as aramid and carbon fiber-reinforced plastics recommend their use in aircraft and automobile construction. Attention is presently given to the role of continuous filament-wound composite structural elements in such major applications as the 767 airliner fleet, a cardan shaft, and an engine connecting rod. Performance levels are presented. O.C.

A85-15629#
DESIGN AND DEVELOPMENT OF A PULTRUDED FRP LAMINATE TO REPLACE ALUMINUM SHAPE IN A HIGH STRESS HIGH FATIGUE APPLICATION
M. BERGEY (Bergey Wind Power Co., Norman, OK) and R. ANDERSON (Morrison Molded Fiber Glass Co., Bristol, VA) IN: Reinforced Plastics/Composites Institute, Annual Conference, 38th, Houston, TX, February 7-11, 1983, Preprints . New York, Society of the Plastics Industry, Inc., 1984, p. 6-D-1 to 6-D-4.

Aluminum wind turbine blades are supplanted by a series of pultruded composite blades which are expected to improve service life and permit the use of novel airfoil profiles exhibiting higher aerodynamic efficiency. Varying ratios of roving and mat reinforcement were used in these composite extrusions. Attention is given to test data obtained for blade torsional, flexural, and fatigue characteristics. Accelerated fatigue testing indicates that the composite blades have essentially unlimited fatigue life. O.C.

A85-15631#
STRUCTURAL USES OF ARAMID FIBERS AS A PLASTIC REINFORCEMENT IN AIRCRAFT AND MISSILES
P. R. LANGSTON (Du Pont de Nemours and Co., Marketing Communications Dept., Wilmington, DE) IN: Reinforced Plastics/Composites Institute, Annual Conference, 38th, Houston, TX, February 7-11, 1983, Preprints . New York, Society of the Plastics Industry, Inc., 1984, p. 12-B-1 to 12-B-17.

The relatively rapid acceptance of Kevlar fibers by aircraft and missile designers for composite structure reinforcement is due to the fact that these fibers are 20 percent lighter than carbon fibers and 50 percent lighter than glass fibers, yielding the highest tensile strength-to-weight ratio commercially available. Kevlar-reinforced composites are more durable than those reinforced by fiberglass and carbon because of superior resistance to damage, vibration, and crack propagation, coupled with excellent fatigue resistance. Airliners, turbojet engines, helicopters, and diverse external fuel tanks, have all employed Kevlar reinforcement. O.C.

N85-12095*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HIGH PERFORMANCE FIBERS FOR STRUCTURALLY RELIABLE METAL AND CERAMIC COMPOSITES
J. A. DICARLO 1984 16 p refs Presented at a Conf. on High Performance Textiles Structures, Philadelphia, 6-8 Jun. 1984; sponsored by The Fiber Soc. and SAMPE
(NASA-TM-86878; E-2339; NAS 1.15:86878) Avail: NTIS HC A02/MF A01 CSCL 11D

Very few of the commercially available high performance fibers with low densities, high Young's moduli, and high tensile strengths possess all the necessary property requirements for providing either metal matrix composites (MMC) or ceramic matrix composites (CMC) with high structural reliability. These requirements are discussed in general and examples are presented of how these property guidelines are influencing fiber evaluation and improvement studies at NASA aimed at developing structurally reliable MMC and CMC for advanced gas turbine engines. A.R.H.

N85-12115# Federal Aviation Agency, Atlantic City, N.J.
THE PYROLYSIS TOXIC GAS ANALYSIS OF AIRCRAFT INTERIOR MATERIALS Final Report, Jun. 1980 - Nov. 1981
T. M. GUASTAVINO, L. C. SPEITEL, and R. A. FILIPCZAK Apr. 1982 49 p
(AD-A146285; DOT/FAA/CT-82/13) Avail: NTIS HC A03/MF A01 CSCL 21B

Selected aircraft interior materials previously reported are tested by a new methodology. Gas and ion chromatographs linked to computers are utilized to identify and quantify gases evolved from a specific thermal exposure. Results are compared to those reported by other methods and instruments. Time concentration profiles are utilized to Fingerprint and identify the material by this test evaluation. Author (GRA)

N85-12139# National Materials Advisory Board, Washington, D. C.
STRUCTURAL USES FOR DUCTILE ORDERED ALLOYS. REPORT OF THE COMMITTEE ON APPLICATION POTENTIAL FOR DUCTILE ORDERED ALLOYS Final Report, 2 May 1983 - 1 Nov. 1984
A. L. BEMENT, JR., C. T. LIU, and A. SCHAFFHAUSER 31 Aug. 1984 110 p
(Contract MDA903-82-C-0220)
(AD-A146313; NMAB-419) Avail: NTIS HC A06/MF A01 CSCL 11F

The unique mechanical properties of ordered alloys that make them attractive for structural applications are described. A major difficulty with these alloys has been a lack of ductility; however, in recent years several methods of ductility improvement have been developed. These techniques are discussed. Current research efforts worldwide are reviewed, and it is concluded that the U.S. effort, although substantially smaller than it was 15 years ago, is yielding the most significant progress in the development of ductile ordered alloys. A number of possible generic applications are suggested for the newly developed ductile ordered alloys, including applications in gas turbine engines, rocket propulsion systems, and space power systems. Areas where additional engineering data are required about these alloys are identified and a phased program of data acquisition is recommended. It is emphasized that there is a great need for materials processing information. Areas for scientific research also are identified. Finally, it is concluded that the properties of the newly developed ductile ordered alloys appear to be sufficiently promising to warrant a coordinated program for the application of these alloys to be undertaken. Author (GRA)

N85-12183*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LUBRICITY OF WELL-CHARACTERIZED JET AND BROAD-CUT FUELS BY BALL-ON-CYLINDER MACHINE
G. M. PROK and W. S. KIM Nov. 1984 15 p refs
(NASA-TM-83807; E-2308; NAS 1.15:83807) Avail: NTIS HC A02/MF A01 CSCL 21D

A ball-on-cylinder machine (BOCM) was used to measure the lubricity of fuels. The fuels tested were well-characterized fuels available from other programs at the NASA Lewis Research Center plus some in-house mildly hydroprocessed shale fuels from other programs included Jet-A, ERBS fuel, ERBS blends, and blend stock. The BOCM tests were made before and after clay treatment of some of these fuels with both humidified air and dry nitrogen as the preconditioning and cover gas. As expected, clay treatment always reduced fuel lubricity. Using nitrogen preconditioning and cover gas always resulted in a smaller wear scar diameter than when humidified air was used. Also observed was an indication of lower lubricity with lower boiling range fuels and lower aromatic fuels. Gas chromatographic analysis indicted changes in BOCM-stressed fuels. Author

N85-12185# Naval Research Lab., Washington, D. C.
COMPOUND CLASS QUANTITATION OF JP-5 JET FUELS BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY-DIFFERENTIAL REFRACTIVE INDEX DETECTION Memorandum Report, Jun. 1982 - Jun. 1983
C. W. SINK, D. R. HARDY, and R. N. HAZLETT 13 Sep. 1984 22 p
(AD-A145754; NRL-MR-5407) Avail: NTIS HC A02/MF A01 CSCL 21D

Fuel composition effects are known to significantly affect jet turbine engine performance. Currently, one important composition parameter, total aromatics (% v/v), is actually defined in all JP-4 and JP-5 military fuel specifications governing procurement. This report outlines an improved method for defining not only total aromatics but also the two sub-classes, mono-cyclic and di-cyclic aromatics, that make up the total aromatics in JP-5. Special emphasis has been placed on the accurate and precise quantitation of saturates, mono-cyclic and di-cyclic aromatic fractions. This has been accomplished for fuels in the JP-5 distillation range by direct quantitation with a low sensitivity differential refractive index (DRI) detector. The detector is first calibrated by an appropriate standard and the response factors (= weight/area) for each compound class are used by a calculating electronic integrator/recorder to report directly each subsequently analyzed fuel in weight percent for each compound class. The analysis of each fuel is fast and very precise. Accuracy appears to be quite good and is under further investigation. Long term analytical stability has proven (up to one year). Quantitative data for thirteen JP-5 fuels have been compared with data from fluorescence indicator absorption, HPLC/GC (High Performance Liquid Chromatography/Gas Chromatography) and gravimetric data. The thirteen fuels include several experimental jet fuel blends and one shale JP-5 fuel. GRA

N85-12245# Joint Publications Research Service, Arlington, Va.
CRACK RESISTANCE OF PRESSED AND ROLLED SEMIFINISHED GOODS OF ALUMINUM ALLOYS USED IN LOAD-BEARING AIRCRAFT WING STRUCTURES Abstract Only
A. G. VOVNYANKO and A. M. DOTSENKO *In its* USSR Rept.: Mater. Sci. and Met. (JPRS-UMS-84-007) p 1 24 Oct. 1984 Transl. into ENGLISH from Fiz.-Khim. Mekhan. Materialov (Kiev), v. 20, no. 2, Mar. - Apr. 1984 p 99-102 Original language doc. previously announced in IAA as A84-35724
Avail: NTIS HC A04/MF A01

The growth rate of cracks 30-500 mm long and with large stress intensity factors is analyzed in specimens of the alloys D16chT, V95pchT1, V95pchT2, 1161T, and 1163T which are used in aircraft panels and wind-box skin. The conditional stress intensity factors characterizing the residual strength of thin-walled structures with a crack are determined. The influence of thickness on crack resistance was studied in semifinished products 4, 8, and 12 mm thick that were cut with the grain. The influence on crack growth rate of sigma-max, which ranged from 68.5 to 216 MPa, was also examined. According to cyclic crack resistance and the conditional critical stress intensity factor, pressed panels of D16chT were superior to rolled slabs of the same alloy. The application of a softening aging regime T2 instead of T1 for the V95pch alloy significantly lowered the crack growth rate, especially for high values of K-max. J.N.(AIAA)

N85-12268# Joint Publications Research Service, Arlington, Va.
METALLURGY INSTITUTE'S DEVELOPMENTS FOR ALLOY AND AIRCRAFT PRODUCERS Abstract Only
T. SIGUA *In its* USSR Rept.: Mater. Sci. and Met. (JPRS-UMS-84-007) p 47 24 Oct. 1984 Transl. into ENGLISH from Zarya Vostoka (Tbilisi, USSR), 4 Sep. 1984 p 2
Avail: NTIS HC A04/MF A01

Metallurgical processes developed for specific production facilities are described. One development involved a process for obtaining a silicomanganese-titanium alloy which is used to deoxidize steel. This process was introduced at the Rustavi Metallurgical Plant. Present plans call for the plant to expand its assortment of steels deoxidized with the silicomanganese-titanium alloy, and to begin supplying the alloy to other steelmakers. Results of the metallurgy institute's cooperation with the Zestafoni Ferroalloys Plant, which is said to be the country's only producer of refined ferromanganese, are also discussed. A process was developed for the purpose of expanding the plant's capacity for the production of this alloy without building a new shop. The new process increased the capacity of an electric furnace in an existing shop. The institute also took part in the development of a process for a new silicomanganese production facility that is under construction at the plant. The facility's first phase is scheduled for completion in 1986. The institute and the Aircraft Plant imeni Dimitrov have been doing important work on conserving scarce high-speed steels by recycling waste. In particular, the institute proposed a process for melting waste products that involves alloying with nitrogen. Author

N85-12960*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SOLVENT RESISTANT THERMOPLASTIC COMPOSITE MATRICES
P. M. HERGENROTHER, B. J. JENSEN, and S. J. HAVENS (Kentron International, Inc., Hampton, Va.) *In its* Tough Composite Mater. p 317-335 Dec. 1984 refs
Avail: NTIS HC A17/MF A01 CSCL 11D

The following approaches improved the solvent resistance and raised the Tg of thermoplastics: end-capping aligomers with ethynyl groups; incorporating ethynyl groups pendent along the polymer chain; and correcting polymers containing pendent ethynyl groups with a low molecular weight diethynyl compound. The following conclusions were reached: (1) film and composite properties off an ethynyl-terminated sulfone were better than those of UDEL (trademark); (2) fracture energy of an ethynyl-terminated sulfone was lower than that of UDEL (trademark); (3) residual palladium in the cured ethynyl-terminated sulfone lower the thermooxidative stability of the cured resin; (4) the properties of a phenoxy resin were altered considerably by placing pendent ethynyl groups along the polymer chain; and (5) property trade-offs must be considered when thermoplastics are modified via reactant groups. B.G.

N85-12963*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMPOSITE FRACTURE TOUGHNESS AND IMPACT CHARACTERIZATION
In its Tough Composite Mater. p 381-383 Dec. 1984
Avail: NTIS HC A17/MF A01 CSCL 11D

The basic threat to the more widespread use of composites in aircraft primary structure is the problem of residual strength in the presence of damage. Specific problem areas that need to be addressed include the following: (1) modeling/understanding composite failure (impact: relate strain energy release rate to strain-to-failure, open hole compression: relate shear crippling to strain-to-failure, and account for variables such as thickness and stacking sequence); (2) micromechanics models; (3) consider the use of hybrid combinations, both interply and intraply, using graphite, Kevlar, and glass; and (4) modeling/understanding the role of the interface. Solving these problems involves a multidisciplinary approach including dynamics, structural stability, composite mechanics, and fracture mechanics. B.G.

N85-12966*# Rensselaer Polytechnic Inst., Troy, N. Y. School of Engineering.
COMPOSITE STRUCTURAL MATERIALS Semiannual Progress Report, 30 Sep. 1983 - 30 Apr. 1984
G. S. ANSELL, R. G. LOEWY, and S. E. WIBERLY Aug. 1984 174 p refs Sponsored in cooperation with AFOSR
(Contract NGL-33-018-003)
(NASA-CR-174077; NAS 1.26:174077; SAPR-46) Avail: NTIS HC A08/MF A01 CSCL 11D

The development and application of filamentary composite materials, is considered. Such interest is based on the possibility of using relatively brittle materials with high modulus, high strength, but low density in composites with good durability and high tolerance to damage. Fiber reinforced composite materials of this kind offer substantially improved performance and potentially lower costs for aerospace hardware. Much progress has been made since the initial developments in the mid 1960's. There were only limited applied to the primary structure of operational vehicles, mainly as aircrafts.

N85-13045*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HIGH-TEMPERATURE EROSION OF PLASMA-SPRAYED, YTTRIA-STABILIZED ZIRCONIA IN A SIMULATED TURBINE ENVIRONMENT
R. F. HANSCHUH Dec. 1984 19 p refs Prepared in cooperation with Army Research and Technology Labs., Cleveland
(NASA-TP-2406; E-2271; NAS 1.60:2406; AVSCOM-TR-84-C-17) Avail: NTIS HC A02/MF A01 CSCL 11B

A series of rig calibration and high temperature tests simulating gas path seal erosion in turbine engines were performed at three impingement angles and at three downstream locations. Plasma sprayed, yttria stablized zirconia specimens were tested. Steady state erosion curves presented for 19 test specimens indicate a brittle type of material erosion despite scanning electron microscopy evidence of plastic deformation. Steady state erosion results were not sensitive to downstream location but were sensitive to impingement angle. At difference downstream locations specimen surface temperature varied from 1250 to 1600 C (2280 to 2900 F) and particle velocity varied from 260 to 320 m/s (850 to 1050 ft/s). The mass ratio of combustion products to erosive grit material was typically 240. Author

N85-13055# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
CERAMIC TECHNOLOGY FOR ADVANCED HEAT ENGINES PROGRAM PLAN
Jun. 1984 85 p refs
(Contract DE-AC05-840R-21400)
(DE84-013567; ORNL/TM-8896) Avail: NTIS HC A05/MF A01

A plan for a generic ceramic research effort that supports and parallels existing advanced heat engine programs is presented. This long-range plan is to identify technology base needs; coordinate activities with other industry, government, and university programs; and develop a multiyear technical and resource agenda. DOE

N85-13066*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LIQUID PHASE PRODUCTS AND SOLID DEPOSIT FORMATION FROM THERMALLY STRESSED MODEL JET FUELS
W. S. KIM and D. A. BITTKER Nov. 1984 30 p refs
(NASA-TM-86874; E-2334; NAS 1.15:86874) Avail: NTIS HC A03/MF A01 CSCL 21D

The relationship between solid deposit formation and liquid degradation product concentration was studied for the high temperature (400 C) stressing of three hydrocarbon model fuels. A Jet Fuel Thermal Oxidation Tester was used to simulate actual engine fuel system conditions. The effects of fuel type, dissolved oxygen concentration, and hot surface contact time (reaction time) were studied. Effects of reaction time and removal of dissolved oxygen on deposit formation were found to be different for n-dodecane and for 2-ethylnaphthalene. When ten percent tetralin is added to n-dodecane to give a simpler model of an actual jet fuel, the tetralin inhibits both the deposit formation and the degradation of n-dodecane. For 2-ethylnaphthalene primary product analyses indicate a possible self-inhibition at long reaction times of the secondary reactions which form the deposit precursors. The mechanism of the primary breakdown of these fuels is suggested and the primary products which participate in these precursor-forming reactions are identified. Some implications of the results to the thermal degradation of real jet fuels are given. R.S.F.

N85-13067# Monsanto Co., Dayton, Ohio.
VARIABILITY OF MAJOR ORGANIC COMPONENTS IN AIRCRAFT FUELS. VOLUME 2: ILLUSTRATIONS Interim Report, Dec. 1982 - Nov. 1983
B. M. HUGHES, G. G. HESS, K. SIMON, S. MAZER, and W. D. ROSS Tyndall AFB, Fla. AFESC 27 Jun. 1984 218 p
(Contract F08635-83-C-0067)
(AD-A145831; AFESC/ESL-TR-84-02-VOL-2) Avail: NTIS HC A10/MF A01 CSCL 21D

This report summarizes qualitative and quantitative data on the chemical variability of approximately 300 features (chemical components or mixtures of components) with concentrations greater than 0.1 mg/ml in Air Force distillate fuels obtained from over 50 sources. These data were obtained to better understand the environmental effects of possible fuel spills and to serve as a data baseline in photochemical smog and soot formation studies. Fifty-four petroleum-derived JP-4 fuels, one shale-derived JP-4 fuel, and one petroleum derived JP-5 fuel were analyzed. The variability of the absolute concentrations in mg/ml was assessed for each feature in the capillary GC/FID (gas chromatography/flame ionization detection) analysis of the 54 fuels. Data base management programs developed and used in this assessment included the calculation of averages, ranges, standard deviations, and percent relative standard deviations of the 300 chromatographic feature concentrations in duplicate analyses of almost all of the fuels. GRA

N85-13073# Research Inst. of National Defence, Umea (Sweden).
METHOD FOR EVALUATING PETROL PRODUCTS CORROSIVITY USING PIEZOELECTRIC CRYSTALS. PART 2: INSTRUCTION MANUAL
B. HEDMAN and R. ROFFEY May 1984 24 p refs In SWEDISH; ENGLISH summary Sponsored by Swedish National Board of Economic Defence and Swedish Defence Material Administration
(FOA-C-40198-B4; ISSN-0347-2124) Avail: NTIS HC A02/MF A01; Research Institute for National Defence, Stockholm KR 50

A method based on the use of piezoelectric crystals covered with silver was developed for measuring the corrosivity of stored jet fuel. Sample handling the use of instruments and crystals analysis procedures and the different problems that may appear are described. Author (ESA)

12

ENGINEERING

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

A85-12716*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FLUTTER OF TURBOFAN ROTORS WITH MISTUNED BLADES
K. R. V. KAZA and R. E. KIELB (NASA, Lewis Research Center, Cleveland, OH) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers. Part 2, p. 446-461) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1618-1625. Previously cited in issue 13, p. 2111, Accession no. A82-30175. refs

A85-12721*# Massachusetts Inst. of Tech., Cambridge.
FLUTTER AND FORCED RESPONSE OF MISTUNED ROTORS USING STANDING WAVE ANALYSIS
J. DUGUNDJI and D. J. BUNDAS (MIT, Cambridge, MA) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 2, p. 149-159) AIAA Journal (ISSN 0001-1452), vol. 22, Nov. 1984, p. 1652-1661. Previously cited in issue 12, p. 1742, Accession no. A83-29823. refs
(Contract NAG3-214)

A85-12768#
THE NUMERICAL SOLUTION OF FLOW AROUND A ROTATING CIRCULAR CYLINDER IN UNIFORM SHEAR FLOW
F. YOSHINO and T. HAYASHI (Tottori University, Koyama, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 27, Sept. 1984, p. 1850-1857. refs

The Navier-Stokes equations were numerically solved on the flow around a rotating circular cylinder in a uniform shear flow for various rotating speeds and shear parameters at the Reynolds number of 80. The aerodynamic forces on the cylinder, stream lines and vorticity distributions around it were determined together with the range of rotating speeds and shear parameters where the largest lift oscillations occur. Author

A85-12944
ACCUMULATION OF FRACTURE PROBABILITY AS DAMAGE ACCUMULATION FOR THE PREDICTION OF SERVICE LIFE AND CRACK PROPAGATION IN DYNAMICALLY LOADED AVIATION SHEET METAL [BRUCHWAHRSCHEINLICHKEITSAKKUMULATION ALS SCHADENSAKKUMULATION ZUR LEBENSDAUER- UND RISSFORTSCHRITTSVORHERSAGE DYNAMISCH BEANSPRUCHTER LUFTFAHRTBLECHE]
P. MAKRIS and K. STEIN (Athens, National Technical University, Athens, Greece) Materialpruefung (ISSN 0025-5300), vol. 26, Oct. 1984, p. 349-353. In German. refs

A technique for predicting the service life and crack-growth behavior of sheet alloys on the basis of the stochastic approach to fracture probability developed by Makris (1969) and extended by Kierner (1981) is presented and demonstrated for Al alloy sheets of thicknes 2 mm and initial crack length 6.18 or 26.3 mm. The material is assumed to consist of submicroscopic particles having the same elastic characteristics as the bulk material and passing from the unbroken to the fractured state without partial damage. Model predictions and experimental data are compared in tables and graphs, and it is found that the difference between prediction and experiment is of the same order of magnitude as the test-to-test variation of the experimental data. T.K.

A85-13505#
A CASE STUDY - INTEGRATED DESIGN/ANALYSIS OF AN ADVANCED COMPOSITE FIN ASSEMBLY
Y. S. KIM (Boeing Aerospace Co., Seattle, WA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 9 p.
(AIAA PAPER 84-2394)

An advanced composite Fin assembly has been subjected to a Finite Element Stress Analysis. The Finite Element Model was created completely on a Computervision CADDS4 interactive graphics system and the analysis was done with NASTRAN running on a Control Data Corporation (CDC) Cyber 175. The framework for the analysis is the macromechanical behavior of composite structures based on anisotropic plate theory. A three dimensional finite technique is used. 3-D solid elements are employed to show detailed laminate behavior and to facilitate modeling to exact dimensions. The results of the analysis are compared to previously collected experimental data to validate the technique used. The technique provides an accurate capability for design optimization of advanced composite structures with both complex geometry and laminate composition. Author

A85-13540#
CRACK GROWTH OF LUGS UNDER SPECTRUM LOADING
J. A. HARTER (Sikorsky Aircraft, Stratford, CT) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 14 p. refs
(AIAA PAPER 84-2451)

The finite element method has been used to determine stress intensity factors for many structural geometries with a great deal of success. However, the method is time consuming and expensive in terms of the runs involved in calculating stress intensities for a number of crack lengths. Closed form solutions based on finite element results have been published in the open literature for various plate and crack geometries under remote loading. These solutions have been modified to obtain solutions for the lug geometry. The resulting stress intensity factors were used to predict crack growth lives which agreed well with constant amplitude test data for corner, surface, and through-the-thickness flaws. Stress intensity solutions developed in this manner may also be used, in the form of beta values, to determine crack growth times for components subjected to complex spectrum loading. Author

A85-13584#
A METHODOLOGY FOR ANALYZING LASER INDUCED STRUCTURAL DAMAGE
S. K. BRYAN (U.S. Air Force Academy, Colorado Springs, CO), P. J. TORVIK (USAF, Institute of Technology, Wright-Patterson AFB, OH), and V. B. VENKAYYA (USAF, Wright Aeronautical Laboratories and Institute of Technology, Wright-Patterson AFB, OH) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 10 p. refs
(AIAA PAPER 84-2521)

The analysis of laser-induced structural damage requires the merging of a thermal analysis which includes the characterization of the laser damage with a structural analysis which enables the determination of the deformation and the residual load carrying ability. Three types of laser-induced damage are considered: loss of structure due to melting, change of material properties due to temperature changes, and addition of load due to thermal stress. The thermal solution is calculated from a set of finite difference equations obtained from heat balances performed at successive finite time increments on an array of finite cells. The structural analysis is performed by a re-analysis technique, applicable when changes in structural stiffness are small compared to the initial value. The combined procedure for evaluating laser damage is applied to two structures, representing two levels of complexity. The first was a simple two-dimensional plate and the second a three-dimensional wing structure. The displacement solutions were compared to results obtained from NASTRAN to determine the accuracy of the iterative solution technique. The procedure was found to be efficient, and permits the parametric studies needed for a-priori estimates of the effectiveness of potential laser weapons systems. Author

A85-13699#
IMPROVED AUXILIARY CLUTCH FOR CH-53 HELICOPTERS
M. SINGER (Mata Helicopters, Engineering Dept., Jerusalem, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 229-235.

This paper describes the design and development of an I.A.C. (Improved Auxiliary Clutch) for the Sikorsky CH-53 Helicopter. The Improved Auxiliary Clutch is currently in Operational use in the Israel Air Force Helicopter fleet. The immediate result has been a significant improvement in operating and maintenance characteristics. This is expressed in much longer clutch service life, reduced cost and complete interchangeability with the Sikorsky original clutch. Details of the selected clutch configuration are presented as well as the supporting rational for the various design features. Author

A85-13703#
THE INFLUENCE OF AN INCLUSION OR A HOLE ON THE BENDING OF A CRACKED BEAM
J. UZAN, M. PERL, and A. SIDES (Technion - Israel Institute of Technology, Haifa, Israel) IN: Israel Annual Conference on Aviation and Astronautics, 25th, Technion - Israel Institute of Technology, Haifa and Tel Aviv, Israel, February 23-25, 1983, Collection of Papers . Haifa, Technion - Israel Institute of Technology, 1984, p. 267, 268.

An analysis of the effect of an inclusion or a hole on the stress intensity factor at the tip of an edge crack in a three-point bend specimen is presented. A finite element method is used to model the situation, with a numerical solution being obtained with singular and transitional elements introduced into the NONSAP code. A hole is found to increase the beam deflection while an inclusion decreases it. The disturbance is symmetric relative to the beam axis, but can change the location of the neutral axis of the beam. Additional analyses are performed of the effects of the distance between the disturbance center and the crack tip and the relative area of the disturbance. Finally, applications of the Paris law to fatigue life prediction of aircraft beam, composite beams, and pavement experiencing traffic loading are discussed. M.S.K.

A85-13898
LOOKING AROUND AT VISUALS
D. BOYLE Interavia (ISSN 0020-5168), vol. 39, Oct. 1984, p. 1077-1079.

For both civil and military transport aircraft, the WIDE visual image representation system for flight simulators makes image data available over the full display width of 150 deg in azimuth, though at the expense of display resolution and scene brightness. The follow-on WIDE I system uses three TV projectors to produce an image on a curved screen above the simulator cockpit, which is then seen by the crew through a curved collimating mirror in front of the cockpit windows. A further development, WIDE II, increases the number of projectors to five. The IMAGE III System, which uses separate microprocessors for the generation of surfaces, light points, moving coordinates, etc, can furnish radar simulation and weapon effects. O.C.

A85-13995
TWO-DIMENSIONAL UNSTEADY FLOW IN COMPREX ROTOR
H. JIANG (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Scientia Sinica, Series A - Mathematical, Physical, Astronomical and Technical Sciences (ISSN 0253-5831), vol. 27, Aug. 1984, p. 847-858. refs

A two-dimensional model of the unsteady compressible inviscid adiabatic flow in the meridional plane of a Comprex rotor of the type used as a Diesel supercharger is developed. The Euler equations governing the flow are solved numerically by the difference-scheme approach of MacCormack (1969, 1975), and numerical results are compared with experimental data in graphs and tables: good agreement is found. T.K.

A85-14107
NON-DESTRUCTIVE TESTING OF AIRCRAFT COMPOSITE STRUCTURES
A. MAHOON (British Aerospace, PLC, Aircraft Group, Weybridge, Surrey, England) IN: Testing, evaluation and quality control of composites; Proceedings of the International Conference, Guildford, Surrey, England, September 13, 14, 1983 . Sevenoaks, Kent, England, Butterworth Scientific, Ltd., 1983, p. 93-101. refs

Nondestructive testing requirements for aircraft structural applications of composites are discussed. Requirements such as development and testing for airworthiness certification, quality control of production processes and examinations to assess damage/repair are described. State-of-the-art techniques employed for the production quality control of carbon fiber reinforced composites are detailed. The nature and limitations of information obtainable from radiography, ultrasonics, and bond testing are presented. Requirements for automation are outlined and the in-house developed computer automated ultrasonic system is described. Future requirements and the techniques currently under development are also included. Author

A85-14126
ANNUAL AIRLINE PLATING AND METAL FINISHING FORUM, 19TH, SAN ANTONIO, TX, MARCH 7-10, 1983, PROCEEDINGS
Forum sponsored by the Society of Automotive Engineers. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE Proceedings P-127), 1983, 81 p. For individual items see A85-14127 to A85-14134.

Among the topics discussed are the simplification of chrome plating by means of a two-bus bar system, a novel zinc-nickel electroplating process that presents an alternative to conventional cadmium plating, the 'AeroNikl' brush-plated coating process, the wider applicability obtained for ion-vapor deposition of aluminum through equipment productivity improvements, and the development of compact, high efficiency plasma spray guns for jet engine component coating. Also considered are the effects of stress on the properties of electroless nickel-phosphorus deposits, innovative waste control and resource recovery technology developed for a naval air rework facility electroplating shop, and the use of robots in thermal spraying processes. O.C.

A85-14131
COMPACT, HIGH EFFICIENCY PLASMA SPRAY GUNS FOR JET ENGINE COATINGS
R. T. SMYTH (Metco, Inc., Westbury, NY) IN: Annual Airline Plating and Metal Finishing Forum, 19th, San Antonio, TX, March 7-10, 1983, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1983, p. 29-39.

The design and operation of a new range of compact, high efficiency guns is described. Data is presented to show that high quality coatings are obtained using low operating power levels and that narrow spray patterns are produced. The use of this new technology to produce coatings for jet engine components, such as, burner cans or combustion liners, turbine blade areas, and fan disc slots, is discussed. Author

A85-14348#
THE INFLUENCE OF A SPOILER ON THE DEVELOPMENT OF A HIGHLY CURVED TURBULENT WALL JET
U. HARTMANN (Berlin, Technische Universitaet, Berlin, West Germany) IN: Symposium on Turbulent Shear Flows, 4th, Karlsruhe, West Germany, September 12-14, 1983, Proceedings . University Park, PA, Pennsylvania State University, 1984, p. 6.1-6.5. refs

A sharp edged spoiler increases the deflection angle of a curved turbulent wall jet significantly. The spoiler creates a large negative pressure gradient at the wall at the end of the channel which 'relaminarizes' the turbulent wall boundary layer in this region. This effect occurs only for spoiler heights above a certain value and Reynolds numbers below a certain critical value. A discussion of the streamwise component of the turbulent Navier-Stokes equation in orthogonal Cartesian coordinates for two-dimensional flow with wall boundary conditions shows that in the present case the 'ordinary' turbulent wall jet separates more easily than a wall jet with a 'laminar' wall region. Author

A85-14378#

A COMPARISON OF TRIPLE-MOMENT TEMPERATURE-VELOCITY CORRELATIONS IN THE ASYMMETRIC HEATED JET WITH ALTERNATIVE CLOSURE MODELS

I. DEKEYSER (Aix-Marseille II, Universite, Marseille, France) and B. E. LAUNDER (University of Manchester Institute of Science and Technology, Manchester, England) IN: Symposium on Turbulent Shear Flows, 4th, Karlsruhe, West Germany, September 12-14, 1983, Proceedings . University Park, PA, Pennsylvania State University, 1984, p. 14.1-14.8. refs

Measurements are reported of all triple moments of velocity and temperature in a heated asymmetric two-dimensional turbulent jet involving velocity fluctuations in the x(1)-x(2) plane. The data thus obtained have been compared with those given by alternative algebraic models of the triple moments using, in the model formulae, experimental values of the second-moment quantities and the dissipation rate of kinetic energy. The study supports the view that in strongly asymmetric flows the contribution of mean temperature gradients to the triple moments can be appreciable. The comparison also provides some support for the use of the generalized gradient transport hypothesis in approximating dissipation of the triple moments. Author

A85-14631

ANALYSIS AND SYNTHESIS OF RADIO-ELECTRONIC COMPLEXES [ANALIZ I SINTEZ RADIOTEKHNICHESKIKH KOMPLEKSOV]

A. V. PETROV and A. A. IAKOVLEV Moscow, Izdatel'stvo Radio i Sviaz', 1984, 248 p. In Russian. refs

The application of the systems theory to the design of radio-electronic complexes of various types and their subsystems is discussed. The discussion covers the classification of radio-electronic complexes, digital simulation of such complexes, and simulation software. Attention is also given to methods for optimizing complex systems of trajectory measurements, system efficiency, and adaptation of the complexes. The discussion is illustrated by examples involving radio-electronic complexes of various types, including the radio-electronic equipment of space vehicles and navigational and traffic-control systems. V.L.

A85-14888

EXPERIMENTAL STUDY OF MACH REFLECTION OF WEAK SHOCK WAVES

G. A. MAKAREVICH, G. S. LISENKOVA, N. A. TIKHOMIROV, and A. V. KHODSTEV (Zhurnal Tekhnicheskoi Fiziki, vol. 54, Mar. 1984, p. 625-628) Soviet Physics - Technical Physics (ISSN 0038-5662), vol. 29, March 1984, p. 370-372. Translation. refs

The pressure dependence of Mach reflection of shock waves was studied experimentally at angles of attack (AOA) from 0-90 deg. The shock waves were generated in a shock tube fitted with a plate barrier to cause the reflections. Six pressure sensors were inserted into the 150 X 250 mm tube 50 mm from the plate. Shadowgraphs were obtained of the diffracted shock waves produced at different Mach numbers and AOA. The pressure data were employed to formulate a numerical model for the reflections as a function of the AOA. In comparison with the data, the model predictions became less accurate as the AOA approached 90 deg. M.S.K.

A85-14899

INSPECTION INTERVALS FOR FAIL-SAFE STRUCTURE

P. J. YOUNG IEEE Transactions on Reliability (ISSN 0018-9529), vol. R-33, June 1984, p. 165-170.

Bayesian and non-Bayesian approaches are taken to determining inspection schedules for fail-safe structures. Fail-safe means redundant, with each component working sufficiently below maximum to ensure that failure of one component does not strain the adjacent parts. The inspection schedule must reveal the failed component before failure of the redundant component. Two- and three-parameter Weibull distributions are employed to generate risk estimates, using Bayes inferences for the scale parameters with reference to survivor time. A risk estimate is obtianed for the no-failure case and confirmed by a non-Bayesian analysis. The risk estimate is judged suitable only as a comparison figure for other estimates. Sample calculations are performed for a 747 inspection schedule, showing that reevaluation of the schedule is indicated when the projected lifetime of the aircraft is approached. M.S.K.

A85-15171

ADVANCED GEARBOX HEALTH MONITORING TECHNIQUES

D. G. ASTRIDGE (Westland Helicopters, Ltd., Yeovil, Somerset, England) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, Sept. 1984, p. 165-169.

The state of the art in helicopter gearbox health monitoring systems is reviewed and illustrated in terms of the systems on the Westland 30 helicopter. Redundancy is not feasible for the heavy, flight critical gearbox, so monitoring systems are of paramount importance. An inductive sensor which is inserted into the crankcase can detect the number of particles above a certain size, giving a direct indication of engine wear. The system, when first installed on the Westland 30, detected excessive wear quickly and led to a redesign of the gearbox. Vibration sensors signal gear tooth and web fractures in the drive train by means of microprocessor-based Fourier analysis of the waveform harmonics detected. Finally, borescope ports have been installed on the rotor gearbox to permit visual inspections without dismantling or removing the gearbox. M.S.K.

A85-15248

DYNAMIC EDGE EFFECTS DURING THE AEROELASTIC VIBRATION OF PLATES [DINAMICHESKIE KRAEVYE EFFEKTY PRI AEROUPRUGIKH KOLEBANIIAKH PLASTIN]

N. I. ZHINZHER Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), Sept.-Oct. 1984, p. 175-180. In Russian. refs

The stability of an elastic plate in supersonic gas flow is investigated asymptotically. The normal modes of the plate in the internal region are represented by a superposition of solutions in the form of traveling waves and corrected at each edge using solutions of the dynamic edge effect type. The properties of the dynamic edge effects at the leading and trailing edges of the plate are examined. The effect of internal and external damping is discussed, as is the limiting case of a semiinfinte plate. V.L.

A85-15339#

EFFECT OF RESIDUAL STRESSES ON CRACK GROWTH FROM A HOLE

A. F. LIU (Northrop Corp., Aircraft Div., Hawthorne, CA) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers, Part 1, p. 191-195) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1784, 1785. Research supported by the Northrop Independent Research and Development Program. Previously cited in issue 12, p. 1737, Accession no. A83-29747.

A85-15521

THEORY AND PRACTICE OF LUBRICATION FOR ENGINEERS (2ND REVISED AND ENLARGED EDITION)

D. D. FULLER New York, Wiley-Interscience, 1984, 697 p. refs

The theory of hydrostatic and hydrodynamic lubrication and its practical application are presented in an introductory text for engineering students and practicing engineers. Topics examined include the fundamental principles of viscosity and flow, viscometers, factors affecting viscosity, hydrostatic lubrication, squeeze films, hydrodynamic lubrication of journal bearings, friction and power losses in journal bearings, dynamics of bearings and rotor systems, viscous pumps, compliant-surface bearings, types of industrial bearings, gas-lubricated bearings, dry friction, boundary friction, and bearing materials. Diagrams, drawings, graphs, photographs, and tables are provided. T.K.

A85-15584

STRESS INTENSITY FACTORS FOR CRACKS AT A DOUBLE ROW OF HOLES

D. P. ROOKE (Royal Aircraft Establishment, Farnborough, Hants., England) Journal of Strain Analysis for Engineering Design (ISSN 0309-3247), vol. 19, Oct. 1984, p. 231-236. refs

The presence of cracks at more than one fastener hole in a row of fastener holes limits the safe use of a component more than if cracks exist at the edge of one hole only, since the stress intensity factor is greater, the crack growth-rate is faster, and the fatigue lifetime is less. The limitations can be made less severe if the component is made with alternate fastener holes in the row displaced to form another parallel row. The compounding method of evaluating stress intensity factors is used to calculate the stress intensity factor as a function of crack length, hole spacing, and row separation. Fatigue growth-rates are calculated for the particular case of a periodic array of holes with two cracks of equal length at each hole. Author

A85-15606

EVOLUTION OF AN AUTOMATED EDDY CURRENT INSPECTION SYSTEM

A. THOMPSON (General Electric Co., Fairfield, CT) Materials Evaluation (ISSN 0025-5327), vol. 42, Nov. 1984, p. 1511-1514. USAF-sponsored research.

Two automated eddy current injection (ECI) systems designed for the USAF for implementation in manufacturing and overhaul facilities are discussed. The system was designed to inspect the critically stressed areas of aircraft turbine engines. All operations, including motion in seven independent axes, are automatically controlled by a small, large-scale-integration based computer. The scan and calibration files, which contain motion-control requirements, calibration and inspection parameters, data-analysis parameters, and all operator-interface information, undergo a self-teach routine in which the operator is prompted through a series of steps that provide the necessary information to the system. The mechanical system provides the precision of + or - 0.001 in. in all linear axes and + or - 2 min of arc in all rotational axes. The system met the inspection requirements for high-performance aircraft turbine engines, and increased productivity by 30 to 50 percent. A block diagram is included. L.T.

A85-15608

EXPLICIT CONSTRAINT APPROXIMATION FORMS IN STRUCTURAL OPTIMIZATION. II - NUMERICAL EXPERIENCES

B. PRASAD (Ford Motor Co., Dearborn, MI) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 46, Sept. 1984, p. 15-38. refs

A numerical study of explicit constraint approximation forms as applied to structural design is presented. Seven structural examples for design optimization are considered in order to assess the effectiveness of simple forms and generalized power approximation forms. A total of 13 test cases, differing mainly in the starting values for the design parameters or the forms of linking relationship used, is considered. The effect of tuning parameters on the accuracy and conservativeness of constraints is investigated for various approximation forms. Results on numerical efficiency are given as a function of the number of iterations required to obtain optimum designs. C.D.

A85-15815

OPTOELECTRONIC GUIDANCE INSTRUMENTS FOR FLIGHT VEHICLES (4TH REVISED AND ENLARGED EDITION) [OPTIKO-ELEKTRONNYE PRIBORY NAVEDENIIA LETATEL'NYKH APPARATOV /4TH REVISED AND ENLARGED EDITION/]

L. P. LAZAREV Moscow, Izdatel'stvo Mashinostroenie, 1984, 480 p. In Russian. refs

The theory and design of optoelectronic guidance instruments and their principal components are discussed. Attention is given to the physical principles underlying the operation of communication channels, the emission of the target and the environment, and estimation of the pursuit, approach, and interception trajectories. The discussion also covers the design and principle of operation of optoelectronic homing devices, optical systems of homing and guidance instruments, image analyzers, and electromechanical elements of homing and guidance systems. Finally, the optoelectronic instrumentation of flight simulators is examined. V.L.

A85-15833#

CRACK GROWTH LIFE-TIME PREDICTION UNDER AERONAUTICAL TYPE LOADING

G. BAUDIN and M. ROBERT (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (European Conference on Fracture, 5th, Lisbon, Portugal, Sept. 17-21, 1984) ONERA, TP, no. 1984-113, 1984, 15 p. refs
(ONERA, TP NO. 1984-113)

The ONERA variable-loading fatigue-crack service-life-prediction model of Baudin and Robert (1981) is extended to account for the effect of material thickness and to permit the determination of the loading parameter for any type of loading. The results of computations for various standard aeronautical loading spectra and for different specimen types, alloys, thicknesses, and load levels are presented in graphs and found to be in good agreement with experimentally determined values. T.K.

A85-15837#

A STRAIGHT CASCADE WIND-TUNNEL STUDY OF FAN BLADE FLUTTER IN STARTED SUPERSONIC FLOW

E. SZECHENYI, I. CAFARELLI, C. NOTIN, and J. P. GIRAULT (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (International Union of Theoretical and Applied Mechanics, Symposium on Unsteady Aerodynamics of Turbomachines and Propellers, Cambridge University, Cambridge, England, Sept. 23-27, 1984) ONERA, TP, no. 1984-117, 1984, 14 p. refs
(ONERA, TP NO. 1984-117)

Two distinct forms of blade flutter are known in started supersonic flow: one in bending and one in torsion. Aerodynamic damping coefficients and unsteady pressure distributions were measured in a straight cascade wind-tunnel at Mach = 1.4 and pressure ratios ranging from 1 to 1.6 and for both heaving and pitching motion. The experimental set-up simulated closely (in two dimensions) conditions near the blade tips of a typical high speed fan. The existence of high pressure ratio bending flutter and low pressure ratio torsional flutter is demonstrated and their causes are explained through measured steady and unsteady pressure distributions. Author

A85-15859

DAMAGE TOLERANCE OF METALLIC STRUCTURES: ANALYSIS METHODS AND APPLICATIONS

J. B. CHANG, ED. (Aerospace Corp., Los Angeles, CA) and J. L. RUDD, ED. (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) Philadelphia, PA, American Society for Testing and Materials , 1984, 155 p. For individual items see A84-15860 to A84-15866.

Procedures, design requirements, and applications of damage-tolerance or fracture-control analysis are examined in contributions to the ASTM Forum on Damage Tolerance Analysis (DTA) held in Los Angeles on June 29, 1981. Topics considered include the general principles of DTA, damage-accumulation techniques in DTA, models of crack-growth retardation and acceleration, the ASTM fatigue-life-prediction round robin, fracture analysis of stiffened structures, application of fracture mechanics on the Space Shuttle, and the US Air Force damage-tolerance design philosophy. Drawings, diagrams, tables, and graphs are provided. T.K.

A85-15861
DAMAGE ACCUMULATION TECHNIQUES IN DAMAGE TOLERANCE ANALYSIS
R. M. ENGLE, JR. (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Damage tolerance of metallic structures: Analysis methods and applications . Philadelphia, PA, American Society for Testing and Materials, 1984, p. 25-35. refs

Damage tolerance analysis requires the capability to assess the damage, usually measured by incremental crack growth, accumulating in a given piece of structure under flight-by-flight spectrum loading. This requirement implies the need to process this damage accumulation over thousands of flights consisting of millions of load cycles. Many models have been developed to analyze the process of damage accumulation under spectrum loading. All these models have been computerized to permit timely cost-effective damage tolerance analyses to be performed. This paper examines the techniques used to perform the damage accumulation process within these computerized models. Techniques range from simple closed-form numerical integration to sophisticated equivalent damage techniques based on statistical representation of the flight-by-flight spectrum. Recommendations for applications to various types of spectra are offered. Author

A85-15862
CRACK GROWTH RETARDATION AND ACCELERATION MODELS
C. R. SAFF (McDonnell Aircraft Co., St. Louis, MO) IN: Damage tolerance of metallic structures: Analysis methods and applications . Philadelphia, PA, American Society for Testing and Materials, 1984, p. 36-49. refs

In predicting crack growth behavior under arbitrary spectrum loads, one must consider the effects of tensile and compressive overloads to retard and accelerate growth. There are two major categories of crack growth models for prediction of retardation and acceleration behavior: yield zone models and closure models. Capabilities and limitations of these models are discussed with respect to accuracy in predicting various growth behaviors. Yielding at notches or holes can significantly alter the retardation behavior caused solely by crack-tip plasticity. Careful analysis of notch plasticity is required to predict behavior of flaws growing from notches under spectrum loading. Author

A85-15864
FRACTURE ANALYSIS OF STIFFENED STRUCTURE
T. SWIFT (FAA, Long Beach, CA) IN: Damage tolerance of metallic structures: Analysis methods and applications . Philadelphia, PA, American Society for Testing and Materials, 1984, p. 69-107. refs

A method, based on displacement compatibility, is presented for the fracture analysis of cracked stiffened structure. The method provides an economical means for the determination of crack-tip stress intensity factors and stiffener stress concentration factors that can be used for parametric crack growth and residual strength studies during the initial design phase of an aircraft structure. The results of a typical parametric study are included. Emphasis is placed on the need to account for stiffener bending stresses in residual strength calculations. This need is supported by test evidence. Fastener shear failure known as unzipping is discussed. An example, supported by test evidence, is shown where this phenomenon can precipitate failure of stiffened structure containing cracks. A method of analysis, based on fastener nonlinear shear displacements, is described, which can account for the effect of fastener failure during the failure process of a cracked stiffened panel. The method is verified by test. Author

A85-15866
AIR FORCE DAMAGE TOLERANCE DESIGN PHILOSOPHY
J. L. RUDD (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Damage tolerance of metallic structures: Analysis methods and applications . Philadelphia, PA, American Society for Testing and Materials, 1984, p. 134-141.

This paper summarizes the U.S. Air Force damage tolerance design requirements for metallic airframes. The requirements are a function of the design concept and degree of inspectability of the airframe. Both analytical and experimental requirements are presented. The requirements include the initial damage size, shape, and location, which must be assumed in design. Also presented are the subsequent crack growth and residual strength requirements, which must be satisfied because of the presence of this initial damage. Author

A85-15937
THE MEASUREMENTS OF DRAG RESULTING FROM SMALL SURFACE IRREGULARITIES IMMERSED IN TURBULENT BOUNDARY LAYERS
M. G. HIGAZY and D. J. COCKRELL (Leicester, University, Leicester, England) Experiments in Fluids (ISSN 0723-4864), vol. 2, no. 4, 1984, p. 197-202. refs

Different methods for measuring the drag of small two-dimensional surface irregularities are considered. The presssure distribution technique is employed to measure the drag of small backward-facing steps in six different free stream pressure gradient flows. Results obtained show that Gaudet and Johnson's logarithmic drag coefficient relationship for zero pressure gradient is valid over a wide range of pressure gradients. Author

A85-15962#
DEVELOPMENT OF A FILAMENT WOUND COMPOSITE SHAFT FOR AN AIRCRAFT GENERATOR
R. S. RAGHAVA (Westinghouse Research and Development Center, Pittsburgh, PA) and E. F. HAMMOND (Westinghouse Electric Corp., Electrical Systems Div., Lima, OH) IN: Reinforced Plastics/Composites Institute, Annual Conference, 39th, Houston, TX, January 16-19, 1984, Preprints . New York, Society of the Plastics Industry, Inc., 1984, p. 11-F-1 to 11-F-5.

This paper describes the development of graphite/epoxy and glass/epoxy filament wound composite shafts for a 20 kVA military aircraft generator. The influence of mandrel types on the filament winding process and on the performance of the shaft is discussed. The effect of winding angles on mechanical properties of the shafts was evaluated. A fixture was designed and used for static testing of the shafts under both combined bending-torsion and pure bending loads. Rectangular rosettes were used at several locations on the shafts and principal strains were calculated. Author

N85-11986# Ogden Air Logistics Center, Hill AFB, Utah.
AIR FORCE, ROBOTIC PAINTING
R. V. GRABLER *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 307-314 1983
(AD-P004006) Avail: NTIS HC A21/MF A01 CSCL 13H

This paper briefly reviews Ogden ALC's proposed applications of robotics in an aerospace industrial facility. Specifically the paper presents their experiences with the Devilbiss/Trallfa TR-3500 robot that is used for stripping and painting U.S. Air Force Sidewinder missiles at the Ogden depot. GRA

N85-11988# Defense Logistics Agency, Alexandria, Va.
DEPOT MODERNIZATION AT THE DEFENSE LOGISTICS AGENCY
T. L. KIRKHAM *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 364-367 1983
(AD-P004008) Avail: NTIS HC A21/MF A01 CSCL 15E

Since DLA has a mission of storing and handling hazardous materials in our depots and disposal sites, there are some areas of potential application of robotics for the sake of safety and health of our employees. The author concludes that: (1) DLA's investment in robotics equipment will be primarily in support of automated/mechanized materials handling systems, and (2) Since

DLA is oriented towards buying off-the-shelf equipment, whatever is available in robotics equipment as a proven materials handling device will be considered for application in our depots. GRA

N85-11989# Air Force Logistics Command, Wright-Patterson AFB, Ohio.
LASER PAINT REMOVAL
T. MALLETS *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 368-371 1983
(AD-P004009) Avail: NTIS HC A21/MF A01 CSCL 13H
The Laser Paint Stripper program is a three phase effort which includes: feasibility demonstration; prototype optimization; and implementation at our Air Logistic Centers (depots) by FY88. Major technical areas that make up the automated system include: (1) laser device with power and uptime to handle the number and size of aircraft (F-16 vs C-5A); (2) the beam transport and manipulation system; (3) controls for beam/aircraft safety, alignment, and surface condition sensors; (4) integration software; and (5) cleanup of residue products. GRA

N85-11991# San Antonio Air Logistics Center, Kelly AFB., Tex.
FUTURE ROBOTICS PROGRAM AT SAN ANTONIO ALC (AIR LOGISTICS CENTER)
D. FERRY *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 381-384 1983
(AD-P004011) Avail: NTIS HC A21/MF A01 CSCL 13H
The main thrust of a 1982 study is the identification of six candidates for best application of robotic and automation. These six were then designed, cost estimated, and analyzed for cost/benefit and return on investment for possible future implementation. They are: Robotic Machine Vision Inspection Station; Robotic Material Handling System; Robotic Deriveting System; Robotic Welding Station; Robotic Rework Station; and Robotic Inspection Station (F100 Flame Holder). The processes recommended are for high production and difficult to repair components. We intend to pursue these six projects during FY84 through 1986 timeframe, as potential initiatives in the productivity, reliability, availability, maintainability program (PRAM). GRA

N85-11992# Sacramento Air Logistics Center, McClellan AFB, Calif.
ROBOTICS IN NONDESTRUCTIVE INSPECTION AT SACRAMENTO AIR LOGISTICS CENTER
D. FROOM *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 385-390 1983
(AD-P004012) Avail: NTIS HC A21/MF A01 CSCL 14B
Topics include: On-aircraft Maneuverable Real Time X-ray Inspection System; and On-aircraft Maneuverable Radiography Inspection System. GRA

N85-11993# Naval Supply Center, San Diego, Calif.
SUPPLY CENTER PROCESSES
A. SENHEN *In* Defense Systems Management Coll. DoD Robotics Appl. Workshop Proc. p 438-461 1983
(AD-P004014) Avail: NTIS HC A21/MF A01 CSCL 15E
The Naval Supply Centers supply the material needs for the fleet and shore activities including virtually all parts, provisions, and fuel needed to sustain day-to-day operations. (The Supply Centers are not responsible for maintaining or distributing ordnance). GRA

N85-12003# Joint Publications Research Service, Arlington, Va.
MINISTRY WANTS BETTER COMMO FACILITIES FOR AGROAVIATION
In its USSR Rept.: Transportation (JPRS-UTR-84-028) 4 Oct. 1984 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 25 Aug. 1984 p 2
Avail: NTIS HC A06/MF A01
A decree was issued making it incumbent upon managers of both territorial administrations and those in the ministry's central organization to take the necessary steps to further improve radio communications support for aircraft operations in the national economy. The problem of stocks of uninstalled costly radio and electrical equipment at aviation enterprises was investigated and a decree was also issued mandating installation and operation of this equipment. Penalties for noncompliance were established. A.R.H.

N85-12202# Cambridge Univ. (England). Dept. of Engineering.
ACTIVITIES REPORT OF THE DEPARTMENT OF ENGINEERING Annual Report, 1982/83
1983 34 p refs
Avail: NTIS HC A03/MF A01
Acoustics, aerodynamics, fluid mechanics, design, electrical, materials science, mechanical, control, robotics, soil mechanics, structural engineering, thermodynamics, and turbomachine engineering research are described. Author (ESA)

N85-12230# Joint Publications Research Service, Arlington, Va.
MEASUREMENTS OF POLARIZATION CHARACTERISTICS OF RADIATION FIELD OF ON-BOARD AIRCRAFT ANTENNAS Abstract Only
E. D. GAZAZYAN and V. G. PANCHENKO *In its* USSR Rept.: Electron. and Elec. Engr. (JPRS-UEE-84-014) p 28 15 Oct. 1984 Transl. into ENGLISH from Metrologiya (Moscow), no. 6, Jun. 1984 p 44-49
Avail: NTIS HC A04/MF A01
A method for measuring the polarization characteristics of onboard antennas is analyzed in which an aircraft following an assigned trajectory is tracked from the ground and its angle of evolution with respect to the center of mass and the signal parameters at the output of the master antenna on the ground are measured. It is determined that rectilinear horizontal trajectories with no pitch or roll of the vehicle should be used. The requirements for the pitch and roll transducers must be made stiffer when selecting angle of measurement means; methods based on measuring amplitude ratios should be used when selecting a method for measuring the polarization characteristics of onboard antennas with arbitrary polarization. Author

N85-12282# Ohio State Univ., Columbus. ElectroScience Lab.
ON AIRCRAFT ANTENNAS AND BASIC SCATTERING STUDIES Final Report
R. C. RUDDUCK, R. J. MARHEFKA, and W. D. BURNSIDE 1 Jul. 1984 8 p
(Contract N62269-80-C-0384)
(AD-A146017; ESL-713303-4; NADC-84081-30) Avail: NTIS HC A02/MF A01 CSCL 20N
This report summaries the work accomplished in each of two areas. The on-aircraft studies involved the GTD (Geometrical Theory of Diffraction) analysis of a strip scatterer in the near field of an antenna. In addition, a method for determining the aperture distribution of a linear array through near field measurements has been developed. The basic scattering studies portion attempts to provide an understanding of ray optical solutions and UTD (Uniform GTD) in particular for the analysis of scattering from basic shapes. Specific examples of scattering from plate models, composite cone frustrums and the near zone effects of a basic aircraft model are presented. GRA

N85-12314*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
VORTEX-GENERATING COOLANT-FLOW-PASSAGE DESIGN FOR INCREASED FILM-COOLING EFFECTIVENESS AND SURFACE COVERAGE
S. S. PAPELL Nov. 1984 24 p refs
(NASA-TP-2388; E-2147; NAS 1.60:2388) Avail: NTIS HC A02/MF A01 CSCL 20D
The thermal film-cooling footprints observed by infrared imagery for three coolant-passage configurations embedded in adiabatic-test plates are discussed. The configurations included a standard round-hole cross section and two orientations of a vortex-generating flow passage. Both orientations showed up to factors of four increases in both film-cooling effectiveness and surface coverage over that obtained with the round coolant passage. The crossflow data covered a range of tunnel velocities

from 15.5 to 45 m/sec with blowing rates from 0.20 to 2.05. A photographic streakline flow visualization technique supported the concept of the counterrotating apability of the flow passage design and gave visual credence to its role in inhibiting flow separation.
M.G.

N85-12315*# Texas A&M Univ., College Station. Dept. of Mechanical Engineering.
HEAT TRANSFER AND PRESSURE DROP IN BLADE COOLING CHANNELS WITH TURBULENCE PROMOTERS Final Report
J. C. HAN, J. S. PARK, and C. K. LEI Washington NASA Nov. 1984 156 p refs
(Contract DA PROJ. 1L1-62209-AH-76)
(NASA-CR-3837; E-2249; NAS 1.26:3837) Avail: NTIS HC A08/MF A01 CSCL 20D

Repeated rib roughness elements have been used in advanced turbine cooling designs to enhance the internal heat transfer. Often the ribs are perpendicular to the main flow direction so that they have an angle-of-attack of 90 deg. The objective of the project was to investigate the effect of rib angle-of-attack on the pressure drop and the average heat transfer coefficients in a square duct with two opposite rib-roughned walls for Reynolds number varied from 8000 to 80,000. The rib height-to-equivalent diameter ratio (e/D) was kept at a constant value of 0.063, the rib pitch-to-height ratio (P/e) was varied from 10 to 20, and the rib angle-of-attack (alpha) was varied from 90 deg to 60 deg to 45 deg to 30 deg respectively. Two types of entrance conditions were examined, namely, long duct and sudden contraction. The heat transfer coefficient distribution on the smooth side wall and the rough side wall at the entrance and the fully developed regions were measured. Thermal performance comparison indicated that the pumping power requirement for the rib with an oblique angle to the flow (alpha = 45 deg to 30 deg) was about 20 to 50 percent lower than the rib with a 90 deg angle to the flow for a given heat transfer duty.
B.W.

N85-12316*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
NUMERICAL STUDIES OF UNSTEADY TRANSONIC FLOW OVER AN OSCILLATING AIRFOIL
W. J. CHYU and S. S. DAVIS Oct. 1984 25 p refs
(NASA-TM-86011; A-9857; NAS 1.15:86011) Avail: NTIS HC A02/MF A01 CSCL 20D

A finite-difference solution to the Navier-Stokes equations combined with a time-varying grid-generation technique was used to compute unsteady transonic flow over an oscillating airfoil. These computations were compared with experimental data (obtained at Ames Research Center) which form part of the AGARD standard configuration for aeroelastic analysis. A variety of approximations to the full Navier-Stokes equations was used to determine the effect of frequency, shock-wave motion, flow separation, and airfoil geometry on unsteady pressures and overall air loads. Good agreement is shown between experiment and theory with the limiting factor being the lack of a reliable turbulence model for high-Reynolds-number, unsteady transonic flows. Author

N85-12324# Illinois Univ., Urbana. Dept. of Mechanical and Industrial Engineering.
MODELING OF PROPULSIVE JET PLUMES--EXTENSION OF MODELING CAPABILITIES BY UTILIZING WALL CURVATURE EFFECTS Interim Report, Sep. 1982 - Jun. 1984
S. E. DOERR Jun. 1984 121 p
(Contract DAAG29-83-K-0043)
(AD-A146262; UILU-ENG-84-4005; ARO-19823.3-EG) Avail: NTIS HC A06/MF A01 CSCL 20D

Modeling of aerodynamic interference effects of propulsive jet plumes, by using inert gases as substitute propellants, introduces design limits. To extend the range of modeling capabilities, nozzle wall curvature effects may be utilized. Numerical calculations, using the Method of Characteristics, were made and experimental data were taken to evaluate the merits of the theoretical predictions. A bibliography, listing articles that led to the present report, is included. Author (GRA)

N85-12330*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
NASA THUNDERSTORM OVERFLIGHT PROGRAM: ATMOSPHERIC ELECTRICITY RESEARCH. AN OVERVIEW REPORT ON THE OPTICAL LIGHTNING DETECTION EXPERIMENT FOR SPRING AND SUMMER 1983
O. H. VAUGHAN, JR. Nov. 1984 57 p refs
(NASA-TM-86468; NAS 1.15:86468) Avail: NTIS HC A04/MF A01 CSCL 14B

This report presents an overview of the NASA Thunderstorm Overflight Program (TOP)/Optical Lightning Experiment (OLDE) being conducted by the Marshall Space Flight Center and university researchers in atmospheric electricity. Discussed in this report are the various instruments flown on the NASA U-2 aircraft, as well as the ground instrumentation used in 1983 to collect optical and electronic signatures from the lightning events. Samples of some of the photographic and electronic signatures are presented. Approximately 4132 electronic data samples of optical pulses were collected and are being analyzed by the NASA and university researchers. A number of research reports are being prepared for future publication. These reports will provide more detailed data analysis and results from the 1983 spring and summer program.
Author

N85-12372# IIT Research Inst., Chicago, Ill.
WEAR AND CORROSION OF COMPONENTS UNDER STRESS AND SUBJECTED TO MOTION Final Report
K. Y. KIM and S. BHATTACHARYYA 5 Mar. 1984 150 p
(Contract N62269-79-C-0702)
(AD-A145781; IITRI-M06060-16; NADC-79137-60) Avail: NTIS HC A07/MF A01 CSCL 20K

The initial two-year study with full rotational motion (NADC-79137-60) was further extended with investigations under oscillatory motion to advance understanding of simultaneously occurring corrosion-wear phenomena in Navy aircraft components, and to use this knowledge to improve reliability in component performance. An additional corrosion-wear parameter, namely, coefficient of friction, was evaluated along with open-circuit potential, corrosion current density, and wear loss, which were statistically analyzed in terms of load, frequency, corrosion inhibitor, and lubricant, as well as run-in time. Corrosion-wear surface morphologies were examined with SEM and EDX, and surface roughness measurements were analyzed. The effect of wear on the corrosion process was very marked for alloys which were able to form a passive film. Disruption of the passive film was the principal factor leading to an increase in corrosion rate and wear loss, while surface deformation by increasing load and motion within the range evaluated appeared to be secondary. An increase in load at a constant frequency did not affect the polarization reaction processes as much as an increase in frequency at a constant load. It was clearly demonstrated that wear phenomena dominate the anodic polarization process, but not the cathodic polarization process. GRA

N85-12384# Centre d'Essais Aeronautique Toulouse (France). Lab. M4m.
THE TA6ZR5D (IMI 685) CHARACTERIZATION IN STRAIN CONTROLLED TESTS. (SPECIMENS OBTAINED FROM A FORGED SPINNING WHEEL) NO. M4-45870 [TA6ZR5D (IMI 685) COMPLEMENT DE CARACTERISATION EN DEFORMATION IMPOSEE (EPROUVETTES PRELEVEES DANS UN ROUET FORGE). PROCES VERBAL DE L'ESSAI NO. M4-458700]
8 Jun. 1984 22 p In FRENCH
(M4-45870) Avail: NTIS HC A02/MF A01

Low cycle strain controlled fatigue tests were performed on 16 specimens of the IMI 685 alloy in order to select the construction material for aircraft engine parts. The results show fatigue characteristics which are clearly lower than those corresponding to the IMI 679 alloy. The difference at 10000 cycles is 100 MPa at 200 C and 200 MPa at 425 C. Author (ESA)

N85-12976*# Rensselaer Polytechnic Inst., Troy, N. Y.
INITIAL SAILPLANE PROJECT: THE RP-1
In its Composite Struct. Mater. p 147 Aug. 1984
Avail: NTIS HC A08/MF A01 CSCL 20K

The annual static loading tests were made on the assembled wing/fuselage structure of the RP-1 sailplane. Simple wing bending and wing bending/torsion tests up to about four G's were made, using sand bag loading on the inverted aircraft. Bending a torsion deflections were measured and compared to those obtained in previous years' tests. It appears that the structure is retaining its original strength and stiffness very well. This aircraft has been disassembled and stored on the Jonsson Engineering Center under ambient, indoor conditions of temperature and humidity. B.W.

N85-12977*# Rensselaer Polytechnic Inst., Troy, N. Y.
SECOND SAILPLANE PROJECT: THE RP-2
In its Composite Struct. Mater. p 149-154 Aug. 1984
Avail: NTIS HC A08/MF A01 CSCL 20K

Progress has been made on the design fabrication and installation of a tension carry-through linkage between the aft parts of the port and starboard wings to resist forward bending deflection on the RP-2 sailplane. In addition, towhook/release mechanisms, landing gear and wheel brake assembly, compound curved sandwich composite fuselage shells and an enclosed trailer to house and transport the complete disassembled aircraft, have all undergone various stages of design, fabrication, installation and testing. B.W.

N85-13139*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FIBER OPTIC DATA BUS USING FREQUENCY DIVISION MULTIPLEXING (FDM) AND AN ASYMMETRIC COUPLER
M. ZANGER (City Univ. of N.Y., Bayside) and L. WEBSTER Oct. 1984 15 p
(NASA-TM-86015; A-9870; NAS 1.15:86015) Avail: NTIS HC A02/MF A01 CSCL 17B

A fiber optic data bus, using frequency division multiplexing (FDM) is discussed. The use of FDM is motivated by the need to avoid central control of the bus operation. A major difficulty of such a data bus is introduced by the couplers. An efficient low loss access coupler with an asymmetric structure is presented, and manufacturing processes for the coupler are proposed. Author

N85-13188# Tectonics Research, Inc., Minneapolis, Minn.
DEVELOPMENT OF A BRAUN LINEAR ENGINE-DRIVEN, HEAT-ACTUATED HEAT PUMP Final Report
Jul. 1984 136 p refs Prepared in cooperation with Honeywell, Inc., Roseville, Minn., and with Honeywell, Inc., Bloomington, Minn.
(Contract DE-AC05-84OR-21400)
(DE84-016647; ORNL/SUB-80-61619-1) Avail: NTIS HC A07/MF A01

The operation of a Braun engine/compressor in a heat pump mode was demonstrated. Performance factors with the carbureted breadboard engine version were on the low side and the range of operation below maximum. Component analyses are summarized and the breadboard design, fabrication, and performance tests are described. R.S.F.

N85-13233*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF TWO INNER-RING OIL-FLOW DISTRIBUTION SCHEMES ON THE OPERATING CHARACTERISTICS OF A 35 MILLIMETER BORE BALL BEARING TO 2.5 MILLION DN
F. T. SCHULLER, S. I. PINEL (Industrial Tectonics, Inc., Rancho Dominquez, Calif.), and H. R. SIGNER (Industrial Tectonics, Inc., Rancho Dominquez, Calif.) Jan. 1985 14 p refs
(Contract NAS3-19779)
(NASA-TP-2404; E-2127; NAS 1.60:2404) Avail: NTIS HC A02/MF A01 CSCL 13I

Parametric tests were conducted with a 35-mm-bore, split-inner-ring ball bearing with a double-inner-land-guided cage. Provisions were made for through-the-inner-ring lubrication. Test condictions were either a thrust load of 667 N (150 lb) or a combined load of 667 N (150 lb) thrust and 222 N (50 lb) radial, shaft speeds from 32000 to 72000 rpm, and an oil-inlet temperature of 394 K (250 deg F). Outer ring cooling was used in some tests. Tests were run with either 50 or 75 percent of the total oil flow distributed to the inner-ring raceway. Successful operation was experienced with both 50% and 75% flow patterns to 2.5 million DN. Cooling the outer ring had little effect on inner-ring temperature; however, the outer-ring temperature decreased as much as 7% at 2.5 million DN. Maximum recorded power loss was 3.1 kW (4.2 hp), and maximum cage slip was 8.7 percent. Both occurred at a shaft speed of 72000 rpm, a lubricant flow rate of 1900 cu/min (0.50 gal/min), a combined load, and no outer-ring cooling. Author

N85-13260# Societe Nationale Industrielle Aerospatiale, Suresnes (France). Lab. Central.
DEFECT DETECTION THRESHOLD IN RIVETED JOINTS, TEST REPORT NO.44-833/F [SEUIL DE DETECTABILITE DES DEFAUTS DANS LES ASSEMBLAGES RIVES, PROCES-VERBAL NO.44-833/F]
D. LECURU 2 Feb. 1984 195 p In FRENCH
(Contract STPA-80.96.025)
Avail: NTIS HC A09/MF A01

The utilization of ultrasonic and Foucault currents for the detection of fatigue cracks in rivet holes is studied in order to determine the levels of detection thresholds and assured detection. Longitudinal aluminum riveted joints of the type used in aircraft structures were tested by operators with different training levels. The apparatus and control methods are described. It is shown that the detection level is significantly dependant on operator expertise. Author (ESA)

N85-13267*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FULL-SCALE CRASH-TEST EVALUATION OF TWO LOAD-LIMITING SUBFLOORS FOR GENERAL AVIATION AIRFRAMES
H. D. CARDEN Dec. 1984 60 p refs
(NASA-TP-2380; L-15764; NAS 1.60:2380) Avail: NTIS HC A04/MF A01 CSCL 20K

Three six place, low wing, twin engine general aviation airplane test specimens were crash tested at the Langley Impact Dynamics Research Facility under controlled free flight conditions. One structurally unmodified airplane was the base line specimen for the test series. The other two airplanes were structurally modified to incorporate load limiting (energy absorbing) subfloor concepts into the structure for full scale crash test evaluation and for comparison with the unmodified airplane test results. Typically, the lowest floor accelerations, the lowest anthropomorphic dummy responses, and the least seat crushing of standard and load limiting seats occurred in the airplanes modified with load limiting subfloors, wherein the greatest structural crushing of the subfloor took place. The better performing of the two load limiting subfloor concepts reduced the peak airplane floor accelerations to -25g to -30g as compared with approximately -40g to -55g for the unmodified airplane structure. Author

N85-13269*# Boeing Commercial Airplane Co., Seattle, Wash.
FLUTTER PARAMETRIC STUDIES OF CANTILEVERED TWIN-ENGINE-TRANSPORT TYPE WING WITH AND WITHOUT WINGLET. VOLUME 1: LOW-SPEED INVESTIGATIONS Final Report, Dec. 1983 - Sep. 1984
K. G. BHATIA and K. S. NAGARAJA Sep. 1984 95 p refs
(Contract NAS1-17539)
(NASA-CR-172410-VOL-1; NAS 1.26:172410-VOL-1) Avail: NTIS HC A05/MF A01 CSCL 20K

Flutter characteristics of a cantilevered high aspect ratio wing with winglet were investigated. The configuration represented a current technology, twin-engine airplane. A low-speed and high-speed model were used to evaluate compressibility effects through transonic Mach numbers and a wide range of mass-density ratios. Four flutter mechanisms were obtained in test, as well as analysis from various combinations of configuration parameters. The coupling between wing tip vertical and chordwise motions was shown to have significant effect under some conditions. It is concluded that for the flutter model configurations studied, the winglet related flutter was amenable to the conventional flutter analysis techniques. B.W.

N85-13270*# Boeing Commercial Airplane Co., Seattle, Wash.
FLUTTER PARAMETRIC STUDIES OF CANTILEVERED TWIN-ENGINE TRANSPORT TYPE WING WITH AND WITHOUT WINGLET. VOLUME 2: TRANSONIC AND DENSITY EFFECT INVESTIGATIONS Final Report, Dec. 1983 - Sep. 1984
K. G. BHATIA and K. S. NAGARAJA Sep. 1984 144 p refs
(Contract NAS1-17539)
(NASA-CR-172410-VOL-2; NAS 1.26:172410-VOL-2) Avail: NTIS HC A07/MF A01 CSCL 20K

Flutter characteristics of a cantilevered high aspect ratio wing with winglet were investigated. The configuration represented a current technology, twin engine airplane. Compressibility effects through transonic Mach numbers and a wide range of mass-density ratios were evaluated on a low speed and high speed model. Four flutter mechanisms were obtained from test, and analysis from various combinations of configuration parameters. It is shown that the coupling between wing tip vertical and chordwise motions have significant effect under some conditions. It is concluded that for the flutter model configurations studied, the winglet related flutter is amenable to the conventional flutter analysis techniques. The low speed model flutter and the high-speed model flutter results are described. E.A.K.

13

GEOSCIENCES

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

A85-15072#
CHARGE SEPARATION IN A FLORIDA THUNDERSTORM
R. D. HILL (California, University, Santa Barbara, CA) Royal Meteorological Society, Quarterly Journal (ISSN 0035-9009), vol. 110, Oct. 1984, p. 1190-1194.
(Contract N00014-80-C-0293)

The locations and movement of a breakdown region in a Florida storm were determined from Doppler radar, radar echoes, lightning detection and ranging, and field change measurements. The storm occurred on Aug. 13, 1978 and exhibited an abrupt large magnitude increase in the electrical burst rate, e.g., 60 events/min. A charge separation model was developed for the burst events and associated field characteristics. Breakdown was projected to occur at 3 kV/cm, and charged particles were regarded as constantly streaming toward equilibrium positions. Positively charged particles dominated over negatively charged particles, and the particles were mainly represented by an ice crystal group. The separation of the particles was caused by aerodynamic forces, i.e., a strong updraft, which also caused the field breakdown. M.S.K.

A85-15425* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SPATIAL VARIATION OF SEA SURFACE TEMPERATURE AND FLUX-RELATED PARAMETERS MEASURED FROM AIRCRAFT IN THE JASIN EXPERIMENT
W. T. LIU (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) and K. B. KATSAROS (Washington, University, Seattle, WA) Journal of Geophysical Research (ISSN 0148-0027), vol. 89, Nov. 20, 1984, p. 10,641-10,644. NASA-supported research. refs
(Contract N0014-80-C-0252)

Spatial variation of some parameters measured on two aircraft flying 100-km box and 200-km triangular patterns at low levels in the atmospheric boundary layer during the Joint Air Sea Interaction Experiment in the North Atlantic was studied. The variation should be representative of summer conditions in mid-latitude oceans. The variance density of remotely sensed sea surface temperature, corrected for sky reflection, is found to depend on the one-dimensional wave number raised to the power of approximately -5/3. Nonuniform clouds add low-frequency variance to observations of a downward looking radiometer and result in steeper slope of the spectra of uncorrected sea surface temperature. Turbulent fluxes of momentum, sensible heat, and moisture were determined with the bulk formulae from the parameters (wind speed, temperature, specific humidity, and sea surface temperature) measured from the aircraft. The averages of these fluxes over each flight leg were compared with the fluxes determined from the parameters averaged over the same leg. The difference is negligible, showing that spatially averaged observations, such as those from spaceborne sensors, can be used in the bulk formulae to evaluate the fluxes. Author

N85-12476 Cornell Univ., Ithaca, N.Y.
AIRPORT NOISE IMPACT PREDICTION AND MEASUREMENT Ph.D. Thesis
A. T. STODDARD, III 1984 244 p
Avail: Univ. Microfilms Order No. DA8415413

The prediction of noise impact based on activity interference is discussed. Nonresidential impact is quantified in terms of the time lost because of the noise intrusion. Residential interference is estimated using a probabilistic model because of the large random element in individual response to aircraft noise. The residential model is developed from the concept of household loss of utility due to increased noise. The methodology developed for estimating airport noise impact is unique in several ways. It incorporates several models for different activities. Nonresidential noise impact is quantified for the first time. Separate models are used for different times of the day, allowing for different numbers of people in residence and for changing sensitivity as home activities change throughout the day. The impact which is predicted based on ctivity interference has an economic meaning and may be used in economic analyses of noise mitigation measures which are proposed for alleviating an airport noise problem.
Dissert. Abstr.

N85-12518 Colorado State Univ., Fort Collins.
A SPATIAL MODEL OF WIND SHEAR AND TURBULENCE FOR FLIGHT SIMULATION Ph.D. Thesis
C. W. CAMPBELL 1984 133 p
Avail: Univ. Microfilms Order No. DA8417080

A three dimensional model which combines measurements of wind shear in the real atmosphere with three-dimensional Monte Carlo simulated turbulence was developed. The measurement of three-dimensional wind shear is a recent development. Measurements were made on a rather coarse (approximately 200 m) grid scale so that high frequency, short length scale turbulence information was not included. The spatial model adds three-dimensional, Monte Carlo simulated turbulence conforming to the von Karman model. The turbulence was generated in the frequency domain and transformed to the space domain using Fast Fourier Transform techniques. With the present model, the wind field over the body of an aircraft can be simulated and all aerodynamic loads and moments calculated. The inclusion of

three-dimensional variation of winds and turbulence is believed to be a significant advance over previous wind simulation models.
Dissert. Abstr.

N85-12521*# National Aeronautics and Space Administration, Washington, D. C.
WIND SHEAR MEASURING ON BOARD AN AIRLINER
P. KRAUSPE May 1984 24 p refs Transl. into ENGLISH of "Scherwindmssungen im Linienflugbetrieb" rept. DFVLR-MITT-80-09 DFVLR, presented at the 10th Symp. on Aircraft Integrated Data Systems, 1980 p 95-119 Symp. held in Aachen, 26-27 Mar. 1980 Original language document was announced as N81-20011 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-3541)
(NASA-TM-77463; NAS 1.15:77463; DFVLR-MITT-80-09) Avail: NTIS HC A02/MF A01 CSCL 04B
A measurement technique which continuously determines the wind vector on board an airliner during takeoff and landing is introduced. Its implementation is intended to deliver sufficient statistical background concerning low frequency wind changes in the atmospheric boundary layer and extended knowledge about deterministic wind shear modeling. The wind measurement scheme is described and the adaptation of apparatus onboard an A300 airbus is shown. Preliminary measurements made during level flight demonstrate the validity of the method. Author (ESA)

N85-12529# National Aeronautical Establishment, Ottawa (Ontario).
AIRCRAFT FLOW EFFECTS ON CLOUD DROPLET IMAGES AND CONCENTRATIONS Aeronautical Note
A. M. DRUMMOND Jun. 1984 38 p
(AD-A146176; NAE-AN-21; NRC-23508) Avail: NTIS HC A03/MF A01 CSCL 04B
Cloud physics measurements by the Twin Otter aircraft are affected to some degree by local flow effects from the wing and from the probe canister. Droplet images and concentration are distorted in the worst case by no more than 20% for an aircraft lift coefficient (C sub L) of 0.75 and by only a few percent for low values of C sub L. Corrections for a Particle Measuring Systems probe mounted on a short pylon at the inboard spanwise location have been given which are based on an experimentally verified model for the flow velocity. GRA

N85-13394# Argonne National Lab., Ill. Geoscience and Engineering Group.
OUTLINE OF A NEW EMISSIONS MODEL FOR MILITARY AND CIVILIAN AIRCRAFT FACILITIES
D. M. ROTE Jan. 1984 60 p
(Contract W-31-109-ENG-38)
(DE84-016455; ANL/EES-TM-253) Avail: NTIS HC A04/MF A01
The proposed computational version of the Airport Vicinity and Air Pollution model and the Air Quality Assessment Model is intended to meet the need for computer models usable by a wider community of users on small, modern minicomputers. A detailed series of computer program flowcharts are presented. These figures show the overall structure of the system as well as the detailed structure of the most important components of the emissions portion of the system. Detailed descriptions of the structures and contents of the major data files used to store input and output data and to transfer data between the independently executable computer codes that make up the entire system are given. An example of a possible interactive data file program designed to simplify the task of compiling and editing the various data files is also presented. DOE

15

MATHEMATICAL AND COMPUTER SCIENCES

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

A85-13502#
INTERACTIVE GRAPHICS FOR GEOMETRY GENERATION - A PROGRAM WITH A CONTEMPORARY DESIGN
W. F. LABOZZETTA, P. E. COLE, and K. E. BORN (Lockheed-Georgia Co., Marietta, GA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 8 p.
(AIAA PAPER 84-2389)
The Interactive Graphics for Geometry Generation (I3G) program allows aerodynamic computational code models to be expeditiously produced, though its support multiple geometry data sources and multiple analysis codes. The approach used emphasizes code-independent data formats and common data operations. Six major functional areas are encompassed by I3G: data base operations, surface manipulation, surface grid-point generation, surface generation, display functions, and output functions. O.C.

A85-13632#
PURSUIT-EVASION BETWEEN TWO REALISTIC AIRCRAFT
B. JARMARK (Saab-Scania AB, Linkoping, Sweden) and C. HILLBERG Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Nov.-Dec. 1984, p. 690-694. Previously cited in issue 19, p. 2894, Accession no. A83-41944. refs

A85-13750
FUNDAMENTALS OF THE GENERAL STRUCTURAL-PHYSICAL THEORY OF FLIGHT INSTRUMENTS [OSNOVY OBSHCHEI STRUKTURNO-FIZICHESKOI TEORII PRIBOROV LETATEL'NYKH APPARATOV]
V. L. MOROCHEVSKII Moscow, Izdatel'stvo Mashinostroenie, 1983, 224 p. In Russian. refs
The general design and the principle of operation of flight instruments are examined from the standpoint of the physical measurement processes and their hardware implementation. The theoretical concepts developed here provide a means for the analysis, synthesis, and design of flight instruments. A new method is proposed for improving the accuracy of instruments, and experimental data illustrating the effectiveness of this method are presented. V.L.

A85-15651
SIMULATION IN ENGINEERING SCIENCES: APPLICATIONS TO THE AUTOMATIC CONTROL OF MECHANICAL AND ENERGY SYSTEMS; PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM, NANTES, FRANCE, MAY 9-11, 1983
J. BURGER, ED. and Y. JARNY, ED. (Ecole Nationale Superieure de Mecanique, Nantes, France) Symposium sponsored by the International Association for Mathematics and Computers in Simulation, IFAC, CNRS, et al. Amsterdam and New York, North-Holland, 1983, 448 p. In English and French. For individual items see A85-15652 to A85-15662.
Simulation of software and hardware for developing, predicting, and controlling various processes and machines are explored. Detailed disruptions of parallel processors for engineering sciences and Fourier methods applied to computational fluid dynamics are presented. The controllability and observability of linear time delay systems and fractional order position control are discussed. Attention is given to simulating and controlling electromagnetic suspension systems, a helicopter, and an aircraft on an approach run in real-time. Optimized control of a robot manipulator and nonlinear coupled control laws for a walking robot are defined. A modular approach is outlined for simulating aircraft performance.

Finally, simulation validation of autoadaptive robot control laws is considered. M.S.K.

A85-15654
CONTROLLABILITY AND OBSERVABILITY OF LINEAR TIME DELAY SYSTEMS
V. M. MARCHENKO (Belorusskii Lesotekhnicheskii Institut, Minsk, Belorussian SSR) IN: Simulation in engineering sciences: Applications to the automatic control of mechanical and energy systems; Proceedings of the International Symposium, Nantes, France, May 9-11, 1983 . Amsterdam and New York, North-Holland, 1983, p. 193-198. refs

The analytical basis and applications of control laws for linear time delay systems are detailed. The concepts of controllability and observability are defined, together with criteria for decisions if the systems are controllable and/or observable. The minimum number of inputs is quantified and modally controllable and stabilizable systems are outlined. The control laws are illustrated in terms of managing a flare maneuver on an aircraft. M.S.K.

A85-15661
MODULAR PROGRAMMING STRUCTURE APPLIED TO THE SIMULATION OF NON-LINEAR AIRCRAFT MODELS
J. A. HOOGSTRATEN and G. A. J. VAN DE MOESDIJK (Delft, Technische Hogeschool, Delft, Netherlands) IN: Simulation in engineering sciences: Applications to the automatic control of mechanical and energy systems; Proceedings of the International Symposium, Nantes, France, May 9-11, 1983 . Amsterdam and New York, North-Holland, 1983, p. 401-408. refs

A sequential technique for defining a basic programming structure for accommodating a mathematical model in a way that is understandable to the user of a simulator is described. A modular system is recommended, so that subsystem boundaries can be precisely defined, and thereby the module input/output before the program is run. The concept is illustrated in terms of a simulation of aircraft motions, with the module boundaries defining the degrees of freedom which the program can simulate, e.g., gyroscopic moments, lift, thrust, etc. The subsystems can account for cross-coupling between parameters, provided the correct computational sequences are defined. A generalized programming equation is presented and illustrated in terms of an aerodynamic model, an autopilot, a landing gear, and aircraft elasticity. The flexibility of the core program is decisive when varying the components and parameters modeled on a host computer. M.S.K.

N85-12627# Aeronautical Research Labs., Melbourne (Australia).
A COMPARATIVE STUDY OF THE FINITE ELEMENT AND BOUNDARY ELEMENT METHODS AS APPLIED TO A BOUNDARY VALUE PROBLEM OF A HARMONIC FUNCTION
T. TRAN-CONG Apr. 1984 21 p
(AD-A146018; ARL-AERO-TM-363) Avail: NTIS HC A02/MF A01 CSCL 12A

The Finite Element and Boundary Element Methods are described with their essential features illustrated using an example of a boundary value problem for a harmonic function. Analysis of the methodical errors is then carried out. This is followed by a consideration of the relative computational advantages of the two methods. GRA

N85-13478*# Michigan Univ., Ann Arbor. Computing Research Lab.
A UNIFIED METHOD FOR EVALUATING REAL-TIME COMPUTER CONTROLLERS: A CASE STUDY
K. G. SHIN, C. M. KRISHNA, and Y. H. LEE 1982 45 p refs
(Contract NAG1-296)
(NASA-CR-174168; NAS 1.26:174168) Avail: NTIS HC A03/MF A01 CSCL 09B

A real time control system consists of a synergistic pair, that is, a controlled process and a controller computer. Performance measures for real time controller computers are defined on the basis of the nature of this synergistic pair. A case study of a typical critical controlled process is presented in the context of new performance measures that express the performance of both controlled processes and real time controllers (taken as a unit) on the basis of a single variable: controller response time. Controller response time is a function of current system state, system failure rate, electrical and/or magnetic interference, etc., and is therefore a random variable. Control overhead is expressed as a monotonically nondecreasing function of the response time and the system suffers catastrophic failure, or dynamic failure, if the response time for a control task exceeds the corresponding system hard deadline, if any. A rigorous probabilistic approach is used to estimate the performance measures. The controlled process chosen for study is an aircraft in the final stages of descent, just prior to landing. First, the performance measures for the controller are presented. Secondly, control algorithms for solving the landing problem are discussed and finally the impact of the performance measures on the problem is analyzed. M.G.

16

PHYSICS

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

A85-12775
THE INVERSE PROBLEM OF AZIMUTHAL CORRELATIONS OF AN ACOUSTIC FAR FIELD AND MODELING OF SOURCES OF JET NOISE [INVERSION DES CORRELATIONS AZIMUTALES DU CHAMP ACOUSTIQUE LOINTAIN ET MODELISATION DES SOURCES DE BRUIT DES JETS]
C. BUTY and D. JUVE (Lyon, Ecole Centrale, Ecully, Rhone, France) Academie des Sciences (Paris), Comptes Rendus, Serie II Mecanique, Physique, Chimie, Sciences de l'Univers, Sciences de la Terre (ISSN 0249-6305), vol. 299, no. 8, Sept. 15, 1984, p. 405-408. In French. refs

An inverse technique is presented for extracting azimuthally correlated coherence modes from a measured set of coherence modes when studying far field jet noise sources. A relation is defined between the coherence and the Fourier series spectra. The relation is examined in terms of a Fredholm equation of the first kind, which can be regularized using the method developed by Phillips (1962), i.e., possible solutions are tested by ascertaining which ones have a minimal norm of the second derivative. In a discretized form, a Lagrange multiplier can be found which will sufficiently smooth the curve of the coherence predictions to reveal peak frequencies. M.S.K.

A85-12880
INFLUENCE OF VISCOSITY ON AERODYNAMIC SOUND EMISSION IN FREE SPACE
T. KAMBE (Tokyo, University, Tokyo, Japan) Journal of Sound and Vibration (ISSN 0022-460X), vol. 95, Aug. 8, 1984, p. 351-360. refs

The equation for aerodynamic sound production and propagation is formulated taking viscosity effects into account. It is shown that the acoustic pressure emitted by a viscous vortex motion localized in space is composed of Moehring's quadrupole and two kinds of monopole. One of the latter is associated with the change of the isotropic part of the Reynolds stress, which also depends on the kinetic energy dissipation. The production of the other monopole suggests that the isotropic part of the Reynolds stress corresponds to the dynamical pressure of fluid motion with vorticity. Thus the vortex system responds dynamically to its change by emitting a monopole sound. The two monopoles have opposite tendencies and the dynamical effect is usually larger in magnitude than the viscous heating effect except for monatomic gases with gamma = 5/3. It is verified that Moehring's quadrupole is equivalent to the quadrupole derived from the nonisotropic part of the Reynolds stress. C.D.

A85-13724
ON THE GENERATION OF SOUND BY TURBULENT BOUNDARY LAYER FLOW OVER A ROUGH WALL
M. S. HOWE (Southampton, University, Southampton, England) Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences (ISSN 0080-4630), vol. 395, no. 1809, Oct. 8, 1984, p. 247-263. refs

The present investigation is concerned with the development of the theory of sound generation by turbulent boundary layer flow over a rough wall. This development is based on an approach in which the sound is treated as a component of the scattered field produced according to classical, ideal fluid diffraction theory, when the near field of the turbulence Reynolds stresses interacts with the surface irregularities. No explicit account has been taken of the influence of surface roughness on the evolution of the boundary-layer turbulence. The turbulence interaction with the wall produces sound of an intensity which varies as the sixth power of the flow velocity at low Mach numbers, in accordance with Curle's (1955) theory of aerodynamic sound production by nonplanar surfaces. G.R.

A85-13955*# Arizona Univ., Tucson.
EFFECT OF AIRFOIL MEAN LOADING ON CONVECTED GUST INTERACTION NOISE
M. R. MYERS and E. J. KERSCHEN (Arizona, University, Tucson, AZ) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 13 p. refs
(Contract NAG3-357)
(AIAA PAPER 84-2324)

The present theoretical model for noise generation when a convected vortical or entropic gust encounters an airfoil at a nonzero angle-of-attack is based on a linearization of the Euler equations for the steady, subsonic flow past the airfoil. Noise generation is found to be concentrated at local regions which scale on the gust wavelength and are present at airfoil leading and trailing edges. Steady loading of the airfoil affects noise generation at the leading and trailing edges in significantly different ways. Parametric calculations are presented which illustrate that, at high frequencies, moderate levels of airfoil steady loading can drastically increase the noise level produced by airfoil-convected gust interactions. O.C.

A85-13956*# Arizona Univ., Tucson.
NOISE PRODUCED BY THE INTERACTION OF A ROTOR WAKE WITH A SWEPT STATOR BLADE
E. ENVIA and E. J. KERSCHEN (Arizona, University, Tucson, AZ) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 11 p. refs
(Contract NAG3-357)
(AIAA PAPER 84-2326)

An analysis is developed for the noise generated by the interaction of rotor viscous wakes and a single swept stator vane. The stator vane spans a channel with infinite parallel walls which contains a uniform subsonic mean flow. High frequency wakes, for which the noise generation is concentrated at the vane leading edge, are considered. The general wake pattern is expanded in spanwise modes and solutions for each mode are derived using the Wiener-Hopf technique applied to the equations in the nonorthogonal coordinates. Closed form expressions for the acoustic farfield are obtained. The results of the analysis are used in parametric calculations of rotor viscous wake-stator vane interactions in order to study the effectiveness of sweep as a noise reduction mechanism. For the cases studied, moderate stator sweep angles produce sizeable reductions in the level of the farfield noise. The presence of rotor wake circumferential lean actually increases the noise reduction produced by moderate stator sweep angles. Author

A85-13958#
ADVANCED TURBOPROP NOISE - A HISTORICAL REVIEW
B. MAGLIOZZI (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 20 p. refs
(AIAA PAPER 84-2261)

Advanced Turboprop (ATP) rotor blades, while expected to meet far-field noise requirements in takeoff and landing, generate cabin noise levels in cruise due to their high tip speed which may create a rather uncomfortable passenger environment. After giving an historical account of previous research efforts in the field of propeller noise determination and reduction, attention is given to noncompact noise theories which are valid for supersonic tip speeds and include nonlinear effects. Acoustic treatments for cabin noise control have been experimentally studied. It is noted that the counterrotation propfan concept presents additional noise-generation mechanisms. O.C.

A85-13959*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ADVANCES IN HIGH SPEED JET AEROACOUSTICS
J. M. SEINER (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 41 p. refs
(AIAA PAPER 84-2275)

This paper provides an assessment from an experimental point of view of the present understanding of high speed jet noise primarily as it pertains to shock containing supersonic jet plumes. The nature of this assessment involves an examination of the complex flow and related acoustic field associated with this problem. A certain emphasis is placed on prediction of the near acoustic field to satisfy a motivation driven by a new set of guiding principles, namely the high performance tactical fighter and second generation space transportation vehicles. The review concludes that after weighing all the experimental evidence, only after consideration of the role of large scale coherent structure is adopted can a consistent unifying theme be achieved to physically interpret and properly predict noise generation by the fundamental mechanisms. Author

A85-13961*# Pennsylvania State Univ., University Park.
TURBULENCE CHARACTERISTICS OF THE NOISE PRODUCING REGION OF AN EXCITED ROUND JET. II - LARGE SCALE STRUCTURE CHARACTERISTICS
C. BALTAS and P. J. MORRIS (Pennsylvania State University, University Park, PA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 13 p. refs
(Contract NSG-1580)
(AIAA PAPER 84-2342)

A conditional sampling of digital hot wire records obtained at several radial positions of an axisymmetric jet indicates the existence of regions within the mixing layer which are more orderly than a fully chaotic turbulent flow. A Fourier decomposition of the flow has shown that most of the turbulent energy is contained in the fundamental frequency of the excitation and the first harmonic. O.C.

A85-13962*# Pennsylvania State Univ., University Park.
TURBULENCE CHARACTERISTICS OF THE NOISE PRODUCING REGION OF AN EXCITED ROUND JET. I - TIME-AVERAGE FLOW PROPERTIES
C. BALTAS and P. J. MORRIS (Pennsylvania State University, University Park, PA) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 12 p. refs
(Contract NSG-1580)
(AIAA PAPER 84-2343)

Experiments were conducted to determine the mean turbulence characteristics of the noise-producing region of a 3 in. cold excited round jet. The jet was excited by plane acoustic waves with a high amplitude of excitation (2 percent of the jet dynamic head), and at a Strouhal number of 0.5. The flow Reynolds number was 280,000. The exit boundary layer was made turbulent by artificially tripping it with sandpaper strips. The data were obtained with single and X-hot-wires and processed in digital form. Mean and higher order statistics were also deduced. The results showed an increase in all three velocity components and stresses. However, most of the increase was noticed from the longitudinal component, while the changes in the radial velocity and the azimuthal component were much smaller. Substantial widening of the jet occurred, accompanied by a shortening of the potential core. Increased rates of production of energy close to the lip-line were a characteristic feature of the mixing region behavior. Author

A85-13963#
THE PREDICTION OF STATIC-TO-FLIGHT CHANGES IN JET NOISE
W. D. BRYCE (Royal Aircraft Establishment, Farnborough, Hants., England) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984. 14 p. refs
(AIAA PAPER 84-2358)
While the static-to-flight changes in the overall level of the jet noise from single-stream circular nozzles can be predicted simply, the spectral changes are complex. By taking account of the changes in the jet refraction, using geometric acoustics, it is shown that excellent spectral predictions can be obtained. Recent flight-simulation tests covering a wide range of jet conditions have resulted in some new observations related to flight effects and this data has been used to develop a new prediction method. Author

A85-14172
ADHESIVE BONDED NOISE SUPPRESSION STRUCTURES FOR COMMERCIAL AND MILITARY AIRCRAFT
F. J. RIEL and P. M. ROSE (Rohr Industries, Inc., Chula Vista, CA) SAMPE Quarterly (ISSN 0036-0821), vol. 16, Oct. 1984, p. 45-50.
Noise suppression requirements for future commercial and military aircraft are reviewed, and methods for reducing noise emissions are summarized. The use of adhesive bonded sandwich structures for acoustic treatment in nacelles is defined, and process parameters and special processes and quality control techniques are discussed. The relative advantage of various concepts are outlined from the standpoint of cost, acoustic performance, and structural efficiency. Author

A85-14895#
NOISE GENERATED BY A SUBSONIC JET
R. LEGENDRE (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 3, May-June 1984, p. 79-81.
A model is presented for calculating the noise emission from a jet. Account is taken of the pressure, the density, the velocity field, weak pressure variations, viscosity and the conductivity of droplets and dusts in an inviscid flow calculation. A logarithmic formulation permits introducing the temperature. The jet is assumed to fly at subsonic speed. The noise field is divided into far and near fields and a rotational field in the boundary layers. Attention is given to transitions between the fields and convection and refraction effects. The model is asserted capable of yielding an exact solution for the acoustic field if sufficient experimental data are forthcoming to validate the computational form. M.S.K.

A85-15330*# Canterbury Univ., Christchurch (New Zealand).
WAVE ENVELOPE AND INFINITE ELEMENT SCHEMES FOR FAN NOISE RADIATION FROM TURBOFAN INLETS
R. J. ASTLEY (Canterbury, University, Christchurch, New Zealand; Missouri-Rolla, University, Rolla, MO) and W. EVERSMAN (Missouri-Rolla, University, Rolla, MO) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1719-1726. Previously cited in issue 10, p. 1474, Accession no. A83-25925. refs
(Contract NAG1-198)

A85-15346*# *Cornell Univ., Ithaca, N.Y.*
EFFECT OF ANGLE OF ATTACK ON ROTOR TRAILING-EDGE NOISE
S.-T. CHOU and A. R. GEORGE (Cornell University, Ithaca, NY) AIAA Journal (ISSN 0001-1452), vol. 22, Dec. 1984, p. 1821-1823. refs
(Contract NAG1-107)
Previous analyses of boundary layer trailing edge noise for large rotors have used zero blade angle of attack as input data. Attention is presently given to the important effects of blade angle of attack changes on rotor trailing edge noise in the case of a UH-1 helicopter. The primary effect is in the low to mid-frequency range, where noise level increases with angle of attack. O.C.

A85-15856#
THEORETICAL STUDY OF HELICOPTER-ROTOR NOISE [ETUDE THEORIQUE DU BRUIT DE ROTORS D'HELICOPTERE]
M. CAPLOT (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (Colloque d'Acoustique Aeronautique, 9th, Compiegne, France, Nov. 14-16, 1984) ONERA, TP, no. 1984-140, 1984, 26 p. In French. refs
(ONERA, TP NO. 1984-140)
The discrete-frequency component of the acoustic emission of a helicopter main rotor is characterized theoretically. Model equations in frequency domain are derived and used to identify thickness noise and loading noise as the principal contributors to discrete-frequency noise in the subsonic regime. Model predictions for thickness noise are presented graphically and shown to be in good agreement with test data. A review of ongoing investigations of quadrupolar noise and blade-vortex interactions as factors in loading noise is provided in an appendix. T.K.

N85-12656# Army Construction Engineering Research Lab., Champaign, Ill.
PREDICTION AND MODELING OF HELICOPTER NOISE Final Report
R. RASPET, M. KIEF, and R. DANIELS Aug. 1984 54 p
(Contract DA PROJ. 4A1-62720-A-896)
(AD-A145764; CERL-TR-N-186) Avail: NTIS HC A04/MF A01 CSCL 20B
Sound exposure level (SEL) data from three Army helicopters were used to test a proposed method for calculating sideline decay developed for fixed-wing aircraft. The Federal Aviation Administration (FAA) and the U.S. Air Force (USAF) have adopted this method for use with fixed-wing aircraft, and it was desired to know if the same method could predict rotary-wing aircraft sideline decay with distance or if a more complex computer model is necessary. The procedure was found accurate for limited altitudes and slant distances. In addition, the sideline decay data were studied using variables known to affect sound attenuation. The purpose was to gain further insight into the mechanisms of sideline decay with distance. Variations in the results suggest an unknown mechanism is contributing to this attenuation. Author (GRA)

N85-12661# Naval Underwater Systems Center, New London, Conn. New London Lab.
DETECTION, CLASSIFICATION, AND EXTRACTION OF HELICOPTER-RADIATED NOISE
R. F. DWYER 25 Jul. 1984 14 p
(Contract DA PROJ. RR0-1405)
(AD-A145993; NUSC-TM-841134) Avail: NTIS HC A02/MF A01 CSCL 20A
Surface ships operating in conjunction with supporting helicopters may experience sonar performance degradation due to the accompanying interference from helicopter-radiated noise. The interference manifests itself in the time domain as impulses due to blade vortex interactions and in the frequency domain as harmonic components from both the main and tail rotors. But these components are not pure sinusoids. In addition, they have non-Gaussian probability distributions. They appear to be caused by frequency modulation due to the rotating blades. The paper discusses detection and classification of helicopter-radiated noise

from cumulative distribution function estimates, autocorrelation estimate, spectrum estimates, and from higher-order moment estimates. After the detection and classification problem is discussed a method to extract the interference by implementing a non-linearity in the frequency domain is presented. It is shown with real helicopter-radiated noise data that autocorrelation estimates can be improved by extracting the interfering components. The extracted components are also available as an enhanced time domain representation. Author (GRA)

N85-12662# Army Construction Engineering Research Lab., Champaign, Ill.
ROTARY-WING AIRCRAFT NOISE MEASUREMENTS: ANALYSIS OF VARIATIONS AND PROPOSED MEASUREMENT STANDARD Final Report
P. D. SCHOMER Sep. 1984 24 p
(AD-A146207; CERL-TR-N-184) Avail: NTIS HC A02/MF A01 CSCL 20A

The Army Installation Compatible Use Zone (ICUZ) Program seeks to safeguard Army Installation operational capability. As part of ICUZ, helicopter noise is assessed using a computerized model developed by the U.S. Air Force and modified by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) for rotary-wing aircraft use. Helicopter source emissions data are required as input to this model. This report explores the statistical variations in helicopter source emissions characterization and recommends a draft measurement standard designed to minimize the effects of these variations. Author (GRA)

N85-12665# Rolls-Royce Ltd., Derby (England).
COMMERCIAL AIRCRAFT NOISE
M. J. T. SMITH 1 Aug. 1984 9 p refs
(PNR-90206) Avail: NTIS HC A02/MF A01

The state of the art in aircraft noise reduction is reviewed. Turbomachinery and exhaust noise; the use of advanced signal detection and source location techniques; and installation effects are discussed. Noise levels are close to those in the pre-jet era. A technology plateau has been reached, where no single engine noise source can be regarded as dominant, and further progress is possible only if significant improvement is made on all fronts. Author (ESA)

N85-12687# Rolls-Royce Ltd., Derby (England). Electronics and Measurement Techniques Dept.
THE APPLICATIONS OF FIBRE OPTICS IN GAS TURBINE ENGINE INSTRUMENTATION
I. DAVIDSON 3 May 1984 12 p refs
(PNR-90209) Avail: NTIS HC A02/MF A01

Fiber optic instrumentation in aircraft engines is reviewed. Data transmission, endoscopy, flame detection, radiation pyrometry, laser anemometry, blade tip clearance sensors, and pinhole cameras are described. Author (ESA)

N85-13549*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
EXPERIMENTAL INVESTIGATION OF SHOCK-CELL NOISE REDUCTION FOR DUAL-STREAM NOZZLES IN SIMULATED FLIGHT Final Report
B. A. JANARDAN, K. YAMAMOTO, R. K. MAJJIGI, and J. F. BRAUSCH Washington NASA Nov. 1984 189 p refs
(Contract NAS3-23166)
(NASA-CR-3846; E-2283; NAS 1.26:3846; R83AEB358) Avail: NTIS HC A09/MF A01 CSCL 20A

Six scale-model nozzles were tested in an anechoic facility to evauate the effectiveness of convergent-divergent (C-D) terminations in reducing shock-cell noise of unsuppressed and mechanically suppressed coannular plug nozzles. One hundred fifty-three acoustic test points with inverted velocity profiles were conducted under static and simulated flight conditions. Diagnostic flow visualization with a shadowgraph and velocity measurements with a laser velocimeter were performed on selected plumes. Shock-cells were identified on the plug and downstream of the plug of the unsuppressed convergent coannular nozzle with truncated plug. Broadband peak frequencies predicted with the two shock-cell structures were correlated with the observed spectra using the measured shock-cell spacings. Relative to a convergent circular nozzle, the perceived noise level (PNL) data at an observer angle of 60 deg relative to inlet, indicated a reduction of (1) 6.5 dB and 9.2 dB with unsuppressed C-D coannular nozzle with truncated plug and (2) 7.7 dB and 8.3 dB with suppressed C-D coannular nozzle under static and simulated flight conditions, espectively. The unsuppressed C-D coannular nozzle with truncated plug, operating at the C-D design condition, had shock-cells downstream of the plug with no shock-cells on the plug. The downstream shock-cells were eliminated by replacing the truncated plug with a smooth extension to obtain an additional 2.4 dB and 3 dB front quadrant PNL reduction, under static and simulated flight conditions, respectively. Other results are discussed. M.G.

N85-13550*# General Electric Co., Cincinnati, Ohio.
EXPERIMENTAL INVESTIGATION OF SHOCK-CELL NOISE REDUCTION FOR SINGLE STREAM NOZZLES IN SIMULATED FLIGHT Final Report
K. YAMAMOTO, J. F. BRAUSCH, T. F. BALSA, B. A. JANARDAN, and P. R. KNOTT Washington NASA Dec. 1984 397 p refs
(Contract NAS3-22514)
(NASA-CR-3845; E-2282; NAS 1.26:3845; R82AEB492) Avail: NTIS HC A17/MF A01 CSCL 20A

Seven single stream model nozzles were tested in the Anechoic Free-Jet Acoustic Test Facility to evaluate the effectiveness of convergent divergent (C-D) flowpaths in the reduction of shock-cell noise under both static and mulated flight conditions. The test nozzles included a baseline convergent circular nozzle, a C-D circular nozzle, a convergent annular plug nozzle, a C-D annular plug nozzle, a convergent multi-element suppressor plug nozzle, and a C-D multi-element suppressor plug nozzle. Diagnostic flow visualization with a shadowgraph and aerodynamic plume measurements with a laser velocimeter were performed with the test nozzles. A theory of shock-cell noise for annular plug nozzles with shock-cells in the vicinity of the plug was developed. The benefit of these C-D nozzles was observed over a broad range of pressure ratiosin the vicinity of their design conditions. At the C-D design condition, the C-D annual nozzle was found to be free of shock-cells on the plug. R.S.F.

N85-13551*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STATIC JET NOISE TEST RESULTS OF FOUR 0.35 SCALE-MODEL QCGAT MIXER NOZZLES
D. E. GROESBECK and C. A. WASSERBAUER Oct. 1984 47 p refs
(NASA-TM-86871; E-2333; NAS 1.15:86871) Avail: NTIS HC A03/MF A01 CSCL 20A

As part of the NASA Quiet Clean General Aviation Turbofan (QCGAT) engine mixer-nozzle exhaust system program, static jet exhaust noise was recorded at microphone angles of 45 to 155 deg relative to the nozzle inlet for a conventional profile coaxial nozzle and three 12-lobed coaxial mixer nozzles. Both flows in all four nozzles are internally mixed before being discharged from a single exhaust nozzle. The conventional profile coaxial nozzle jet noise is compared to the current NASA Lewis coaxial jet noise prediction and after applying an adjustment to the predicted levels based on the ratio of the kinetic energy of the primary and secondary flows, the prediction is within a standard deviation of 0.9 dB of the measured data. The mass average (mixed flow) prediction is also compared to the noise data for the three mixer nozzles with a reasonably good fit after applying another kinetic energy ratio adjustment (standard deviation of 0.7 to 1.5 dB with the measured data). The tests included conditions for the full-scale engine at takeoff (T.O.), cutback (86% T.O.) and approach (67% T.O.). M.G.

N85-13553*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EVALUATION OF THE LANGLEY 4- BY 7-METER TUNNEL FOR PROPELLER NOISE MEASUREMENTS
P. J. BLOCK and G. L. GENTRY, JR. Dec. 1984 29 p refs
(NASA-TM-85721; L-15738; NAS 1.15:85721) Avail: NTIS HC A03/MF A01 CSCL 20A

An experimental and theoretical evaluation of the Langley 4- by 7- Meter Tunnel was conducted to determine its suitability for obtaining propeller noise data. The tunnel circuit and open test section are described. An experimental evaluation is performed using microphones placed in and on the tunnel floor. The reflection characteristics and background noise are determined. The predicted source (propeller) near-field/far-field boundary is given using a first-principles method. The effect of the tunnel-floor boundry layer on the noise from the propeller is also predicted. A propeller test stand used for part of his evaluation is also described. The measured propeller performance characteristics are compared with those obtained at a larger scale, and the effect of the test-section configuration on the propeller performance is examined. Finally, propeller noise measurements were obtained on an eight-bladed SR-2 propeller operating at angles of attack -8 deg, 0 deg, and 4.6 deg to give an indication of attainable signal-to-noise ratios. M.G.

17

SOCIAL SCIENCES

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

A85-13580#
AIR CARGO SUPPORT TECHNOLOGY - ECONOMIC REALITIES
R. G. BRAZIER (Airborne Freight Corp., Seattle, WA) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 5 p.
(AIAA PAPER 84-2514)

The paper deals, in a non-technical manner, with the cost barriers to the development and utilization of new technology designed specifically for the air cargo industry. The history of air cargo is used to demonstrate the evolution of the air cargo carrier and consumer buying patterns based on fundamental changes in the structure of the U.S. manufacturing economy. Emphasis is placed on the cost-to-benefit ratio of employing new technology in the place of readily adaptable existing technology. Author

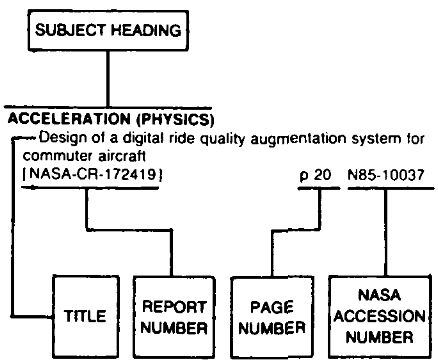
A85-13586#
COMPUTER-AIDED PROJECT DESIGN METHODS USED IN AERONAUTICAL ENGINEERING COURSES
L. R. JENKINSON and D. SIMOS (Loughborough University of Technology, Loughborough, Leics., England) AIAA, AHS, ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 7 p. refs
(AIAA PAPER 84-2526)

Teaching of aircraft project design incorporating computer-aided design methods has been included in aeronautical engineering courses at Loughborough University (England) for the past three years. This paper describes the development of these programs and how they are used in undergraduate and postgraduate courses. This experience has shown advantages in the student's assimulation of the design method and in their appreciation of the often conflicting requirements of aircraft design. The easy access to the design process and the development of a conversational control segment, or driver, has made it possible to use the method on non-engineering courses. Author

N85-12790# Lesley Coll., Cambridge, Mass.
MAINTENANCE MANAGEMENT INFORMATION AND CONTROL SYSTEM (MMICS): ADMINISTRATIVE BOON OR BURDEN
T. P. MURRAY Mar. 1984 59 p
(AD-A145762) Avail: NTIS HC A04/MF A01 CSCL 05B

Thirteen years of Air Force design and development went into the Maintenance Management Information and Control System (MMICS), an automated maintenance information system, because maintenance managers need fast, up-to-date maintenance-related data. MMICS is an on-line computer system accessed through remote terminals located in the work area. These terminals communicate with a central base-level computer via telephone circuits. MMICS has wide application and provides automated information to managers of aircraft, missile and communications-electronic organizations. MMICS is currently in operation at one hundred forty Air Force units located at more than one hundred bases. Approximately eight hundred remote terminals and five hundred line printers are installed and in use worldwide. In aircraft maintenance organizations, MMICS provides information on changing aircraft and equipment conditions, parts requirements, aircraft schedules, equipment status and personnel resources and training. Personnel training is an important aspect of a manager's job and is vital to any organization that must maintain a proficient and experienced work force. The purpose of the project is to examine, determine and evaluate the benefit of the MMICS to managers and supervisors in conducting and monitoring training and training programs within their sections. GRA

Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of the document content, the title extension is added, separated from the title by three hyphens. The (NASA or AIAA) accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

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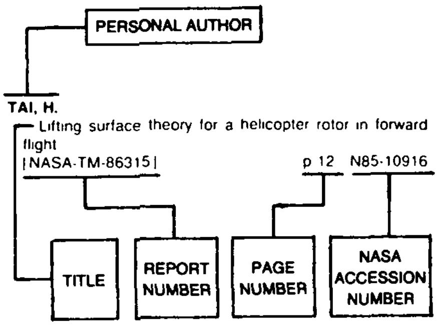
Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title. Under any one author's name the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

A

ABBOUD, M.
Theoretical study of the transonic flow past wedge profiles with detached shock waves p 74 A85-12870

ADACHI, T.
A numerical analysis of unsteady separated flow by the discrete vortex method combined with the singularity method p 81 A85-15884

ADAIR, W. A.
Boeing 737-300 flight test progress report
[AIAA PAPER 84-2464] p 99 A85-13550

ADAMS, D. O.
Fatigue substantiation of the SH-60B stabilator by test
[AIAA PAPER 84-2452] p 98 A85-13541

ADAMSON, T. C., JR.
Forced oscillations of transonic channel and inlet flows with shock waves p 73 A85-12711

ADCOCK, J. B.
Effect of boundary layers on solid walls in three-dimensional subsonic wind tunnels
p 84 N85-12023
Adaptation of a four-wall interference assessment/correction procedure for airfoil tests in the 0.3-m TCT p 85 N85-12035

AGARWAL, R. K.
Numerical solutions of the Euler equations for complex three-dimensional aerodynamic configurations
[AIAA PAPER 84-2399] p 74 A85-13509

AGRELL, N.
A local slot boundary condition for transonic flow calculations in slotted-wall test sections of wind tunnels
[FFA-TN-1984-34] p 88 N85-12879

AKIMOTO, T.
An experimental study on the induced normal force on tail-fins due to wing-tail interference
[NAL-TR-814] p 104 N85-12051

AL-JAAR, R. Y.
Nonlinear model simplification in flight control system design p 114 A85-13631

ALEKSANDROV, M.
Study of effects of lightning on aircraft systems stressed p 90 N85-12005

ALLEN, L. B.
High-temperature optically activated GaAs power switching for aircraft digital electronic control
[NASA-CR-174711] p 116 N85-12901

ALSPACH, D. L.
An approach to the multi-sensor integration problem
p 93 A85-14443

ANDERSON, R.
Design and development of a pultruded FRP laminate to replace aluminum shape in a high stress high fatigue application p 119 A85-15629
Composite nacelle development p 71 A85-15960

ANDREWS, J. W.
Operational evaluation of an experimental TCAS
[AIAA PAPER 84-2407] p 89 A85-13514

ANDRIYICH-VARDA, D.
Flight and wind-tunnel comparisons of the inlet-airframe interaction of the F-15 airplane
[NASA-TP-2374] p 105 N85-12884

ANGELINI, J. J.
Computation of unsteady aerodynamic pressure coefficients in a transonic straight cascade
p 79 A85-14893
Computation of unsteady aerodynamic pressure coefficients in a transonic straight cascade. II
[ONERA, TP NO. 1984-118] p 80 A85-15838

ANSELL, G. S.
Composite structural materials
[NASA-CR-174077] p 121 N85-12966

ARIELI, R.
Lifting rotor analysis at subsonic and transonic flow
p 75 A85-13689

ARNETT, J. B.
Transatmospheric vehicles - A challenge for the next century
[AIAA PAPER 84-2414] p 98 A85-13519

ARNEY, A. M.
Estimation of helicopter performance using a program based on blade element analysis
[AD-A146341] p 105 N85-12055

ASHJAEE, J.
C/A code receivers for precise positioning applications p 95 A85-14838

ASTLEY, R. J.
Wave envelope and infinite element schemes for fan noise radiation from turbofan inlets p 134 A85-15330

ASTRIDGE, D. G.
Advanced gearbox health monitoring techniques
p 124 A85-15171

ATTA, E. H.
Numerical simulation of the transonic flowfield for wing/nacelle configurations
[AIAA PAPER 84-2430] p 76 A85-13964

B

BAILEY, D. G.
Integrated modular flight control - Costs and benefits
[AIAA PAPER 84-2490] p 114 A85-13564

BAILEY, M. L.
Flight test configuration for verifying inertial sensor redundancy management techniques
[AIAA PAPER 84-2496] p 92 A85-13568

BALAN, C.
Performance deterioration of cascades exposed to solid particles p 112 N85-12057

BALASHOV, B. F.
A statistical analysis of the fatigue strength characteristics of turbomachine blades
p 110 A85-14801

BALDWIN, A. W.
Low cost demonstrators for maturing technologies
[AIAA PAPER 84-2472] p 99 A85-13554

BALSA, T. F.
Experimental investigation of shock-cell noise reduction for single stream nozzles in simulated flight
[NASA-CR-3845] p 135 N85-13550

BALTAKIS, F.
An inviscid computational method for supersonic inlets
[AD-A145997] p 86 N85-12042

BALTAS, C.
Turbulence characteristics of the noise producing region of an excited round jet. II - Large scale structure characteristics
[AIAA PAPER 84-2342] p 133 A85-13961
Turbulence characteristics of the noise producing region of an excited round jet. I - Time-average flow properties
[AIAA PAPER 84-2343] p 133 A85-13962

BAR-ITZHACK, I. Y.
GPS aided low cost strapdown INS for attitude determination p 92 A85-13684

BARDAKHANOV, S. P.
Transformation of acoustic disturbances into coherent structures in the turbulent wake of an airfoil
p 75 A85-13794

BARNETT, R. J.
The role of freestream turbulence scale in subsonic flow separation
[NASA-CR-174172] p 87 N85-12870

BARNWELL, R. W.
Wind Tunnel Wall Interference Assessment and Correction, 1983
[NASA-CP-2319] p 82 N85-12011
Effect of boundary layers on solid walls in three-dimensional subsonic wind tunnels
p 84 N85-12023

BAUDIN, G.
Crack growth life-time prediction under aeronautical type loading
[ONERA, TP NO. 1984-113] p 125 A85-15833

BAULIN, V. I.
The fundamentals of the automated design of engines for flight vehicles p 111 A85-15820

BAVUSO, S.
New results in fault latency modelling
p 107 A85-14457

BECKER, J. M.
Development of a pavement maintenance management system. Volume 9: Development of airfield pavement performance prediction models
[AD-A146150] p 117 N85-12069

BEDOYA, C. A.
Artificial intelligence applied to the inertial navigation system performance and maintenance improvement
p 94 A85-14830

BEIGLEMAN, Z.
Further investigation of the coupled flapping and torsion dynamics of helicopter rotor blades p 102 A85-13680

BEITLER, R. S.
Engine control considerations for multifunction nozzles
[AIAA PAPER 84-2454] p 108 A85-13542

BELKIN, A. M.
Air navigation p 93 A85-14638

BEMENT, A. L., JR.
Structural uses for ductile ordered alloys. Report of the committee on application potential for ductile ordered alloys
[AD-A146313] p 119 N85-12139

BENGELINK, R. L.
Wall interference measurements for three-dimensional models in transonic wind tunnels: Experimental difficulties p 82 N85-12012

BENNETT, G.
Determination of aircraft propulsive efficiency and drag using steady state measurements and Lock's propeller model
[AIAA PAPER 84-2500] p 109 A85-13571

BERAK, J. M.
High-temperature optically activated GaAs power switching for aircraft digital electronic control
[NASA-CR-174711] p 116 N85-12901

BERGEY, M.
Design and development of a pultruded FRP laminate to replace aluminum shape in a high stress high fatigue application p 119 A85-15629

BERNDT, S. B.
Interference from slotted walls p 84 N85-12028

BERSON, B. L.
Flight phase status monitor study. Phase 1: Systems concepts
[DOT/FAA/PM-84/18] p 90 N85-12046

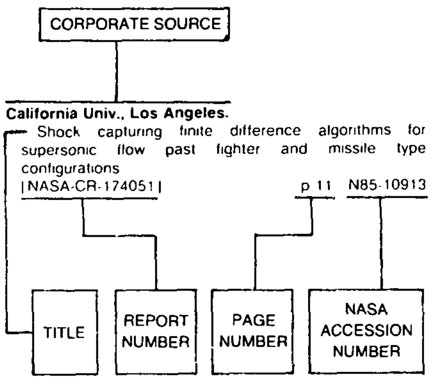
AUTHOR

G

H

CORPORATE SOURCE INDEX

Typical Corporate Source Index Listing



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A

B

C

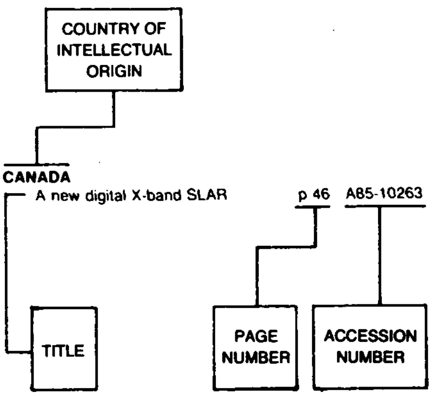
D

E

SOURCE

FOREIGN TECHNOLOGY INDEX

Typical Foreign Technology Index Listing



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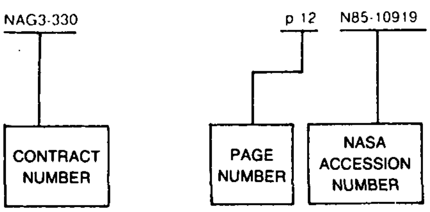
CONTRACT NUMBER INDEX

Typical Contract Number Index Listing



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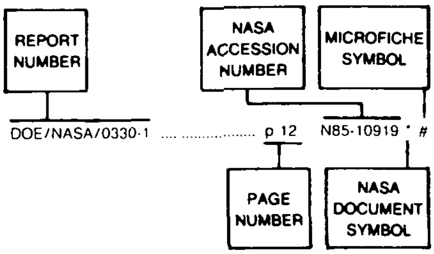

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REPORT

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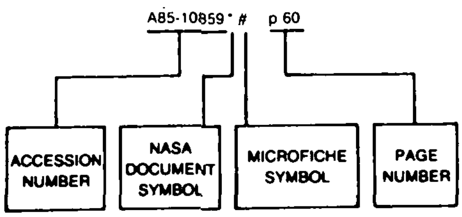

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