

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 145)

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 January 1982 in

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

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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 326 reports, journal articles, and other documents originally announced in January 1982 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 in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes -- subject, personal author, and contract number -- are included.

An annual cumulative index will be published.

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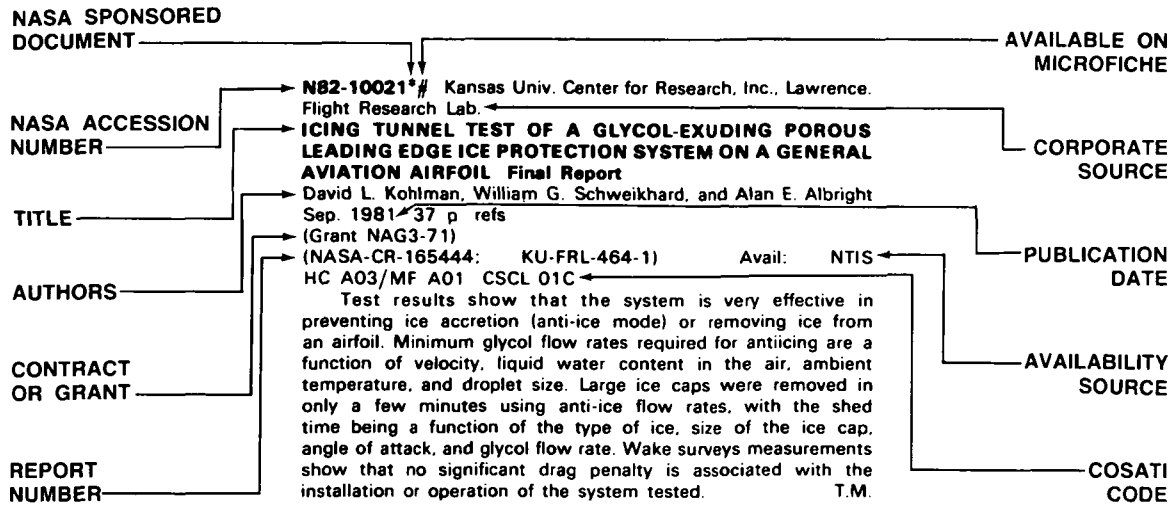
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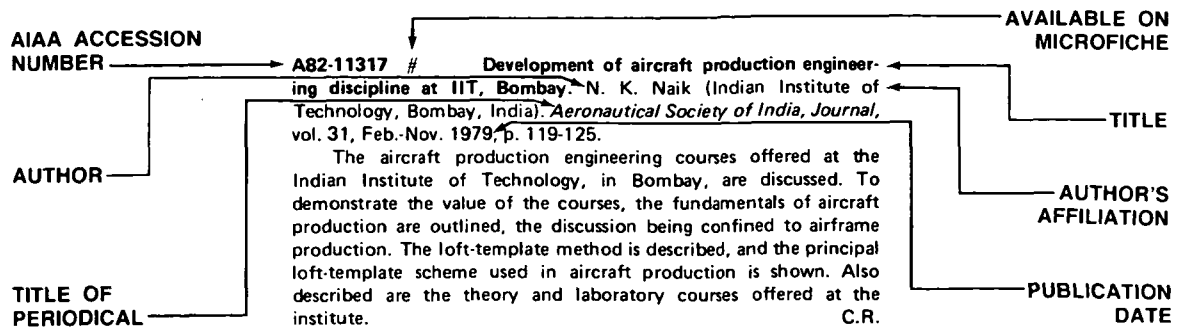
TABLE OF CONTENTS

	Page
IAA ENTRIES (A82-10000)	1
STAR ENTRIES (N82-10000)	25
Subject Index	A-1
Personal Author Index	B-1
Contract Number Index	C-1

TYPICAL CITATION AND ABSTRACT FROM STAR



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AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 145)

FEBRUARY 1982

IAA ENTRIES

A82-10049 Three navigation systems and their costs of acquiring remote sensing data. D. L. Hawley (EG & G, Inc., Las Vegas, NV). In: American Society of Photogrammetry, Annual Meeting, 46th, St. Louis, MO, March 9-14, 1980, ASP Technical Papers. Falls Church, VA, American Society of Photogrammetry, 1980, p. 426-431.

Three types of navigational systems have been analyzed and evaluated as to their capabilities for data acquisition. Two basic systems, visual navigation and strobe-aided navigation, are useful for daylight photographic flights. One additional system, more technical, is the microwave ranging system, crucial to the acquisition of multiple nighttime scanner data flights. These systems have been analyzed as to their capabilities and costs. A table of mission requirements and navigation techniques is presented. These types of studies are not unique, however in this paper, the information is presented in a comparison unique to the equipment involved. This comparison is presented relating the cost of the navigation systems and the costs of their use. The result is a time and dollar comparison of these navigation systems. (Author)

A82-10081 # KC-135 Avionics Modernization Hot Bench. J. L. Archdeacon and C. E. Wilent (TRW Defense and Space Systems Group, Dayton, OH). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 32-40. 10 refs. Contract No. F33600-80-C-0473. (AIAA 81-2105)

The U.S. Air Force has embarked upon an avionics update program for the KC-135 Stratotanker fleet. An overview is provided of the KC-135 Avionics Modernization Hot Bench (AMHB). The objective of the AMHB is to support conceptual definition of a representative KC-135 modernized avionics system. The KC-135 AMHB consists of the Modernization Avionics Suite (MAS), Environmental Systems Simulation (ESS), and the Hot Bench Monitor (HBM). Attention is given to actual avionics hardware, simulated avionic subsystems, avionic application tasks, system control, cockpit device management, guidance and performance management, flight plan management, backup control, and hot bench performance monitoring. The navigation system is also considered. TACAN, Doppler, and Digital Scan Converter data are preprocessed and compared with INS data. G.R.

A82-10082 * # HiMAT onboard flight computer system architecture and qualification. A. F. Myers, M. R. Earls (NASA, Flight Research Center, Edwards, CA), and L. A. Callizo (Rockwell International Corp., Los Angeles, CA). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 41-54. (AIAA 81-2107)

Two highly maneuverable aircraft technology (HiMAT) remotely piloted research vehicles (RPRV's) are being flight tested at NASA Dryden Flight Research Center, Edwards, California, to demonstrate and evaluate a number of technological advances applicable to future fighter aircraft. Closed-loop primary flight control is performed from a ground-based cockpit utilizing a digital computer and up/down

telemetry links. A backup flight control system for emergency operation resides in one of two onboard computers. Other functions of the onboard computer system are uplink processing, downlink processing, engine control, failure detection, and redundancy management. This paper describes the architecture, functions, and flight qualification of the HiMAT onboard flight computer systems. (Author)

A82-10083 # Synchronous fault-tolerant flight control systems. T. B. Smith (Charles Stark Draper Laboratory, Inc., Cambridge, MA). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 55-60. 5 refs. (AIAA 81-2109)

Synchronous fault-tolerant systems have some unique advantages over asynchronous systems, particularly as the flight control task becomes more complex. One of the advantages is related to channel fault-detection. Asynchronous systems must rely upon setting fault thresholds for detecting computational failure within a channel. The design of the threshold can be a difficult problem. There is a rule that a fault must be present for a number of frames to be significant. These problems are largely avoided with synchronous systems, outputs are identical, and a single test of exact agreement is a perfect test. Noisy and skew effects which plague asynchronous fault detection have no effect. Other advantages of synchronous fault-tolerant systems are related to sensor fault-detection and multimode operation. Attention is given to the reasons for the present preponderance of asynchronous designs, and the use of tightly synchronized processing. G.R.

A82-10096 # Integration of computer graphics design with analytical models. R. J. Ricci (Lockheed-California Co., Burbank, CA). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 144-149. (AIAA 81-2134)

The development of Computer-Augmented Design and Manufacturing (CADAM), an interactive computer graphics system is discussed. The system is used throughout the design process from conceptual design through product support. In the conceptual design phase, basic three-view general arrangement drawings are developed. These can be quickly and accurately converted into a three-dimensional mathematical surface definition. From this information, analysis data models are generated semi-automatically for input to batch computing programs. Major areas where analysis modelers have been developed include: parametric mission analysis, aerodynamic drag modelers, structural finite element modelers, 1 g load and mass distribution modelers, fuel tank and volume analyzers, and weight and balance modelers. (Author)

A82-10100 # The Space Shuttle vehicle checkout involving flight avionics software. J. T. B. Mayer (Intermetrics, Inc., Cambridge, MA). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 173-178. (AIAA 81-2141)

A description is presented of the process employed in generating a vehicle test using the flight avionics software. The three types of onboard software available to the verification engineer include flight avionics software, vehicle utility software, and dynamic integrated test software. In most cases the flight software was modified to perform the desired functions in a manner devised by the test

A82-10101

engineer. Attention is given to vehicle test development, test verification, vehicle test execution, and vehicle test considerations. The reported investigation shows that it should be possible in future systems to control the cost of verification and checkout by designing the verification process in conjunction with the operational software. There are operational tradeoffs that can greatly reduce the costs of verification, which in the long run can reduce the total program cost.
G.R.

A82-10101 # Bridging the gap from aircraft to space computers. P. Mitchell and C. Vlcek (Itek Corp., Applied Technology Div., Sunnyvale, CA). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 179-186. 7 refs. (AIAA 81-2142)

This paper investigates the design problems associated with avionics and space computers, and identifies those which are common to both, versus those which are unique to a specific application. Based on historical developments and predictions of future needs, a plan is presented which resolves many of these problems and supports real-time technology insertion in a low cost, rapid deployment approach. A computer development program is described which utilizes a modular family of functional elements, allowing a wide variety of space and aircraft requirements to be met using common hardware. Continuing development activities have expanded this system architecture into a highly fault tolerant and flexible family of computers with incremental design steps depending heavily on existing qualified hardware and software elements.

(Author)

A82-10104 # Airborne associative processor /ASPRO/. T. DiGiacinto (Goodyear Aerospace Corp., Digital Technology Dept., Akron, OH). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 202-205. (AIAA 81-2145)

The ASPRO associative processor is designed for an airborne early warning radar surveillance, command and control application. It augments the existing data processors aboard a surveillance aircraft. The functional requirements of ASPRO call for extraordinary processing capacity for its volume, weight and power constraints (less than 1/2 cubic foot). ASPRO development was made feasible by designing the architecture to make use of available LSI components for arithmetic operations, addressing, program and interrupt control. The memory and parallel processing sections of ASPRO required development of two special components, a multi-chip memory package, and a custom 32-PE chip for the parallel processor.
(Author)

A82-10116 # Controlling the software/hardware interface for the validation of avionics systems. T. G. Lahn and E. R. Rang (Honeywell, Inc., Minneapolis, MN). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 283-287. (AIAA 81-2159)

A methodology is outlined for designing critical embedded avionics by exposing the hardware/software interface during the design and validation of the system. The proposed approach involves the development of a finite-state machine representation for the control of flow of the system's functions and implementation of the finite-state machine by hardware and software. This produces a complete structure that is easy to review and validate. The approach is demonstrated for a triply-redundant flight augmentation system.
V.L.

A82-10120 # Automated Paint and Process Line /APPL/. N. E. Manion (Lockheed-Georgia Co., Marietta, GA). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 319, 321, 323 (3 ff.). (AIAA 81-2166)

In an effort to control costs, the military and industry are pursuing ways to improve production efficiency by increasing the degree of automation of factory operated chemical processing and

painting facilities used in the fabrication of aircraft parts. These parts, and especially those of major weapon systems, are not, however, easily amenable to automation. Critical operations are automated by a five-level control hierarchy developed for a new Automated Paint and Process Line with advanced software which provides operating flexibility. A variety of part sizes and shapes are transformed into uniform handling units by special part holders. The chemical processing computer is programmed to handle ten loads of work simultaneously. A painting robot is programmed by painting a selected target with a spray gun attached to the arm of the manipulator with the robot in a 'teach' mode. Systems will be added later to automatically track shop orders and control chemical solutions.
J.F.

A82-10125 # Use of Space Shuttle technology in conventional aircraft. W. A. Ragsdale (Intermetrics, Inc., Houston, TX). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 358-361. 7 refs. (AIAA 81-2176)

A number of advances in the state-of-the-art for aircraft systems and procedures have been implemented in the Space Shuttle. Much of the new technology used would benefit conventional aircraft, especially airliners. Automatic systems management as employed for the Shuttle would simplify the task of flying an airliner. The pilot is given by the computer only the information he needs to know. The area navigation (RNAV) system used by the Space Shuttle is three-dimensional RNAV. It steers the Space Shuttle not only to a latitude and longitude, but to a specific altitude. The use of a four-dimensional RNAV, including also the monitoring of time, would provide additional advantages. A use of RNAV systems in aircraft makes possible savings in the consumption of fuel and leads to simplifications in air traffic control. Further reduction in fuel consumption can be obtained with the aid of energy management approaches. Additional advantages for aircraft operations can be obtained by the employment of the Microwave Landing System and digital fly-by-wire flight controls.
G.R.

A82-10126 # A microprocessor-based data acquisition system for stall/spin research. M. Sri-Jayantha and R. F. Stengel (Princeton University, Princeton, NJ). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 362-372. 25 refs. Research supported by the Shultz Foundation. (AIAA 81-2177)

Accurate data are necessary for the identification of aerodynamic parameters at high angle of attack and in spinning flight. Modern sensors and microelectronic devices are employed in a stall/spin data acquisition system that will be tested in a Schweizer 2-32 sailplane. This instrumentation package will use a quaternion-based 'strapdown IMU' algorithm to derive vehicle attitude from angular rate data, and it will use fault-detection logic to identify in-flight sensor failures. Details of the system and flight test program are presented, together with results of pre-flight digital simulation analysis.
(Author)

A82-10127 # Real-time, on-line digital simulation of optimum maneuvers of supersonic aircraft. C.-F. Lin (Applied Dynamics International, Ann Arbor, MI). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 373-381. (AIAA 81-2178)

This paper discusses real-time simulation of automatic guidance and control computer system of a supersonic fighter including a complete simulation of the mission computer and the flight control computer before connecting them as hardware in the loop. In this simulation the mission computer generates real-time, on-line optimal trajectories. These trajectories include maximum range glide and minimum time zoom climb. They are then tracked by the flight control computer. For this kind of simulation it is essential that the computational speed be very fast, thus a very fast computer with real-time, on-line capabilities is used for the simulation. Results of the simulation show that the mission computer is capable of generating online optimal trajectories much faster than real time, and

that the flight control computer is capable of following very closely these trajectories at the same speed. (Author)

A82-10140 # Performance analysis of enroute air traffic control computers in the National Airspace System. J. Press (FAA, Systems Research and Development Service, Atlantic City, NJ). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 485-495. 12 refs. (AIAA 81-2203)

This paper describes a computer performance analysis recently completed at the Federal Aviation Administration Technical Center for all twenty enroute air traffic control centers in the National Airspace System. Based on linear regression, the analysis relied on field data collected nationwide in order to quantify the performance of the central computer complex operating at each facility. The data was recorded every minute for several days while the computers were supporting air traffic control operations. Graphs and tables summarize the study's results which will serve as a basis for management plans concerning future system acquisition. As a major conclusion, the methodology developed in this study applies consistently to all enroute traffic control centers. (Author)

A82-10143 # Interoperability testing of decentralized command, control, communications and intelligence /C3I/ systems. E. G. Ries (System Development Corp., McLean, VA) and R. C. Bjorklund (USAF, Tactical Air Command, Langley AFB, VA). In: Computers in Aerospace Conference, 3rd, San Diego, CA, October 26-28, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 513-520. 8 refs. (AIAA 81-2205)

The testing of complex, real-time C3I systems by conventional methods requires considerable resources, time, and realistic operational conditions. The decentralization of systems among diverse locations imposes further demands. Tactical Air Command is developing the Simulation, Monitoring, and Analysis, Reduction, and Test System (SMARTS) to provide a controlled test environment for C3I systems, a design incorporating an operations-scenario generator for efficient test design and analysis. SMARTS is a flexible test platform for Air Force and Joint interoperability testing, configuration management, system testing, and software maintenance. The design of SMARTS provides intercommunications between geographically separated test nodes, test control, recording, analysis, and simulation of radar and data communications for a synchronized test environment. (Author)

A82-10214 * Downbursts and microbursts - An aviation hazard. T. T. Fujita (Chicago, University, Chicago, IL). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 94-101. 12 refs. NSF Grant No. ATM-78-01074; Grants No. NOAA-04-4-158-1; No. NGR-14-001-008.

Downburst and microburst phenomena occurring since 1975 are studied, based on meteorological analyses of aircraft accidents, aerial surveys of wind effects left behind downbursts, and studies of sub-mesoscale wind systems. It is concluded that microbursts beneath small, air mass thunderstorms are unpredictable in terms of weather forecast. Most aircraft incidents, however, were found to have occurred in the summer months, June through August. An intense microburst could produce 150 mph horizontal winds as well as 60 fps downflows at the tree-top level. The largest contributing factor to aircraft difficulties seemed to be a combination of the headwind decrease and the downflow. Anemometers and/or pressure sensors placed near runways were found effective for detecting gust fronts, but not for detecting downbursts. It is recommended that new detection systems placed on the ground or airborne, be developed, and that pilots be trained for simulated landing and go-around through microbursts. J.F.

A82-10215 Applications of conventional and Doppler radars for aviation safety. J. T. Lee and K. E. Wilk (NOAA, National Severe Storms Laboratory, Norman, OK). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 102-109. 24 refs.

Past and present efforts at the National Severe Storms Laborato-

ry to help provide improved operational procedures for aviation support are summarized. Quantitative data presentation and information assimilation now have greater importance, since Doppler radar is evolving toward operational use by weather services. Wind shear, vortices, and turbulence, which constitute weather hazards to aviation, must be identified and measured, and effective ways to disseminate information on the location, intensity, and movement of these hazards to the forecaster and pilot must be found. Despite the progress made thus far, research is still required to better validate radar signatures which identify storm hazards uniquely; even greater advances are needed in the design of displays and types of data parameterizations which will present significant information efficiently to the interpreter. It is suggested that user requirements be included in the designs of future radar systems at an early stage to reduce irrelevant information which complicates displays. J.F.

A82-10217 Description of the meteorological research radar system aboard NOAA/Research Facilities Center WP-3D aircraft. J. D. DuGranut (NOAA, Environmental Research Laboratories, Miami, FL). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 115-117.

The radar system developed for the Research Facilities Center's WP-3D airborne research platform provides data from three radar sets recorded on computer-compatible media: the nose radar scans horizontally over the range + or - 120 deg from the aircraft, heading at tilt angles of + or - 20 deg from the horizon. It operates at C-band frequency (5445 MHz) and has a processed range of 100 nautical miles. The lower fuselage radar scans a full 360 deg horizontally at tilt angles of + or - 10 deg from the horizon; it also operates at C-band frequency (5370 MHz) and has a processed range of 200 nautical miles. The tail radar scans a plane perpendicular to the longitude axis of the aircraft; it operates at X-band frequency (9315 MHz) and has a processed range of 50 nautical miles. The data processing equipment of the radar data system is controlled by video integrator processors, scan converter display units, and magnetic tape units. The radars may be operated without the data system for display of weather avoidance and navigation information when data processing and recording are not required. A more detailed description is given of the receiver/transmitters, the antennas and antenna control units, the video integrator processors, the recording system, and the real-time display system. J.F.

A82-10219 Airborne weather radar and severe weather penetration. J. I. Metcalf (Georgia Institute of Technology, Atlanta, GA). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 125-129. 6 refs.

The effect of rain on airborne weather radar performance and its practical implications are examined. It is shown that whenever the actual reflectivity is greater than 45 dBZ (rainfall rate in excess of 25 mm/hr), significant attenuation (greater than 0.5 dB/km one way) can be expected, leading to major distortions of the reflectivity pattern observed with a 3-cm radar. Examples discussed illustrate the need for aircrews to obtain additional weather information including data from ground-based weather radars at any time when the on-board radar shows weather echoes near the projected flight path, particularly when weather penetration is contemplated. V.L.

A82-10220 * An airport wind shear detection and warning system using Doppler radar. J. McCarthy (National Center for Atmospheric Research, Boulder, CO), W. Frost, B. Terkel (Tennessee, University, Tullahoma, TN), R. J. Doviak (NOAA, National Severe Storms Laboratory, Norman, OK), D. W. Camp (NASA, Marshall Space Flight Center, Huntsville, AL), E. F. Blick, and K. L. Elmore (Oklahoma, University, Norman, OK). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 135-142. 7 refs. NSF Grants No. ATM-74-03406-A02; No. ATM-78-12401; Contracts No. NAS8-31377; No. NAS8-33458.

Two numerical models of aircraft performance are developed to relate atmospheric wind signals in wind-shear situations to aircraft response. Both models produce time histories of pitch angle, airspeed, height above the ground, and other parameters for simulating aircraft making precision approaches along a 3-deg glide

A82-10221

slope to the runway. Simulations conducted using thunderstorm environment wind data indicate that the horizontal wind component is at least as important as the vertical component in determining aircraft response to wind shear. Obtaining quantitative measurements of aircraft approach or departure quality is found to depend on several factors, including the knowledge of winds along the expected flight track, clear-air detection in a quasi-horizontal path, and a near continuous estimate of approach deterioration due to shear conditions. D.L.G.

A82-10221 * **Instrumented aircraft verification of clear-air radar detection of low-level wind shear.** J. McCarthy (National Center for Atmospheric Research, Boulder, CO), K. L. Elmore (Oklahoma, University, Norman, OK), R. J. Doviak, and D. S. Zrnic (NOAA, Severe Storms Laboratory, Norman, OK). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 143-149. NSF Grants No. ATM-74-03406-A02; No. ATM-78-12401; Contracts No. NAS8-31377; No. NAS8-33458.

A technique is described in which the longitudinal wind component at airports, measured by Doppler radar, is put through a Fourier transformation to produce an energy density spectrum. The result is multiplied by the aircraft response characteristics to produce quantitative data on aircraft performance in a wind shear situation. The Doppler radar measurements are made along the intended flight path. Two case studies, along a 3 deg approach path, are described from measurements in two modes: Lagrangian, where predictions were computed one range gate ahead of the plane, and Eulerian, where samples were measured instantaneously along the flight path. Wind data obtained every second were interpolated to fit a numerical model by using a cubic spline. Eulerian data were superior to Lagrangian data in terms of ranging, and nearly equal for wind speeds. Improvements in current 75% accuracy are noted to be possible with shrouded antennas to reduce sidelobes and use of Doppler radar with higher resolution to eliminate effects of small scale disturbances within the pulse volume. M.S.K.

A82-10222 **Detection and display of wind shear and turbulence.** J. Wilson, R. Carbone, and R. Serafin (National Center for Atmospheric Research, Boulder, CO). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 150-156. 9 refs.

Displays of wind shear are given which are obtained by a method for certain cases collected by NCAR 5 cm wavelength radars. A Doppler radar located at an airport or in an aircraft measures the wind shear along flight paths on scales critical to aircraft operations. The magnitude of the shear on the desired scale is then obtained by measuring the wind shear over a distance of one-half the aircraft phugoid wavelength. Four cases classified as severe storms show that significant wind changes occur within 0.5 to 3.0 km, which includes the phugoid wavelength of modern aircraft. It is suggested that a practical solution for the detection of hazardous wind shear is to locate a scanning Doppler at an airport so that quantitative displays of wind changes at the phugoid wavelength can be generated. D.L.G.

A82-10223 **Gust front structure observed by Doppler radar.** R. J. Donaldson, Jr. and C. L. Bjerkaas (USAF, Geophysics Laboratory, Bedford, MA). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 157-161. 6 refs.

Two gust fronts (April 30 and May 2, 1978) are discussed as representative samples of operational data taken during the Joint Doppler Operational Project of 1977-1979. Readings from the 10 cm Doppler radar at Norman, OK, during continuous recording at five or six elevation angles were color coded and displayed for speeds in m/s, range marked at one km intervals, and dated, with time of day indicated. Charts provided show wind direction changes with the passage of a gust front and windspeeds at 0.3 km altitude to be double that of surface wind speeds, a factor considered important for aviators. Extreme wind shears within the fronts were taken as evidence for severe vertical shears, which were not sensed by horizontally scanning radar. The effectiveness of the Doppler radar in identifying and ranging gust fronts commends it to airport use, where

shears invisible to the pilot's eye can be hazardous during takeoff and approach maneuvers at low altitudes. M.S.K.

A82-10225 **The evolution of airborne weather avoidance radar toward a calibrated remote rain gauge using REACT.** J. F. Clark (RCA, Princeton, NJ). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 169-175. 5 refs.

REACT (Rain Echo Attenuation Compensation Technique) is a new digital system that compensates for precipitation attenuation in each small-range increment of each sweep by adaptively increasing the radar receiver sensitivity for the next range increment by an amount equal to the two-way attenuation through the original range increment. A Probable Ground Track and Weather Radar Plot of the Apr. 4, 1977 storm near New Hope, GA was published and used as the ground truth in plotting rainfall data. The storm was first depicted by conventional X-band and C-band radar, and the resolution and range of these bands are compared. REACT was then used with the PriMUS 708 solid-state radar; the plotted result of precipitation attenuation was shown to agree well with the assumed ground truth. The PriMUS 708 airborne radar, compensated with REACT, combines the X-band advantage of higher resolution and antenna gain with an accurate rainfall rate calibration. J.F.

A82-10292 **Multiple Doppler radar observations of PBL structure.** P. H. Hildebrand (National Center for Atmospheric Research, Boulder, CO). In: Conference on Radar Meteorology, 19th, Miami Beach, FL, April 15-18, 1980, Preprints. Boston, MA, American Meteorological Society, 1980, p. 656-661. NSF Grant No. ATM-76-24236.

It is noted that during May and June of 1977, multiple Doppler radars, aircraft and other instrumentation were used to observe the characteristics of the convectively growing planetary boundary layer (PBL) in Central Oklahoma. The observations were made between midmorning and afternoon when the PBL was growing quickly. A preliminary analysis of the data from one of the days is given. It is found that data collected using such a large radar separation appear to be usable to describe large scale PBL kinematics. C.R.

A82-10304 **Helicopter engine technology - With particular reference to the Rolls-Royce Gem engine.** D. Lewis (Rolls-Royce, Ltd., Watford, Herts., England). *Aeronautical Journal*, vol. 85, Sept. 1981, p. 313-319.

A description is presented of the design features incorporated by the Rolls-Royce Gem helicopter engine in light of the following criteria: (1) high structural strength, to withstand low frequency vibration and maneuvering loads; (2) optimization of low altitude performance; (3) operation over a wide power range; (4) high fuel efficiency at part load power; (5) fast and surge-free acceleration and deceleration; (6) insensitivity to intake pressure disturbances; (7) resistance to contaminated intake air; and (8) stability of control. It is observed that in general, the complexities introduced into helicopter engines of the last design generation to improve fuel consumption will be diminished in the next generation of engines for the sake of cost reduction. In addition to the Gem, these engines include the GE T700 and U.S. Army ATDE. O.C.

A82-10305 **The application of improved aluminium alloys and steels in aircraft structures.** C. J. Peel and D. S. McDermid (Royal Aircraft Establishment, Materials Dept., Farnborough, Hants., England). (*Royal Aeronautical Society, Symposium on Developments in Structures and Manufacturing Techniques, London, England, Apr. 14, 1981.*) *Aeronautical Journal*, vol. 85, Sept. 1981, p. 320-326. 16 refs.

It is shown that development efforts in aircraft aluminum alloys and steels over the last 20 years have generally sought to overcome such problems as a lack of resistance to fatigue and stress corrosion cracking rather than achieve increases in specific strength. Significant improvements in fracture toughness and stress corrosion resistance have been achieved, and improved surface treatments are appearing for steel products. Attention is given to new aluminum alloys resulting from the addition of up to 3 wt % Li to Al-Mg, Al-Cu, and Al-Cu-Mg systems, yielding increased stiffness and reduced density. Improvements to 2000- and 7000-series aluminum alloys, rapid

solidification production techniques, and corrosion protection for aircraft steels are also covered. O.C.

A82-10306 **Design aspects of non rigid airship envelopes.** J. A. I. Reid (Airship Industries, Ltd., London, England). (*Royal Aeronautical Society, Symposium on Developments in Structures and Manufacturing Techniques, London, England, Apr. 14, 1981.*) *Aeronautical Journal*, vol. 85, Sept. 1981, p. 327, 328.

The design requirements of nonrigid airship envelopes are addressed in light of recent advances in both (1) the estimation of airship hull loadings under maneuvering and gusts and (2) high-strength fabrics for airship construction woven from polyamide, polyester, and Kevlar fibers. Attention is given to the degree of permeability by helium of hull and ballonnet materials. When determining safety factors for use with such nonmetallic materials, a factor characterizing the degradation of material strength with age must be added to those normally associated with strength calculations. O.C.

A82-10307 **Some possibilities for composite light aircraft construction.** J. H. Webb (Cranfield Institute of Technology, Cranfield, Beds., England). (*Royal Aeronautical Society, Symposium on Developments in Structures and Manufacturing Techniques, London, England, Apr. 14, 1981.*) *Aeronautical Journal*, vol. 85, Sept. 1981, p. 328-331.

Alternative methods for the design and construction of light aircraft and remotely piloted vehicles with composite materials are described, with attention to the minimization of tooling, materials and construction man-hour costs. A four-seat, single-engine light aircraft is assumed for comparison of conventional metal and glass-reinforced plastic composite wing structure construction costs. Weight comparisons are also presented for three novel wing structure design concepts: (1) a tubular spar with plastic foam core and fiberglass-reinforced skin; (2) a similar arrangement incorporating a metal spar; and (3) fiberglass-reinforced plastic foam sandwich skins with a metal spar. The mixed metal/plastic composite structure is incorporated into the Machan RPV, and has proven to be satisfactory in recent flight trials. O.C.

A82-10308 **Light aircraft structural design in non-metallics - Use of composite honeycomb for light aircraft.** G. E. Woodley (Ciba-Geigy Plastics and Additives Co., Duxford, Cambs., England). (*Royal Aeronautical Society, Symposium on Developments in Structures and Manufacturing Techniques, London, England, Apr. 14, 1981.*) *Aeronautical Journal*, vol. 85, Sept. 1981, p. 332, 333.

Recommendations are made toward the application of high-technology prepreg composite systems for the production of nonmetallic honeycomb light aircraft structures. Attention is given to design and assembly methods for wings and control surfaces, with emphasis on the reduction of production costs rather than weight saving. It is shown that the designer's aim should cut down the honeycomb panel piece parts required, thereby reducing the man-hours cost of production, and that the use of composite honeycomb materials results in a more damage-tolerant surface than conventional light aircraft structures, with a more accurate overall shape and reductions of both corrosion and fatigue. O.C.

A82-10309 **Sophisticated aircraft structure developments - Combat aeroplanes.** R. J. Sellars and G. Terry (British Aerospace Public, Ltd., Co., Warton Div., Preston, Lancs., England). (*Royal Aeronautical Society, Symposium on Developments in Structures and Manufacturing Techniques, London, England, Apr. 14, 1981.*) *Aeronautical Journal*, vol. 85, Sept. 1981, p. 334-342. Research supported by the Ministry of Defence (Procurement Executive).

Comparisons of the structural materials and fabrication processes currently under development and assessment in Britain for future combat aircraft construction are presented, with attention to the demonstration of carbon fiber reinforced composites (CFC) and superplastic forming/diffusion bonding of titanium alloy (SPF/DB) in existing aircraft. CFC and SPF/DB structures are compared with respect to specific tensile and compressive strengths and moduli, specific shear strength and modulus, buckling, and ultimate design strengths and design criteria in the application of the materials to the stabilized skins of combat-aircraft surfaces. Emphasis is put on the possibility of aeroelastic tailoring that is introduced by the application of CFC to wing structures. O.C.

A82-10310 **Optimal flight paths for winged, supersonic flight vehicles - Extension to the case where thrust can be vectored.** E. Large (Marconi Space and Defence Systems, Ltd., Stanmore, Middx., England). *Aeronautical Journal*, vol. 85, Sept. 1981, p. 343-348. 5 refs.

A method for determining the optimal trajectory and thrust program of an aircraft or rocket employing vectored thrust is derived, for the practical cases in which the entire thrusting phase is supersonic. It is shown that finding the burning program which gives the Hamiltonian function a zero value automatically satisfies the optimal flight path conditions and makes the final fuel consumption independent of time. It is found that the optimal burning program is not, except in special cases, one that employs constant thrust, the general optimum instead being a linear rate of thrust increase with time. O.C.

A82-10362 # **The use of the Weber method for minicomputer-assisted numerical analysis of airfoils (Zastosowanie metody Webera do numerycznej analizy aerodynamicznej profili na minikomputerach).** K. Czyzewski and M. Lukaszewicz. *Instytut Lotnictwa, Prace*, no. 85, 1981, p. 9-21. 21 refs. In Polish.

A numerical version of the Weber method is developed for calculating pressure distribution over an airfoil in subsonic flow. The method is based on the fact that singularities representing the flow at the airfoil surface are distributed chordwise, and a correction coefficient is introduced, with allowance for airfoil thickness. If the airfoil shape is approximately represented by spline functions, numerical analysis is simplified considerably and the accuracy is improved. The present numerical results are compared with other numerical results for subcritical and supercritical flow conditions, and with wind-tunnel-test results. In addition, an iteration method for determining the critical Mach number has been developed. B.J.

A82-10363 # **Experimental study of subsonic and transonic flows past a wing (Eksperymentalne badania pod- i przydzwiekowego opływu skrzydła).** W. Kania and A. Krzysiak. *Instytut Lotnictwa, Prace*, no. 85, 1981, p. 23-44. 10 refs. In Polish.

The paper reports aerodynamic balance measurements of aerodynamic characteristics and flow visualization tests on a plane trapezoidal uniform-section wing with a small sweepback angle. Tests were performed in a transonic wind tunnel for Mach numbers ranging from 0.3 to 0.96 under conditions of fixed boundary layer transition. Lift, drag, and pitching moment were determined, with attention given to the effect of Mach number. Shock wave formation on the wing is examined, and flow separation and drag rise are determined. Four types of flow separation, depending on Mach number, are revealed; it is found that there is a correlation between the type of flow separation and the value of the lift coefficient at the onset of separation, which depends on the Mach number. B.J.

A82-10364 # **Analytical determination of undercarriage retraction kinematics (Analityczne określenie kinematyki chowania podwozia).** R. Stanczak. *Instytut Lotnictwa, Prace*, no. 85, 1981, p. 45-53. In Polish.

An analytical method is developed for calculating the kinematics of undercarriage retraction. The method is particularly suitable for the design of high-wing and mid-wing monoplanes, the undercarriages of which cannot be attached to the wing. Attention is given to undercarriages with one and two rotation axes. B.J.

A82-10396 **FAA developing new collision avoidance, data acquisition and transmission systems.** A. C. Schwartz. *Airport Forum*, vol. 11, Aug. 1981, p. 93, 94, 96, 97.

The U.S. Federal Aviation Agency (FAA) is concerned with the development of an aircraft collision avoidance system which, it is hoped, will be universally accepted as an aviation standard system. The Discrete Address Beacon System (DABS) contains advanced flight and data link equipment. According to the FAA program, DABS is to become the basis for a ground-based collision avoidance system called the Automatic Traffic Advisory and Resolution Service (ATARS). However, it was recently decided to review the DABS ground station program before a final decision is made regarding the ground installations. Another decision is concerned with the implementation of an airborne collision avoidance system called Threat Alert and Collision Avoidance System (TCAS). The TCAS is to take

the place of the Beacon Collision Avoidance System (BCAS). TCAS will operate independently of ground stations and use a highly directional transmitting antenna. To provide better information for en route air traffic controllers when the main radar system fails, FAA is installing the Direct Access Radar Channel (DARC) at its 20 centers in the continental U.S. G.R.

A82-10401 * # The balloon and the airship technological heritage. N. J. Mayer (NASA, Washington, DC). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1912*. 8 p. 7 refs.

The balloon and the airship are discussed with emphasis on the identification of commonalities and distinctions. The aerostat technology behind the shape and structure of the vehicles is reviewed, including a discussion of structural weight, internal pressure, buckling, and the development of a stable tethered balloon system. Proper materials for the envelope are considered, taking elongation and stress into account, and flight operation and future developments are reviewed. Airships and tethered balloons which are designed to carry high operating pressure with low gas loss characteristics are found to share similar problems in low speed flight operations, while possessing interchangeable technologies. D.L.G.

A82-10403 # Air bag impact attenuation system for the AQM-34V remote piloted vehicle. C. T. Turner (Teledyne Ryan Aeronautical, San Diego, CA) and L. A. Girard, Jr. (Goodyear Aerospace Corp., Akron, OH). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1917*. 8 p.

This paper describes the air bag impact attenuation system (ABIAS) for the AQM-34V remote piloted vehicle. The developed hardware, consisting of the main bag, tail bag, and inflation systems, is described. Operation of the system from electrical initiation, through cover deployment, main and tail bag inflation, and ground impact is discussed. Development ground drop tests, environmental tests, structural tests, and the contractor flight tests are summarized. Test results substantiated system performance. (Author)

A82-10404 # Limiting payload deceleration during ground impact. A. Mironer (Analytical Systems Engineering Corp., Burlington; Lowell, University, Lowell, MA), R. Urquhart (Analytical Systems Engineering Corp., Burlington, MA), and R. Walters (USAF, Geophysics Laboratory, Bedford, MA). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1918*. 7 p.

This paper considers the problem of limiting the deceleration of balloon and sounding-rocket instrument payloads during ground impact by adding energy-dissipating, deformable structures. The basic physics of the two-step deceleration/energy-dissipation process is analyzed and simple force and energy-balance relationships are developed. The pertinent equations are organized in a form that is conducive for computer computation. Two example problems, one of a sounding-rocket payload and the other of a balloon payload are calculated and the results presented in the form of a performance map. (Author)

A82-10405 # Aerodynamics and performance of cruciform parachute canopies. D. S. Jorgensen and D. J. Cockrell (Leicester University, Leicester, England). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1919*. 10 p. 8 refs. Research supported by the Ministry of Defence (Procurement Executive).

Effects of changing the ratio of the arm length and width (the 'arm ratio') on the aerodynamics of cruciform (cross-shaped) parachute canopies are described. Forces and moments were determined from measurements made when fabric canopies were towed under water in a ship tank as well as from integrated pressure distributions determined by using specially-designed pressure transducers fixed in fabric wind tunnel models. Using both techniques, the existence of stochastic variations in aerodynamic behavior was investigated. Experimental results will be analysed using an appropriate computer performance model and the variation of dynamic

performance characteristics thus determined as a function of the arm ratio. (Author)

A82-10406 # Experimental determination of parachute apparent mass and its significance in predicting dynamic stability. T. Yavuz and D. J. Cockrell (Leicester University, Leicester, England). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1920*. 9 p. 6 refs. Research supported by the Ministry of Defence (Procurement Executive) and Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt.

Experimental techniques to measure the components of the apparent mass tensor for parachutes are described. They are evaluated by force and moment measurement during relative motion of parachutes submerged in water in a ship tank. Results show that the components depend on canopy shape, angle of attack and acceleration modulus and, except at high values of the latter, can be considerably in excess of potential flow evaluations. The effect of these results on the dynamic stability of descending parachutes is demonstrated by reference to an appropriate computer model. General conclusions are drawn relevant to canopies whose shapes differ from those tested. (Author)

A82-10407 # Development of new lifting parachute designs with increased trim angle. W. R. Bolton (Sandia Laboratories, Livermore, CA) and I. T. Holt (Sandia Laboratories, Albuquerque, NM). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1921*. 12 p. Research supported by the U.S. Department of Energy.

A development program is being conducted by Sandia National Laboratories on a lifting parachute system which allows aircraft delivery of a payload at high speed from low altitude. Candidate lifting parachute designs, which included ram air inflated leading edge chambers and flow-directing side vents, were evaluated in small and full-scale wind tunnel tests, in whirl tower flight tests, and in aircraft flight tests. The results of these testing activities will be discussed along with the method of using test results to predict system performance. (Author)

A82-10408 # The effects of flexibility on the steady-state performance of small ribbon parachute models. T. Weber (McDonnell Aircraft Co., St. Louis, MO) and W. L. Garrard (Minnesota University, Minneapolis, MN). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1923*. 7 p. 5 refs. Research supported by the U.S. Department of Energy.

Small textile ribbon parachute models were shown to exhibit steady-state aerodynamic coefficients similar to those of rigid parachute models. Since no detailed study of the effects of model flexibility on the steady-state aerodynamic performance of a parachute model has been reported, several ribbon parachute models of varying flexibility and equal geometric porosity were constructed and tested in the wind tunnel. No correlation was found between model flexibility and measured aerodynamic performance. (Author)

A82-10409 # Comparison of simulation and experimental data for a gliding parachute in dynamic flight. T. F. Goodrick (U.S. Army, Natick Research and Development Laboratories, Natick, MA). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1924*. 5 p.

Comparisons are presented of descent rate, total airspeed, horizontal airspeed, yaw rate, pitch rate and roll rate between computer simulation in 6 DOF and flight data for a 200 square foot Parafoil of aspect ratio 2.0 carrying a 350-pound stabilized payload. The payload is specially designed to measure and record all essential parameters of dynamic flight independent of atmospheric wind. The comparison indicates a high degree of agreement in high-rate turns varying greatly from steady-state conditions. Thus, the 6 DOF simulation has been validated. (Author)

A82-10410 # Theoretical analysis of parachute inflation including fluid kinetics. J. W. Purvis (Sandia Laboratories, Albuquerque, NM). *American Institute of Aeronautics and Astronautics,*

Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1925. 12 p. 25 refs. Research supported by the U.S. Department of Energy.

An analysis is presented for predicting parachute inflation. Equations of motion for the complete system are developed from first principles, and are solved with no experimental inputs. Ballistic equations of motion are derived for the canopy, payload, and suspension line masses. However, the enclosed fluid mass is not lumped with the canopy as an apparent mass term. Instead, the fluid conservation equations for a deforming, accelerating control volume are solved to determine the behavior of the captured fluid and its interaction with the canopy. Only first order effects are included, and the analysis is limited to inviscid, incompressible flow. Results for both porous and nonporous canopies are compared with experimental data. (Author)

A82-10411 * # A new thermal and trajectory model for high altitude balloons. L. A. Carlson and W. J. Horn (Texas A & M University, College Station, TX). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1926.* 10 p. 17 refs. Contract No. NAS6-3072.

A new computer model for the prediction of the trajectory and thermal behavior of high altitude balloons has been developed. In accord with flight data, the model permits radiative emission and absorption of the lifting gas and daytime gas temperatures above that of the balloon film. It also includes ballasting, venting, and valving. Predictions obtained with the model are compared with flight data and newly discovered features are discussed. (Author)

A82-10412 # The net-skirt to a parachute canopy as a device to prevent inversion. G. W. H. Stevens. *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1927.* 8 p. 7 refs.

The paper gives a historical account of the circumstances which led to the invention of the net-skirt extension as a device to eliminate parachute canopy inversions, in particular, partial inversions known as 'Blown Peripheries'. Because previous papers do not give a precise account of the mechanism causing the phenomenon it is reanalysed. The paper also records the trends of thought which led to the invention. The phenomenon has been completely eliminated in parachutes modified in this way. Whereas the net-skirt extension solved the difficulties with the Airborne Forces' parachuting system it does not appear to be essential for all deployment systems if adequate line tension can be maintained. Because of the paper's historical nature, Imperial units are used throughout. (Author)

A82-10413 # The constricted rigging line trials technique for assessing the opening characteristics of parachutes. S. A. Birch (Irvin Great Britain, Ltd., Letchworth, Herts., England). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1932.* 8 p. 7 refs.

Constricted rigging line trials of a parachute in which the relationship between the inflation time and the effective line length can be established in drop tests from an aircraft or captive kite balloon, present a simple, quick, cost effective test technique for assessing the performance of a parachute against the known performance of a similar parachute. The technique is being used by Irvin Great Britain Limited as a routine test method for man-carrying and other parachute applications. This paper describes the method of test and gives examples of applications of the technique and the results obtained. (Author)

A82-10414 # A modular asymmetric parachute for wind tunnel testing. P. C. Klimas, H. E. Widdows, and R. H. Croll (Sandia Laboratories, Albuquerque, NM). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1933.* 9 p. Contract No. DE-Ac04-76DP-00789.

The construction of a series of asymmetrical wind tunnel model parachutes designed to a modular concept is described. The static force, inflation force, and dynamic force and motion time history

wind tunnel testing of up to 123 different configurations is discussed. (Author)

A82-10417 # Reductions in parachute drag due to forebody wake effects. C. W. Peterson and D. W. Johnson (Sandia Laboratories, Albuquerque, NM). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1939.* 11 p. 10 refs. Research supported by the U.S. Department of Energy.

The paper evaluates approximate analytic methods for predicting reduction in parachute drag due to forebody wake effects. Velocity distributions are measured behind realistic forebody configurations, and are compared to three turbulent wake velocity models. The velocities are integrated to determine the average effective dynamic pressure acting on the parachute, and comparisons are made of drag loss data and effective dynamic pressure ratios. Predictions are also made for no-fin and finned forebodies with 0 deg, 10 deg, and 20 deg angles of attack. The ratio of measured parachute drag behind a forebody divided by the wake free drag is found to equal the ratio of the average dynamic pressure acting on the parachute divided by the freestream dynamic pressure. Good agreement is found between wake velocity data and theoretical predictions, and the maximum angle of attack providing accurate predictions is determined. D.L.G.

A82-10420 # Stress measurements in a ribbon parachute canopy during inflation and at steady state. T. A. Konicke and W. L. Garrard (Minnesota, University, Minneapolis, MN). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1944.* 10 p. 9 refs. Research supported by the U.S. Department of Energy.

This paper describes the results of an experimental study of canopy stresses in a model ribbon parachute. The distribution of circumferential stress was measured during inflation and at steady state for different values of dynamic pressure. Testing was performed in the wind tunnel at the infinite mass condition. Omega sensors were used to measure stresses and were mounted in different ribbons along the gore centerline. It was found that the steady state stress had two maxima of about equal value. One maxima was near the skirt, the other half-way between the vent and skirt. The distribution of maximum stress during inflation was similar to the steady state distribution and the ratio of maximum stress during inflation to steady state stress ranged from 1.25 to 1.75 and was essentially independent of dynamic pressure. The spectral density of the steady state stress measured at several points on the canopy. (Author)

A82-10421 # Stress measurements in bias constructed parachute canopies during inflation and at steady-state. W. L. Garrard and T. A. Konicke (Minnesota University, Minneapolis, MN). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1945.* 10 p. 8 refs. Research supported by the U.S. Department of Energy.

This paper describes the results of an experimental study of canopy stresses in bias constructed solid flat parachutes. Stresses were measured in the warp and fill directions during inflation and at steady state for different values of dynamic pressure. Omega sensors were used to measure stress. These sensors were mounted along the gore center lines so that the warp and fill stress distributions could be determined as a function of distance from the vent. It was found that stresses in the fill direction were substantially larger than stresses in the warp direction. (Author)

A82-10425 # Aeroballistic characteristics of sonobuoy parachute decelerators limited to a length of three feet. C. T. Caliano (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1950.* 6 p.

Air drop and wind tunnel tests were conducted to verify the stability of sonobuoys with decelerators limited to a total length of 3 feet. This limitation was established for safety reasons. Existing decelerator systems are configured to a length of 5 to 12 feet, with cross-type canopies varying in area from 1.5 to 3.5 square feet.

A82-10427

Sonobuoys are blunt nose right circular cylinders, 4-7/8 inches in diameter, 36 inches long ranging in weight from 12 to 39 pounds. Testing established that 3-foot long decelerators are suitable replacements for the existing configurations. Drag coefficient, opening load, high altitude air descent characteristics, and stability data were determined for different types of decelerators with various area and length. (Author)

A82-10427 # Development of a nylon-Kevlar recovery system for the CL-289 /AN/USD 502/ surveillance drone. D. B. Webb and L. Palm (Irvin Industries Canada, Ltd., Fort Erie, Ontario, Canada). *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1952.* 12 p.

An innovative optimized system has been developed for the automatic recovery of a small (500 lb.) high speed surveillance drone along a precise trajectory. The system requires the use of advanced materials and techniques in order to meet stringent system weight, volume and performance limitations and consists of a two stage highly pressure packed unitized parachute package plus dual landing bags. The specification weight and volume constraints made the maximum use of Kevlar material mandatory for the entire system. Other innovative techniques required included stretch fabric orifices for the landing bags and main parachute opening control features; i.e., continuously variable geometric porosity and use of a special type of auxiliary parachute (Webb chute) positioned in the mouth of the canopy. (Author)

A82-10428 # Inflatable system for fast deployment of parachutes at low altitudes from slow moving aircraft or stationary supports. H. O. Bucker. *American Institute of Aeronautics and Astronautics, Aerodynamic Decelerator and Balloon Technology Conference, 7th, San Diego, CA, Oct. 21-23, 1981, Paper 81-1953.* 6 p. 5 refs.

A preinflated system has been developed for fast expansion and deployment of emergency parachute canopies from buildings or slow-moving aircraft. The model is based on the concept of a quick shape recovery of restrained folded inflated flexible tubing and is tested using modified conventional circular canopies. Three suspension lines are used on buildings at altitudes as low as 25 m, with a 55 kg load. Canopies achieve full deployment at 11 m at normal landing speeds of 4.6 m/sec with a frame expansion time of 0.35 sec. Prototypes tested for slow aircraft achieve a speed of 50 km/hr, with a frame pressure of 4.3 kg/sq cm, and a deployment time of 2 sec. Results indicate that fast expansion and subsequent deployment of canopies operated with portable gas sources can be useful in such sports as hang gliding, or as emergency equipment for firemen in rescue operations. D.L.G.

A82-10455 * # Helicopter rotor trailing edge noise. R. H. Schlinker and R. K. Amiet (United Technologies Research Center, East Hartford, CT). *American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 7th, Palo Alto, CA, Oct. 5-7, 1981, Paper 81-2001.* 26 p. 44 refs. Contract No. NAS1-15730.

An experimental and theoretical study was conducted to assess the importance of trailing edge noise as a helicopter main rotor broadband noise source. The noise mechanism was isolated by testing a rotor blade segment in an open jet acoustic wind tunnel at close to full scale Reynolds numbers. Boundary layer data and acoustic data were used to develop scaling laws and assess a first principles trailing edge noise theory. Conclusions from the isolated blade study were analytically transformed to the rotating frame coordinate system to develop a generalized rotor noise prediction. Trailing edge noise was found to contribute significantly to the total helicopter noise spectrum at high frequencies. (Author)

A82-10456 * # Rotor wake characteristics relevant to rotor-stator interaction noise generation. L. M. Shaw and J. R. Balombin (NASA, Lewis Research Center, Cleveland, OH). *American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 7th, Palo Alto, CA, Oct. 5-7, 1981, Paper 81-2031.* 24 p. 23 refs.

Mean and turbulence wake properties at three axial locations behind the rotor of an aerodynamically loaded 1.2 pressure ratio fan were measured using a stationary cross film anemometer in an anechoic wind tunnel. Wake characteristics at four radial immersions

across the duct at four different fan speeds were determined utilizing a signal enhancement technique. The shapes of the waveforms of the mean rotor relative and mean upwash velocities were shown to change significantly across the span of the blades. In addition, an increase in fan rotational speed caused an increase in the maximum wake turbulence intensity levels near the hub and tip. Spectral analysis was used to describe the complex nature of the rotor wake. (Author)

A82-10457 * # Effects of vane/blade ratio and spacing on fan noise. R. A. Kantola (General Electric Co., Power Generation Group, Lynn, MA) and P. R. Giebe (General Electric Co., Aircraft Engine Group, Cincinnati, OH). *American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 7th, Palo Alto, CA, Oct. 5-7, 1981, Paper 81-2033.* 16 p. 11 refs. Contract No. NAS3-22062.

The effects of vane/blade ratio and spacing on fan noise are investigated to develop a fan noise prediction scheme which is calibrated against experimental data. A 44 blade, 0.504 diameter fan is used to demonstrate the production of fan noise data free from excess noise caused by rotor turbulence interaction. Two stator sets consisting of a cut-off set with 86 vanes, and a cut-on set of 48 vanes are used, with a total range of spacing from 0.5 to 2.3 rotor chords. The model includes viscous wake interaction noise and the potential field interactions of both the rotor and stator. A free-field acoustic environment is achieved by covering the walls, ceiling and floor with 0.7 m polyurethane foam wedges, providing less than + or - 1 dB standing wave ratio at 200 Hz. Only a 3 dB drop in tone level occurs as the spacing is increased from 0.5 to 2.3 rotor chords, and results indicate that the rotor wakes impinging on the stator vanes are the principal noise source for subsonic rotor speeds. D.L.G.

A82-10462 * # Analysis of augmented aircraft flying qualities through application of the Neal-Smith criterion. R. E. Bailey and R. E. Smith (Calspan Advanced Technology Center, Buffalo, NY). *American Institute of Aeronautics and Astronautics, Guidance and Control Conference, Albuquerque, NM, Aug. 19-21, 1981, Paper 81-1776.* 26 p. 9 refs. USAF-NASA-supported research.

The Neal-Smith criterion is examined for possible applications in the evaluation of augmented fighter aircraft flying qualities. Longitudinal and lateral flying qualities are addressed. Based on the application of several longitudinal flying qualities data bases, revisions are proposed to the original criterion. Examples are given which show the revised criterion to be a good discriminator of pitch flying qualities. Initial results of lateral flying qualities evaluation through application of the Neal-Smith criterion are poor. Lateral aircraft configurations whose flying qualities are degraded by roll ratcheting effects map into the Level 1 region of the criterion. A third dimension of the criterion for flying qualities specification is evident. Additional criteria are proposed to incorporate this dimension into the criterion structure for flying qualities analysis. (Author)

A82-10463 # How large should a commuter transport be. R. D. FitzSimmons, J. Seif, and S. C. Nelson (Douglas Aircraft Co., Long Beach, CA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1732.* 12 p. 11 refs.

Definitions of a commuter transport are examined from the viewpoint of a major airframe manufacturer. Selected milestones in commuter air service are reviewed. The impact of deregulation is creating new opportunities for commuter airlines to expand services, resulting in new economic and operating problems. Problems of acquisition and operating costs are discussed. Considerations for commuter transport capacity include number of passengers, frequency of service, airport facilities, and community compatibility. Capacity variations are explored in the 1980s and the 1990s. Some conceptual commuter transport candidates for the future are presented. (Author)

A82-10465 # Design considerations for duty cycle, life and reliability of small limited life engines. D. A. Gries (Williams International Corp., Walled Lake, MI). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1402.* 4 p.

Design requirements, design criteria and verification methods related to preliminary design and program planning for small limited

life turbine engines have significant differences from other engine technologies. Design operating life of components is defined by development test requirements, rather than mission life requirements. Interpolation between operating mission limits is required to demonstrate operating life for limited life engines rather than extrapolation of accelerated testing required for long life. Storage life requirements are very stringent. The correlation of reliability prediction versus accelerated verification testing for engines requiring extended dormant storage is being validated. (Author)

A82-10466 * # Propfan installation aerodynamics of a supercritical swept wing transport configuration. R. C. Smith and A. D. Levin (NASA, Ames Research Center, Moffett Field, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1563*. 14 p. 6 refs.

A semispan model with a powered propeller has been tested to provide data on the installation drag penalty of advanced propfan-powered transports designed to cruise at a Mach number of 0.8. These tests, conducted in 14-foot and 11-foot transonic wind tunnels, are a part of a NASA program to develop efficient, high-speed propellers for more fuel-efficient commercial transports for the 1990s and beyond. The model is instrumented for measuring propeller forces, wing/nacelle forces and moments, and pressure distributions over the wing and nacelle. The body in these tests was nonmetric, being connected to the wing by an RTV seal at the wing/body juncture. Tests were run at angles of attack from -3 to +5 deg over the Mach number range 0.6 to 0.85 at a Reynolds number of about 9,000,000. Results of these tests indicate that the nacelle interference drag can be quite large relative to an uninstalled nacelle. However, the losses due to the nacelle were reduced to acceptable levels by changes to the wing leading edge and nacelle intersection. The propeller slipstream causes substantial changes in the wing span load distribution indicating that twist modifications are needed to recover a more favorable span load distribution. (Author)

A82-10495 # Characteristics and trends of energy consumption in transport missions with aircraft and surface vehicles (Caratteristiche e tendenze del consumo energetico nelle missioni di trasporto con aeroplani e con veicoli di superficie). G. Gabrielli. *Ingegneria*, July-Aug. 1981, p. 193-198. 6 refs. In Italian.

A nondimensional factor is defined which characterizes energy consumption in transport missions. Values of this energy utilization factor are given for a number of aircraft and surface vehicles (e.g., automobiles, buses, and trains). Particular attention is given to the energy utilization factor of turbofan and turbojet aircraft. B.J.

A82-10496 # The possibility of using deformable rubber components in landing gear (Possibilità di impiego di elementi deformabili in gomma in carrelli di atterraggio). C. Caprile and L. Salvioni (Milano, Politecnico, Milan, Italy). *Ingegneria*, July-Aug. 1981, p. 201-212. In Italian.

A test program was devised to evaluate the use of precompressed rubber components as vibration dampers in landing gear for light aircraft. The test program is described, and dynamic and static test results are presented. A dissipationless model is developed which is shown to satisfactorily describe the behavior of the rubber components. B.J.

A82-10497 # Problems relating to the classical rate-gyro (Problematiche relative al rate-gyro di tipo classico). L. Borello (Torino, Politecnico, Turin, Italy). *Ingegneria*, July-Aug. 1981, p. 225-229. In Italian.

A mathematical model is developed for evaluating the accuracy of classical rate-gyros. An analysis is presented of the influence of secondary input signals associated with the angular velocity components of the platform. Ways to minimize the effects of these secondary signals are examined. B.J.

A82-10500 Test Pilots' Aviation Safety Workshop, U.S. Naval Postgraduate School, Monterey, CA, February 25-28, 1981, Proceedings. Workshop sponsored by the Society of Experimental Test Pilots and American Institute of Aeronautics and Astronautics. Edited by C. Tuomela (California Agricultural Aircraft Association, Sacramento, CA), New York, American Institute of Aeronautics and

Astronautics, 1981. 100 p. Members, \$12.50; nonmembers, \$15.

Results are presented of discussions concerning existing and proposed training, equipment and methods for supplying the forecast demand for airline pilots for the period 1985-2000 from the cadre of general aviation. Areas covered include aeromedical education, training and equipment, the air traffic control system, the training and safety aspects associated with cockpit design analysis, pilot and maintenance personnel training accomplished by the fixed base operator, the effects of differences in flying qualities and performances between aircraft on safety and training effectiveness, pilot operating handbooks, regulatory aspects of pilot training and equipment, training and flight simulation programs for commercial pilots, and pilot weather knowledge. A.L.W.

A82-10545 Implementation of AVRADCOM MM&T. G. A. Gorline (U.S. Army, Aviation Research and Development Command, St. Louis, MO). *ManTech Journal*, vol. 6, no. 1, 1981, p. 3-6.

The general implementation plan of the Army Aviation Research and Development Command's (AVRADCOM) efforts in manufacturing methods and technology (MM&T) programs is described. A flowchart of the implementation procedure is presented, and attention is given to several examples of implementation, including a compressor casing, a titanium casting, and aluminum PM parts. B.J.

A82-10547 Composite main rotor tubular braided. M. White (Kaman Aerospace Corp., Bloomfield, CT). *ManTech Journal*, vol. 6, no. 1, 1981, p. 14-16. Army-supported research.

Mechanical tubular braiding has been demonstrated to be a viable blade spar manufacturing process after the completion of a program that included preliminary design of an improved main rotor blade for the OH-58 helicopter. The blade incorporates an advanced aerodynamic shape and has as its primary structural member a Kevlar 49/epoxy spar fabricated by braiding. The achievement of an analytically acceptable blade and spar design satisfying critical structural and dynamic requirements was not hindered by braiding process constraints. B.J.

A82-10646 Navigation task partitioning in distributed-processing avionics systems. J. L. Center (JAYCOR, Woburn, MA). (*Institute of Navigation, National Aerospace Meeting, Warminster, Pa., Apr. 8-10, 1981.*) *Navigation*, vol. 28, Summer 1981, p. 93-100. 10 refs. Contract No. N62269-80-C-0146.

An approach is presented for allocating navigation tasks among multiple processors prior to detailed design and implementation. The method is based on applying rate-distortion techniques from communication theory to navigation system design. All navigation activities are broken down into elementary functions, and rate-distortion methods are used to access the impact on rms position and velocity errors of limiting communication bandwidths among elementary functions. Groups of functions that require high-bandwidth communication are assigned to the same microprocessor, while those that can perform effectively with lower-bandwidth links are separated. The method is illustrated for aircraft motion and sensor errors in the north channel. J.F.

A82-10649 * Improving the MLS through enhanced cockpit displays. R. S. Jensen (Ohio State University, Columbus, OH). (*Institute of Navigation, National Aerospace Meeting, Warminster, Pa., Apr. 8-10, 1981.*) *Navigation*, vol. 28, Summer 1981, p. 138-146. 8 refs. NASA-sponsored research.

A simulator investigation of various prediction and quickening algorithms in computer-generated forward-looking displays is presented; the algorithms are used to improve manual aircraft control on curved microwave landing system approaches. The experimental facility consisted of a Link GAT-2 simulator, a PDP 11/40 minicomputer, a high-speed graphic display, a TV camera, and a CRT monitor. Results indicate that second- and third-order predictor displays provide the best lateral performance and that intermediate levels of prediction and quickening provide the best vertical control. Prediction/quickening algorithms of increasing computational order were found to significantly reduce aileron, rudder, and elevator control responses. The conventional crosspointer displays yielded an average 2-sigma lateral error of + or - 200 over all wind conditions at 500 m from touchdown, and was therefore unable to meet FAA

A82-10650

requirements (+ or - 22.9 m); the pictorial-preview display yielded much better results: an average 2-sigma lateral error of + or - 27 m. Neither display was able to approach the FAA specified accuracy requirement in the vertical dimension (+ or - 3.7 m). J.F.

A82-10650 **Discrete address beacon, navigation and landing system.** R. P. Crow. (*Institute of Navigation, National Aerospace Meeting, Warminster, Pa., Apr. 8-10, 1981.*) *Navigation*, vol. 28, Summer 1981, p. 147-162.

The Discrete Address Beacon, Navigation and Landing System (DABNLS) is an integrated system which will provide not only air traffic control surveillance data and a two-way data link of the FAA's developmental Discrete Address Beacon System, but will provide precision area navigation and versatile landing guidance with a full Category IIIc capability. The DABNLS will utilize a single pair of L-band frequencies for the discretely addressed up-link interrogations and down-link replies. A ground facility will make precise azimuth and range measurements on the bi-phase coded reply pulses, as well as digitally process the reported altitude data to obtain the aircraft's latitude/longitude and other parameters. The data will be used for navigation, collision avoidance and ATC purposes. Multiple channels would be used in terminal areas, each having elevation facilities for landing guidance. Block diagrams of the DABNLS ground subsystem and air-borne transponders are given. J.F.

A82-10816 † **Optimization of the principal design parameters of a passenger aircraft (Optimizatsiia osnovnikh proektnikh parametrov pasazhirskogo litaka).** V. S. Mikalevich, G. M. Iun, and V. M. Kuz'menko. *Akademiia Nauk Ukrain'skoi RSR, Visnik*, vol. 45, Aug. 1981, p. 39-43. 7 refs. In Ukrainian.

A82-10821 # **Strong matching method for computing transonic viscous flows including wakes and separations - Lifting airfoils.** J. C. Le Balleur (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aéropatiale* (English Edition), no. 3, 1981, p. 21-45. 46 refs. Research supported by the Direction des Recherches, Etudes et Techniques.

A method is presented for computing two-dimensional lifting steady viscous flows with wakes and possibly separations inside the viscous layer. A transonic potential calculation is used, which strongly interacts with a defect integral method. A mathematical model is also presented for matching the viscous model for averaged mean velocities with reverse flow, and for turbulent closure in nonequilibrium layers. Numerical coupling is reached through an iterative relaxation technique, and the wake geometry is calculated. The viscous mean flow is determined, and examples of applications to subsonic or supercritical airfoils are given. D.L.G.

A82-10822 # **Electrical ground testing of aircraft antistatic protection.** A. Bruere (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aéropatiale* (English Edition), no. 3, 1981, p. 47-56. 5 refs.

After a review of the methods suggested to ensure aircraft protection regarding electrostatic spurious phenomena, one describes one of the two devices developed at ONERA for ground testing of this protection. These methods give the external surface of the aircraft a conductivity sufficient enough to enable on the one hand the measurement of the surface resistivity of the protected parts even if they are coated with a finishing layer of paint, and, on the other hand, to check the good electrical continuity of each structure element and the aircraft potential reference point. (Author)

A82-10851 **Fluid power technology for the '80s.** Warrendale, PA. Society of Automotive Engineers, Inc. (SAE Proceedings P-85), 1980. 38 p. \$8.00.

Aspects of energy conservation with variable displacement pumps and motors are examined, taking into account approaches for hydraulic power generation, friction loads, elastic loads, regenerative braking, gravity loads, inertia loads, variable displacement pump characteristics, integrated actuator packages, a servopump analysis, a valve analysis, and the computation of pump and motor parameters. High-efficiency hydraulic power transfer units for multisystem aircraft are discussed along with basic approaches for reducing hydraulic system noise in aircraft. A description of developments in boundary layer thrust vector control is also provided. G.R.

A82-10853 **High-efficiency hydraulic power transfer units for multisystem aircraft.** W. E. Boehringer (Douglas Aircraft Co., Long Beach, CA). In: *Fluid power technology for the '80s.* Warrendale, PA, Society of Automotive Engineers, Inc., 1980, p. 15-20.

Multiple pumps are generally employed to provide fully powered aircraft flight controls with a redundant power source. The prime hydraulic source is, in most cases, a pump driven directly by one of the aircraft's engines. This approach provides the most efficient method of converting engine horsepower to hydraulic horsepower. The secondary hydraulic power source is generally not as efficient. Investigations were conducted with the objective to find sources of alternate hydraulic power with improved efficiency. The reasons for the inefficiency of current secondary hydraulic power sources were explored to obtain a basis for the design of systems with a better performance. A unit consisting basically of two hydraulic cylinders mounted back to back was designed and manufactured. The design of this unit was subsequently further improved. It is pointed out that the new hydraulic power transfer units obtained have a comparatively high running efficiency. G.R.

A82-10854 **'Quiet please'.** S. J. Skaistis (Sperry Corp., Sperry Vickers Div., Troy, MI). In: *Fluid power technology for the '80s.* Warrendale, PA, Society of Automotive Engineers, Inc., 1980, p. 21-26.

The considered investigation has the objective to indicate that noise control is the product of good engineering. It does not depend on learning a whole new discipline nor does it depend on invention. Because of the increasing use of hydraulics and the growth of noise sensitivity in aircraft, it was felt that aircraft hydraulic engineers should be aware of the desirability of noise control. A booklet was written for the general practitioner in aerospace hydraulics engineering. The first principle of quieting is that the most favorable cost-effectiveness ratio is achieved when noise control engineering is part of the original design effort. The second principle of quieting is that the loudest noise component must be reduced before appreciable quieting can be achieved. G.R.

A82-10855 **Developments in boundary layer Thrust Vector Control.** R. E. Fitzgerald and R. F. Kampe (Chandler Evans, Inc., West Hartford, CT). In: *Fluid power technology for the '80s.* Warrendale, PA, Society of Automotive Engineers, Inc., 1980, p. 27-35. 7 refs.

Thrust Vector Control (TVC) is commonly employed on a vehicle to provide larger magnitude steering forces during low velocity flight than can be obtained with aerodynamic fins. A method of thrust vectoring called boundary layer thrust vector control (BLTVC) is considered. BLTVC involves a variation of the secondary injection procedure. The limited deflection and flow ratio is amplified by means of an approach including an injection into a highly overexpanded nozzle. Deflections of 15 degrees are possible and ambient air is used as the injectant. Attention is given to the principles of BLTVC operation, a breakthrough in reducing nozzle size, and a scheme for producing roll control. Rocket applications of BLTVC cover a range in size from microthruster to remote piloted vehicle booster. BLTVC can be used on aircraft gas turbines also. Drawbacks of BLTVC are related to the necessity to employ very large nozzles for high-altitude applications. These drawbacks can be overcome with the aid of Confined Jet Thrust Vector Control. G.R.

A82-10889 # **A new APU for medium place aircraft environmental control systems.** C. Rodgers (Solar Turbines International, Turbomach Div., San Diego, CA). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Francisco, CA, July 13-15, 1981, Paper 81-ENAS-1.* 7 p. Members, \$2.00; nonmember, \$4.00.

New small auxiliary power units (APU) are sought to provide aircraft pneumatic power for environmental control and start systems. A new small gas turbine APU in the 20-50 hp class has been developed to meet the smaller aircraft secondary power requirements. The Gemini APU utilizes a single-stage radial compressor and a single-stage radial turbine wheel; it incorporates a single-can combustor with a unique spinning cup fuel atomizer. The electrical control provides for shutdown in case of malfunctions and also has an automatic bleed load control system. The load control valve permits greater operational flexibility by modulating flow to

maintain rated turbine exhaust temperature under varying electrical loads. The engine is available in two configurations: one for combined bleed/shp applications and the other for shaftpower applications. Silent power versions of the Gemini military ground generator sets have been developed which produce an overall noise level as low as 60 dB, and fuel and oil requirements for the Gemini are compatible with those of most main propulsion gas turbines. Successful starting has been demonstrated by the APU from -65 F through 125 F, as well as through 2000 start-stop cycles. J.F.

A82-10890 # Closed loop environmental control systems for fighter aircraft. G. S. Tsujikawa and V. K. Rajpaul (Boeing Military Airplane Co., Seattle, WA). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Francisco, CA, July 13-15, 1981, Paper 81-ENAs-2.* 6 p. Members, \$2.00; nonmembers, \$4.00. USAF-sponsored research.

A favorable thermal environment for aircraft avionics implemented in an energy efficient manner is an important factor in reducing aircraft life cycle costs through improved avionic reliability. This paper discusses the application of closed loop environmental control systems (CECS) to a tactical mission aircraft. The specific objective was to determine CECS configurations which would provide significant savings in fuel consumption and life cycle costs while maintaining stable, low temperature, clean and dry environment for avionics equipment. Preliminary designs were developed for a positive displacement rotary vane air cycle machine system, hybrid air/vapor cycle system, centrifugal Freon compressor vapor cycle system and a turbo-machinery air cycle machine system. System characteristics, details of design, performance and life cycle cost data were compared with an existing open loop air cycle system. The study showed that closed loop system configurations and close avionic temperature control resulted in substantial life cycle cost savings. (Author)

A82-10892 # Towards minimum power for environmental control in transport aircraft. D. Pierrepont (British Aerospace Public, Ltd., Co., Weybridge, Surrey, England). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Francisco, CA, July 13-15, 1981, Paper 81-ENAs-4.* 7 p. Members, \$2.00; nonmembers, \$4.00.

The minimization of the power consumed by the pneumatically powered environmental control system (ECS) on board transport aircraft, primarily the air conditioning system, is considered. It is noted that the development of a low-bleed ECS with subzero air cycle machine exit temperatures, condensing heat exchangers and recirculation leading to the doubling of the temperature difference between the fresh air supply and passenger and crew compartments has resulted in the halving of the fuel penalty associated with the ECS, (from 4% to 2%) while an additional halving of the penalty is possible by further reducing air flow or using a shaft-driven centrifugal compressor to provide the fresh air supply. Relative fuel savings to be had from air bleed reduction are shown to be significant with respect to those to be obtained in the areas of engines, aerodynamics and structures. The minimum fresh air flow required for the efficient operation of air supply systems within limits of passenger health and comfort is considered, and pneumatic and electrical means for the transmission of shaft power to the ECS are compared. The operating principles of air- and vapor-cycle cooling systems are then reviewed with respect to their performances, and advantages of the air cycle in the areas of complexity, maintenance and weight are noted. Consideration is also given to alternatives to bleed for anti-icing applications. A.L.W.

A82-10893 # Design analysis of high temperature transparent windshields for high performance aircraft. V. E. Wilson, A. J. Bockstahler (Rockwell International Corp., North American Aircraft Div., Los Angeles, CA), and C. A. Babish, III (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Francisco, CA, July 13-15, 1981, Paper 81-ENAs-5.* 11 p. 10 refs. Members, \$2.00; nonmembers, \$4.00. Contract No. F33615-68-C-3421.

Design criteria and analysis methods that are required to extend the thermal performance capabilities of lightweight, large field-of-view transparent windshield systems of Air Force aircraft into the Mach 2.5 to 3.5 speed regime are developed and demonstrated. Windshield system design requirements are established and designs

are developed, analyzed, and revised in an iterative process until visual, structural, thermal, weight, and cost analyses show that the design requirements are satisfied. Design details on two windshield systems are presented. Because a successful windshield design for high speed aircraft depends, to a great extent, on the ability of the windshield to withstand the high temperatures associated with supersonic flight, the aerothermodynamic analysis method and results are emphasized. (Author)

A82-10894 # Design challenges of high performance aircraft POD EOCCM cooling systems. R. D. Buckingham (Fairchild Industries, Inc., Fairchild Stratots Div., Manhattan Beach, CA). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Francisco, CA, July 13-15, 1981, Paper 81-ENAs-6.* 7 p. Members, \$2.00; nonmembers, \$4.00.

Modern high performance aircraft and associated Electro-Optical/Countermeasure (EOCCM) pods have introduced very complex, high heat density electronics and avionics equipment, which requires mechanically refrigerated cooling to reject large amounts of heat from relatively small confined areas because of: insufficient/no cooling air from the host aircraft; miniaturization/high heat density of electronics; high temperature heat sink of high performance fighter-type aircraft, precluding ram air cooling; need for increased electronics/avionics reliability through lower operating temperature ranges. Electrically driven vapor compression systems are most effective for the EOCCM-type pod missions, operating well at high and low altitudes, as well as at high and low flight speeds. Vapor cycle systems provide full ground cooling performance capability. (Author)

A82-10895 # Air supply system bite for Boeing 767 airplane. J. P. Patrick and G. F. Atkinson (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Francisco, CA, July 13-15, 1981, Paper 81-ENAs-7.* 7 p. Members, \$2.00; nonmembers, \$4.00.

Modern airplane air supply systems regulate the temperature and pressure of engine bleed air extracted for cabin pressurization, air conditioning, anti-icing, cross-engine starting, air-driven hydraulic pumps and other pneumatic demands. The air supply system for the Boeing Model 767 airplane consists of a set of equipment for each of the airplane's two engines and a remotely located built-in-test-equipment (BITE) module. The air supply BITE system isolates over 95 percent of all failures to the line replaceable unit (LRU) level. The BITE system achieves this fault isolation via a modern digital electronic BITE module that continuously monitors inputs on a time-shared basis from dedicated BITE elements which are integrally contained in the air supply system LRUs. The operation of the all-pneumatic bleed air supply system is unaffected by the BITE system. Faults detected during bleed air system operation are stored in the BITE module nonvolatile memory for interrogation by the ground crew. Provisions are also made to allow BITE detected faults to be used as inputs to aircraft airborne integrated data systems (AIDS). (Author)

A82-10896 # Air-film cooling returns to ramjets. W. E. Roberts and S. Wasserberg (Marquardt Co., Van Nuys, CA). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Francisco, CA, July 13-15, 1981, Paper 81-ENAs-8.* 6 p. Members, \$2.00; nonmembers, \$4.00.

A ramjet engine was configured for the Navy Firebrand program to propel an antiship target missile. After years of using insulation to thermally protect engine combustor/nozzle assemblies, air-film cooling was used in the Firebrand engine. A combustor liner causes a layer of cool air to be injected between the combustion gas and combustor/nozzle structural shell. As this film flows downstream, mixing and reaction with combustion gas causes its cooling effectiveness to deteriorate. A satisfactory structural design requires shell temperature prediction. Using three film cooling correlations, a method of defining the Firebrand film cooling effectiveness is shown. Thermal models are presented which utilize this effectiveness and provide shell temperature predictions under ground test conditions. This analytical method is shown to be sufficient when predicted temperatures are compared with shell temperatures measured during these ground tests. (Author)

A82-10901 # In-situ calibration of flight heat transfer instrumentation. H. W. Kipp and E. A. Eiswirth (McDonnell Douglas

A82-10920

Astronautics Co., St. Louis, MO). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Francisco, CA, July 13-15, 1981, Paper 81-ENAs-13.* 5 p. 8 refs. Members, \$2.00; nonmembers, \$4.00.

In-situ calibration offers a promising approach for economically minimizing errors in surface heating rates obtained from subsurface, transient, temperature measurements. Experience has shown that surface heat flux solutions are sensitive to inaccuracies in variables such as thermocouple location, temperature measurements, model thermal properties and joint conductances. It is the purpose of in-situ calibration to determine the values of finite difference thermal model parameters which result in the least square error solution. A calibration heat flux is imposed on the surface surrounding a thermocouple installation and the thermal response is recorded. The temperature history is used in an inverse solution to obtain the surface heat flux which is then compared with the calibration pulse. Repetitive values of surface heat flux are obtained by systematically varying model parameters until the calculated and calibration fluxes agree within a prescribed tolerance. The concept is illustrated with a numerical example. (Author)

A82-10920 # Air-freon integrated environmental conditioning system for trainer subsonic aircraft. M. Andriano, A. Mannini, and V. Marchis (Microtecnica-Torino, Turin, Italy). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Francisco, CA, July 13-15, 1981, Paper 81-ENAs-33.* 7 p. Members, \$2.00; nonmembers, \$4.00.

Development studies of a cabin environmental control system (ECS) for a new trainer subsonic aircraft are presented. The new vapor cycle cooling system is energy efficient for engines sensitive to bleed air extraction. The hybrid air-freon ECS is composed of four subsystems: the recirculation loop, the bleed air line, the ram air line, and the supplementary cooling assembly (SCA). The air system emergency control law and the SCA system emergency control law are shown schematically in flow charts: if the sensor in the recirculating loop duct measures a temperature higher than 100 C, the bypass valve is immediately closed; it is only opened if the duct temperature decreases below 70 C. The compressor in the SCA system is switched off in cases where the pressure is above 2.5 MPa and lower than 0.3 MPa. Performance tests correlated well with predicted ones, and the system overall weight was optimized at 30 kg. The ECS was compared with the bootstrap air system and found to have a substantially better bleed air flow rate (ECS = 1.20 kg/min; bootstrap = 7.0 kg/min). J.F.

A82-10934 * # Multiple-scale turbulence modeling of free turbulent flows. G. Fabris and P. T. Harsha (Science Applications, Inc., Combustion Dynamics and Propulsion Technology Div., Canoga Park, CA). *American Society of Mechanical Engineers and American Society of Civil Engineers, Joint Applied Mechanics, Fluids Engineering, and Bioengineering Conference, University of Colorado, Boulder, CO, June 22-27, 1981, ASME Paper 81-FE-20.* 11 p. 28 refs. Members, \$2.00; nonmembers, \$4.00. Contract No. NAS1-15988.

As part of an investigation into the application of turbulence models to the computation of flows in advanced scramjet combustors, the multiple-scale turbulence model has been applied to a variety of flowfield predictions. The model appears to have a potential for improved predictions in a variety of areas relevant to combustor problems. This potential exists because of the partition of the turbulence energy spectrum that is the major feature of the model and which allows the turbulence energy dissipation rate to be out of phase with turbulent energy production. To establish the general reliability of the approach, it has been tested through comparison of predictions with experimental data. An appreciable overall improvement in the generality of the predictions is observed, as compared to those of the basic two-equation turbulence model. A Mach number-related correction is found to be necessary to satisfactorily predict the spreading rate of the supersonic jet and mixing layer. (Author)

A82-10952 * # Thermal and flow analysis of a convection, air-cooled ceramic coated porous metal concept for turbine vanes. F. S. Stepka (NASA, Lewis Research Center, Cleveland, OH). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, National Heat Transfer Conference, 20th, Milwaukee, WI, Aug. 2-5, 1981, ASME Paper 81-HT-48.* 7 p. 9 refs. Members, \$2.00; nonmembers, \$4.00.

Analysis was made of the heat transfer and pressure drop through turbine vanes made of a sintered, porous metal coated with a thin layer of ceramic and convection cooled by spanwise flow of cooling air. The analysis was made to determine the feasibility of using this concept for cooling very small turbines, primarily for short duration applications such as in missile engines. The analysis was made for gas conditions of approximately 10 and 40 atm and 1644 K and with turbine vanes made of felt-type porous metals with relative densities from 0.2 and 0.6 and ceramic coating thicknesses of 0.076 to 0.254 mm. (Author)

A82-10965 # Fuel for future transport aircraft. G. D. Brewer (Lockheed-California Co., Burbank, CA). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, National Heat Transfer Conference, 20th, Milwaukee, WI, Aug. 2-5, 1981, ASME Paper 81-HT-80.* 8 p. 6 refs. Members, \$2.00; nonmembers, \$4.00.

Despite attempts at conservation and the development of synthetic aviation-grade kerosene from alternative fossil fuel materials, it is widely recognized that alternatives to conventional petroleum-base aircraft fuels must become available in the near future. The present paper discusses the prospects for liquid hydrogen as a future fuel for transport aircraft. Advantages of liquid hydrogen over synthetic fuels and liquid methane as alternative fuels in the areas of availability, safety, pollution, relative energy efficiency as a function of trip length and aircraft weight, overall costs and airport compatibility are considered. The possible requirements for a development program aimed at preparing liquid hydrogen for use in operational aircraft are examined, and the probable time characteristics of fuel use during the transition to liquid hydrogen, which may significantly replace synthetic fuels by the year 2000, are considered. A comprehensive plan for liquid hydrogen fuels R&D is then presented which is currently being considered for implementation on an international basis. A.L.W.

A82-10985 # Control laws for adaptive wind tunnels. E. H. Dowell (Princeton University, Princeton, NJ). *AIAA Journal*, vol. 19, Nov. 1981, p. 1486-1488. 5 refs. Research supported by Princeton University.

A control law is developed which will permit the systematic modification of wind tunnel wall conditions, in order to minimize the interference about a model. The approach is valid for both three-dimensional and lifting flows and, subject to the assumption of linearity, is not dependent on any particular theoretical description of the fluid. In addition, unlike previous control schemes, the present method does not require an iterative approach. O.C.

A82-10987 # Wind tunnel tests on airfoils in tandem cascade. S. Raghunathan (Belfast, Queen's University, Belfast, Northern Ireland), C. P. Tan, and N. A. J. Wells. *AIAA Journal*, vol. 19, Nov. 1981, p. 1490-1492.

Wind tunnel tests on airfoils in tandem cascade, of the type found on the Wells-type turbine, were conducted in a low-speed tunnel with a maximum air velocity of 35 m/sec. Airfoils tested had a chord of 85 mm and a span of 100 mm and included the NACA 0012, 0018 and 0021 profiles. The freestream dynamic pressure was measured upstream of the cascade by a Pitot tube, as well as the tangential and normal forces on the blades. Tests were performed for several cascade solidities and at angles of incidence varying from zero to 90 deg, with Reynolds numbers of about 100,000. O.C.

A82-11020 Tangential sensitivity of EW receivers. J. Tsui (USAF, Avionics Laboratory, Wright-Patterson AFB, OH). *Microwave Journal*, vol. 24, Oct. 1981, p. 99-102. 8 refs.

A systematic approach to the determination of the tangential sensitivity of a receiver is presented, and calculated results are compared with experimental data. Particular consideration is given to the following topics: the practical determination of the effective noise bandwidth to be used in the sensitivity calculations of an EW receiver; the influence of the RF gain in the receiver on the sensitivity; and the influence of the RF bandwidth and the video bandwidth on the sensitivity. B.J.

A82-11031 Relationships between naval aviation safety and pilot flight experience. M. S. Borowsky (U.S. Naval Safety

Center, Norfolk, VA). *Aviation, Space, and Environmental Medicine*, vol. 52, Oct. 1981, p. 608-610.

Flight activity of all aviators flying naval aircraft and aircraft accident data were analyzed to determine if statistical relationships among lifetime and recent experience variables and accident liability exist. The results demonstrate that accident potential, though not statistically related to flight hours in 30-d periods, is correlated with lifetime flight experience with the higher liability associated with minimal amounts of flight hours and with transitioning into new aircraft. (Author)

A82-11149 Acoustic emission - An emerging technology for assessing fatigue damage in aircraft structure. C. D. Bailey and W. M. Pless (Lockheed-Georgia Co., Marietta, GA). *Materials Evaluation*, vol. 39, Oct. 1981, p. 1045-1050. 12 refs.

Guidelines for the design of a dedicated acoustic emission (AE) system for aircraft fleet installations are discussed. It is shown that the successful development of an on-board AE crack detection system depends on the existence of an integrated body of technology combining AE detection technology, structural and crack growth characteristics, noise and EMI discrimination or rejection, and fleet maintenance practices. These technologies must be fully integrated through the development and deployment of the system to achieve cost-effective results. V.L.

A82-11177 * Rheological behavior of progressively shear-thickening solutions. S. T. J. Peng and R. F. Landel (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA). *Journal of Applied Physics*, vol. 52, Oct. 1981, p. 5988-5993. 13 refs. Contract No. NAS7-100.

The rheological behavior of the recently developed polymer FM-9 in Jet A fuel and JP 8 fuel is reported. In aqueous solution, FM 9 is found to exhibit strong time-dependent shear thickening behavior. Induction time necessary for the onset of thickening is found to depend on shear rate, solvent, concentration, and molecular weight. Altering the nature of the solvent results in effects similar to those obtained by changing the concentration or molecular weight. A critical shear rate is derived, and is inversely proportional to the zero shear rate viscosity of the solution for the temperature and concentrations observed. The onset of shear thickening behavior appears to be related to the onset of viscoelastic response, and thus the time scale follows reduced variable behavior. D.L.G.

A82-11222 Development of the Triflex rotor head. A. Cassier (Société Nationale Industrielle Aérospatiale, Marignane, Bouches-du-Rhône, France). *American Helicopter Society, Journal*, vol. 26, July 1981, p. 25-31.

This paper reviews the development of a new hingeless rotor hub named Triflex. This hub is made of composite materials and features flexible arms that provide blade retention, flap/lag/pitch degrees of freedom through structural deflection, and lag damping. A large part of the Triflex hub design effort has been devoted to determination of the flexible arm characteristics, since these strongly affect the behavior of the rotor in flight. The Triflex hub dynamic characteristics were carefully checked during laboratory and whirl stand tests and found to be in agreement with theoretical predictions. Flight tests of the Triflex rotor on a Gazelle helicopter were successful in demonstrating the feasibility of the concept. Though rotor lag damping was found to be weak, no insurmountable stability problems were encountered, and the flying qualities of the Gazelle helicopter fitted with the Triflex hub were good. The next phase of the Triflex hub development will be aimed at improving the hub's structural damping characteristics and at optimizing the manufacturing process. (Author)

A82-11224 Fatigue substantiation of non-linear structures. B. P. W. Stocker (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT). (*American Helicopter Society, Midwest Region Helicopter Fatigue Methodology Specialists Meeting, St. Louis, MO, Mar. 1980.*) *American Helicopter Society, Journal*, vol. 26, July 1981, p. 51-55.

Structures such as preloaded joints and lugs frequently exhibit non-linear load/stress relationships at critical locations. This paper presents some examples of such structures, including typical attachment lugs and preloaded threaded attachments, to illustrate the importance of test load level selection and determination of load vs

stress relationships at fracture origins. The possibility that accelerated fatigue testing may sometime fail to reveal critical design weaknesses or result in unrepresentative modes of fracture is explored, and simple ways of avoiding this problem are discussed. (Author)

A82-11225 On computing Floquet transition matrices of rotorcraft. G. H. Gaonkar, D. Sastry (Indian Institute of Science, Bangalore, India), and D. S. S. Prasad (National Aeronautical Laboratory, Bangalore, India). *American Helicopter Society, Journal*, vol. 26, July 1981, p. 56-61. 23 refs.

There are conflicting claims concerning the efficiency of different schemes of computing the Floquet transition matrices of rotorcraft. In this paper, computer-generated data are presented on the comparative efficiency of four classes of methods: (1) Runge-Kutta one-step; (2) Hamming's predictor-corrector multistep; (3) Bulirsch-Stoer extrapolation; and (4) hybrid or variable order. Data pertain to single-pass and N-pass schemes for four flap-lag stability models. It is found that Hamming's fourth-order predictor-corrector method in single pass is the most economical with respect to three-significant-figure accuracy. The analytical formulation confirms the advantage of the single-pass approach over the N-pass, provides useful approximations to machine-time data, and is a feasible economical approach to comparing different methods with respect to machine time. B.J.

A82-11300 Model helicopter rotor impulsive noise. J. E. Hubbard, Jr. and W. L. Harris (MIT, Cambridge, MA). *Journal of Sound and Vibration*, vol. 78, Oct. 8, 1981, p. 425-437. 18 refs. Contract No. DAAG29-C-027.

An investigation of helicopter rotor blade slap was performed on a 1.27 m diameter model rotor. The rotor blades were a NACA 0012 section with a -8 deg linear twist. The experiments were conducted in the MIT Anechoic Wind Tunnel. The effects of number of blades, blade pitch, advance ratio, and shaft angle on the generation and intensity of blade slap have been investigated. The effect of each parameter was determined by varying the parameter of interest while keeping the others constant. The rotor tip speeds of the tests performed in this study were limited to approximately Mach 0.4. The directivity associated with the blade slap signature was measured. The results of this investigation are based on a subjective definition of blade slap. (Author)

A82-11302 # Ideal and simulated performance of an aircraft in the terrain following mission. U. R. Prasad (Indian Institute of Science, Bangalore, India) and B. S. Subrahmanyam. *Aeronautical Society of India, Journal*, vol. 31, Feb.-Nov. 1979, p. 13-19. 8 refs.

A new synthesis method of terrain following system design to realize closely the ideal performance obtainable from an aircraft in the mission is presented. Ideal performance analysis and division of the mission into Avoid and Follow modes of flight leads to natural template constructions imbedding the aircraft climb performance and human pilot tolerance limits to accelerations. Simulation of aircraft flight in the mission complements the analysis in fixing the configuration and parameters of the system. Step terrains are used in the design iterations of the system because of their worst-case character. (Author)

A82-11314 # Dynamic response of aircraft structure to gun shock loads. P. N. Raju and V. P. Rangaiah (Hindustan Aeronautics, Ltd., Bangalore, India). *Aeronautical Society of India, Journal*, vol. 31, Feb.-Nov. 1979, p. 103-105. 5 refs.

The dynamic response of a fighter aircraft to gun firing is assessed, the vibration levels on the airframe being measured by flight tests of the aircraft in the development phase. The aircraft is instrumented for measuring the vibration levels at various points on the aircraft structure, for example, the wing tip, fuselage, tail plane, and aileron and elevator. The flight vibration data thus obtained is analyzed using standard methods available in the literature. The analyzed data is plotted to ascertain whether the vibration levels fall below the upper bounds of the envelope drawn from the previous flight-test data for the aircraft of the same class. C.R.

A82-11317 # Development of aircraft production engineering discipline at IIT, Bombay. N. K. Naik (Indian Institute of Technology, Bombay, India). *Aeronautical Society of India, Journal*, vol. 31, Feb.-Nov. 1979, p. 119-125.

The aircraft production engineering courses offered at the Indian Institute of Technology, in Bombay, are discussed. To demonstrate the value of the courses, the fundamentals of aircraft production are outlined, the discussion being confined to airframe production. The loft-template method is described, and the principal loft-template scheme used in aircraft production is shown. Also described are the theory and laboratory courses offered at the institute. C.R.

A82-11359 **Nonlinear prediction of subsonic aerodynamic loads on wings and bodies at high angles of attack.** P. Zhu, W. Shou (China Aeronautical Establishment, Institute of Computing Technology, Xi'an, Shaanxi, People's Republic of China), and S. Luo (Northwestern Polytechnical University, Xi'an, Shaanxi, People's Republic of China). *Computer Methods in Applied Mechanics and Engineering*, vol. 26, June 1981, p. 305-319. 6 refs.

This paper predicts numerically the nonlinear aerodynamic loads on wings and bodies at high angles of attack in subsonic flow separating along certain known lines. It is assumed that the separation vortices are symmetric and unbursting. The wing mean surfaces and body surfaces are simulated by bound vortex lattices, and the separation vortex surfaces by free vortex lines. The vortex system satisfies boundary conditions on wing and body surfaces, separation conditions, and the condition that free vortex lines are tangent to local velocity. The velocity induced by a vortex is computed by the Biot-Savart law with Göthert transformation for subsonic small perturbation flows. The vortex strengths and the free vortex locations are solved by relaxation method. Then the aerodynamic loads on wings and bodies are computed. They agree well with experimental tests. (Author)

A82-11400 **A note on fatal aircraft accidents involving metal fatigue.** G. S. Campbell (National Aeronautical Establishment, Ottawa, Canada). *International Journal of Fatigue*, vol. 3, Oct. 1981, p. 181-185. 6 refs.

A world-wide survey of aircraft accidents was taken to determine the extent to which metal fatigue is responsible for the incidents. A total of 306 fatal accidents since 1934 were found to be either wholly or partially due to metal fatigue; these accidents resulted in 1803 deaths. Two-thirds of the accidents involved fixed-wing aircraft, with wing failure (88 accidents) being the most common cause, followed by engine failure (56 accidents). Of the 90 fatal helicopter accidents, about a third were due to failure of the main-rotor system, and a quarter were due to tail-rotor failure. Over the last four years there has been an average of 18 fatal accidents per year resulting from metal fatigue; about 11 have been for fixed-wing aircraft and seven have been for helicopters. Thirteen accidents were attributed to a failure to increase the inspection frequency required for aircraft used in a role for which they were not originally designed. J.F.

A82-11406 **A mathematical model of an over-sea airborne UHF radio link.** T. Sator. *Marconi Review*, vol. 44, 2nd Quarter, 1981, p. 101-118. 9 refs.

A mathematical model is described which enables the performance of an over-the-sea airborne UHF radio link to be estimated as a function of terminal height and separation distance taking account statistically of variations of signal level caused by such factors as irregular antenna radiation patterns and a rough sea surface. (Author)

A82-11407 **Optical sensors for displacement measurement.** S. M. McGlade. *Marconi Review*, vol. 44, 2nd Quarter, 1981, p. 119-136. 7 refs.

A measurement system consists of sensors which are connected to a control center. The use of fiber optics as the communications link has a number of advantages. Two of the most important are immunity from electromagnetic interference and the elimination of the danger of electrical sparking in explosive environments. These advantages are reduced by the necessity to use electrical devices in the sensors. If the sensors were wholly optical then the advantages of fiber optics would apply to the entire system outside the control center. Optical sensors will be difficult to develop. Initially, at least, they are only justified in applications where such methods are becoming essential. One such area is in military aircraft. An optical displacement transducer can be obtained by using the displacement to alter the transmission aperture of a light beam. Attention is also

given to strain measurement using two beam interferometry, Fabry-Pérot interferometry displacement measurement, and strain induced birefringence. G.R.

A82-11434 **End losses in turbine cascades with porous cooling.** V. M. Epifanov and V. I. Gus'kov. (*Aviatsionnaia Tekhnika*, no. 3, 1980, p. 46-49.) *Soviet Aeronautics*, vol. 23, no. 3, 1980, p. 38-41. 7 refs. Translation.

Experimental results on porous-cooled turbine blades are presented and discussed. Exit losses in the blades are found to depend on coolant flowrate and the degree of roughness of the porous surface. B.J.

A82-11444 **Study of reingestion of exhaust gases with different initial temperature in a reversed turbojet engine.** Z. V. Akhtiamov and M. Sh. Giliyazov. (*Aviatsionnaia Tekhnika*, no. 3, 1980, p. 101-103.) *Soviet Aeronautics*, vol. 23, no. 3, 1980, p. 87-89. Translation.

A82-11446 **Results of experimental study of heat transfer to turbine blades with porous cooling.** S. G. Dezider'ev, A. G. Karimova, and V. I. Lokai. (*Aviatsionnaia Tekhnika*, no. 3, 1980, p. 109-112.) *Soviet Aeronautics*, vol. 23, no. 3, 1980, p. 97-99. 8 refs. Translation.

A82-11448 **One reason for the onset of high-frequency self-excited oscillations.** V. P. Pavlovskii. (*Aviatsionnaia Tekhnika*, no. 3, 1980, p. 116-118.) *Soviet Aeronautics*, vol. 23, no. 3, 1980, p. 104-106. 5 refs. Translation.

Experiments have been carried out to investigate generation mechanisms of high-frequency auto-oscillations resulting from an increase in the pressure differential across the combustion chamber injectors of a flight vehicle engine. It is found that a possible reason for the onset of the high-frequency auto-oscillations is breakdown of the annular gas cavity in the oxidizer injector nozzle which initiates unstable combustion due to the vapor phase removal. V.L.

A82-11459 **Calculation of aerodynamic characteristics of jet flapped airplane.** V. G. Akent'ev and V. V. Guliaev. (*Aviatsionnaia Tekhnika*, no. 4, 1980, p. 3-6.) *Soviet Aeronautics*, vol. 23, no. 4, 1980, p. 1-4. Translation.

A numerical method is developed for calculating the steady-state aerodynamic characteristics of an aircraft with jet flaps. The flow past the aircraft and the jet are modeled as a system of oblique horseshoe-shaped vortices, and the problem is solved in the linear formulation for an incompressible medium. B.J.

A82-11462 **On low-speed wind tunnels with deformable boundaries.** A. A. Gruzdev. (*Aviatsionnaia Tekhnika*, no. 4, 1980, p. 23-26.) *Soviet Aeronautics*, vol. 23, no. 4, 1980, p. 18-20. 7 refs. Translation.

Attention is given to the development of self-streamlining or self-correcting wind tunnels. Linear theory under the assumption of potential flow is used to study the shape of streamline surfaces near a wing of finite aspect ratio moving near a screen. The characteristics of flow macrostructure in the wake are analyzed; and it is shown that, in contrast to the case of two-dimensional flow, it is not possible to streamline the walls of the tunnel in the absence of a vortex wake in the case of three-dimensional flow. B.J.

A82-11463 **Basic problem of aircraft gasturbine engine analytic design.** II. Iu. V. Kozhevnikov, V. O. Borovik, V. S. Ivanov, V. A. Talyzin, I. N. Agliullin, and Iu. V. Meluzov. (*Aviatsionnaia Tekhnika*, no. 4, 1980, p. 27-32.) *Soviet Aeronautics*, vol. 23, no. 4, 1980, p. 21-24. Translation.

The paper presents results of the analytical optimization of the basic thermogasdynamic parameters of the cycle and the characteristic areas of the air path of a turbojet bypass engine; the optimization criterion is minimum engine-mass and minimum fuel required for a given flight distance. The multimode character of engine operation is analyzed. B.J.

A82-11464 **Formation of triangular-element stiffness matrix using sliding interpolation.** P. D. Levashov. (*Aviatsionnaia Tekhnika*, no. 4, 1980, p. 33-37.) *Soviet Aeronautics*, vol. 23, no. 4, 1980, p. 25-28. Translation.

The paper examines the use of sliding interpolation to construct the stiffness matrix of triangular elements of flat rib-stiffened panels. This approach makes it possible to raise the order of the displacement field by employing computational parameters from adjacent elements without increasing the total number of unknowns. A computational example is discussed. B.J.

A82-11465 On evaluating the influence of local disruptions of flow over trailing edge and leading edge flaps from the data of wind tunnel tests of a rectangular wing segment. A. I. Matiazh, V. A. Sterlin, A. B. Kuznetsov, V. V. Isaev, A. A. Shapiro, and E. M. Ksenofontova. (*Aviatsionnaia Tekhnika*, no. 4, 1980, p. 38-42.) *Soviet Aeronautics*, vol. 23, no. 4, 1980, p. 29-32. 5 refs. Translation.

Equipment for the suspension and control of leading and trailing flaps was tested in a low-speed wind tunnel. The influence of the control mechanisms, and, of their positions along the wing span and in the cross section, on the integral aerodynamic characteristics of a rectangular wing was evaluated. It is found that local disturbances of flow past leading and trailing flaps produce a significant reduction of lift and an increase of drag. B.J.

A82-11468 On the use of carbon composites in slat and stabilizer construction. B. N. Kornev, R. I. Guseva, and V. A. Tikhomirov. (*Aviatsionnaia Tekhnika*, no. 4, 1980, p. 72-74.) *Soviet Aeronautics*, vol. 23, no. 4, 1980, p. 59, 60. Translation.

Glass-graphite-plastic composite materials were used in the construction of aircraft deflectors and stabilizers. This paper reviews the details of construction, and examines static-load testing results for both deflector and stabilizer. B.J.

A82-11469 Synthesis of system for evaluating gyro-stabilizer state with unknown disturbances. A. A. Leporskii. (*Aviatsionnaia Tekhnika*, no. 4, 1980, p. 74-76.) *Soviet Aeronautics*, vol. 23, no. 4, 1980, p. 61-63. Translation.

A82-11470 On the question of trailing airplane motion. A. A. Novad. (*Aviatsionnaia Tekhnika*, no. 4, 1980, p. 79-81.) *Soviet Aeronautics*, vol. 23, no. 4, 1980, p. 67, 68. Translation.

Equations are derived for the three-dimensional motion of an aircraft and are solved analytically for the initiation of banking flight. The solution describes the effect of the specific wing load on the normal acceleration overloading of the aircraft. It is noted that the danger of a spin increases with increasing specific load. B.J.

A82-11471 Experimental study of empennage snap-through vibrations. V. A. Pavlov, F. Sh. Khakimullin, A. Ia. Gur'ianov, and M. I. Gershtein. (*Aviatsionnaia Tekhnika*, no. 4, 1980, p. 81-84.) *Soviet Aeronautics*, vol. 23, no. 4, 1980, p. 69-71. 5 refs. Translation.

The snap-through oscillations of a rectangular-planform empennage model were studied in a subsonic wind tunnel. The aim of the study was to isolate the snap-through oscillations from all other possible oscillations in the flow. An analysis of changes of the normal and frontal curvatures of the control surface demonstrate the occurrence of snap-through oscillations. The frontal curvature falls to practically zero in the case of static snap-through. B.J.

A82-11685 Fatigue life of lugs under service loading - Test results and predictions. A. Buch and A. Berkovits (Technion - Israel Institute of Technology, Haifa, Israel). *Materialprüfung*, vol. 23, Oct. 1981, p. 344-348. 27 refs.

Aircraft pin-lug joints with and without interference fit were tested in maneuver loading programs with random loading sequence in order to investigate the effect of design load, lug material and interference fit on the spectrum fatigue life. An interference fit of 0.3% had a strong beneficial effect on the fatigue life for all loading programs, even when local tensile stress peaks exceeded the material yield stress. The spectrum fatigue life of 2024-T351 lug specimens was longer than that of 7075-T7351 specimens, except under the most severe loading program. Test results were compared with predictions based on the Miner's rule, the relative Miner rule, and the Neuber-Topper notch analysis method. The relative Miner rule was superior to the conventional rule in predicting the spectrum fatigue life of aircraft lugs; the Neuber-Topper notch analysis method was

shown to have some application for the prediction of the effect of design load on the fatigue life of lugs with interference fit, but for the case of lugs without interference fit, predicted and test results disagreed completely. The disagreement is explained by the effect of fretting. J.F.

A82-11715 # New separators for battery systems. J. Lee and V. D'Agostino (RAI Research Corp., Hauppauge, NY). In: Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings, Volume 1. New York, American Society of Mechanical Engineers, 1981, p. 111-116.

The reported study takes into consideration separators for miniature cells, such as silver/zinc button cells, and separators for aircraft nickel/cadmium batteries. It is pointed out that separators for energy systems having an aqueous electrolyte, either acid or basic, can be prepared by selective modification of radiation grafting parameters. A new family of separators, known as the 'SC' series, has been developed. The SC separators have very uniform electrolytic resistance, excellent mechanical strength, and lower cost. General improvements in battery service life could be observed as a result of the introduction of the grafted separators. The cycle life of vented aircraft Ni/Cd batteries could be extended three to four times. G.R.

A82-11716 # Sealed lead-acid batteries for aircraft applications. K. L. Senderak and A. W. Goodman (U.S. Navy, Naval Weapons Support Center, Crane, IN). In: Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings, Volume 1. New York, American Society of Mechanical Engineers, 1981, p. 117-122.

In the 1970's, an important advance in lead-acid battery technology occurred with the introduction of sealed, no-maintenance, lead-acid batteries. A description is given of a wide variety of studies and tests conducted to evaluate the suitability of the new batteries for employment in Navy aircraft. The results show that the sealed lead-acid (SLA) cells can be successfully used in a potentially large number of aircraft applications, where very high-rate discharge performance is not required. The Navy is actively pursuing the SLA battery for these applications to substantially reduce the Navy's overall battery procurement and maintenance costs, and to improve reliability. G.R.

A82-11717 # Applications of finite element method in aerospace power systems design. E. U. A. Siddiqui. In: Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings, Volume 1. New York, American Society of Mechanical Engineers, 1981, p. 123-126.

Complex power systems are needed to satisfy the exacting power requirements of current avionics systems. A suitable tool for the design of such power systems is finite element analysis, based on the principle of minimization of total potential energy. This technique is being successfully used to eliminate excess weight and to accurately predict stresses and resonant frequencies. The new method was used to conduct an analysis in connection with a problem related to the occurrence of severe vibrations in a 30,000 rpm generator. The analysis had the objective to determine the effects of modifications made to the generator frame. It was found that the resonant frequency could be raised above the operational speed of the generator by introducing suitable modifications to the design of the frame. G.R.

A82-11718 # Advanced aircraft electric power system. J. D. Segrest (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). In: Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings, Volume 1. New York, American Society of Mechanical Engineers, 1981, p. 127-129.

The Advanced Aircraft Electric Power System is to increase fuel efficiency and reduce life cycle costs. The system includes 270 volt DC generators, solid state regulation, flat bus distribution, solid state switching, digital multiplex control and protection of power distribution through a system algorithm, and switching regulator power conditioning. A description is presented of the system concept, the hardware development, and the status of the Navy program. A high voltage DC power system development had been initiated by the Navy to exploit the advantages of high-voltage DC operation for future aircraft. G.R.

A82-11719

A82-11719 # Variable speed constant frequency (VSCF) electrical system cuts cost of ownership. R. V. Hildebrant and R. C. VanNocker (General Electric Co., Aircraft Equipment Div., Binghamton, NY). In: Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings. Volume 1. New York, American Society of Mechanical Engineers, 1981, p. 130-135. 5 refs.

The methodology employed in the development of the electrical generating system for the F/A-18 aircraft is considered. This system was the first production application in which the cycloconverter electronics were packaged with the generator and mounted directly to the accessory gearbox. Being the first production system of this type, a detailed and comprehensive analysis and evaluation program was undertaken to provide assurance that the design could operate with a high degree of reliability in this generally hostile environment. A primary maintainability design objective was related to the design and the selection of parts and materials which would last for the life of the unit without scheduled maintenance. Attention is given to maintenance cost experience and life cycle costs. G.R.

A82-11720 # A hidden advantage of permanent magnet electrical generating systems. J. J. O'Neill (General Electric Co., Binghamton, NY). In: Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings. Volume 1. New York, American Society of Mechanical Engineers, 1981, p. 136-139. 7 refs. USAF-supported research.

The development of permanent magnet aircraft electrical generating systems heralds the beginning of a new era. This technique brings many advantages to the user in terms of size, weight and reliability. However, the most significant of these advantages is the extremely high efficiency which is characteristic of these systems. This paper examines the effect of the higher system efficiency on the user, specifically in the area of aircraft fuel consumption. Driven by rising fuel costs, engine and aircraft manufacturers are striving for more efficient performance to minimize life cycle costs. The results of a study which examines the effect of several permanent magnet ratings on different aircraft sizes are presented. (Author)

A82-11721 # 60 KVA ADP permanent magnet VSCF starter generator system - Generator system performance characteristics. R. C. Webb (General Electric Co., Binghamton, NY). In: Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings. Volume 1. New York, American Society of Mechanical Engineers, 1981, p. 140-145. Contracts No. F33615-78-C-2200; No. F33615-74-C-2037.

A description is presented of a Variable Speed Constant Frequency (VSCF) system, which consists of a cycloconverter with a synchronous generator that uses samarium cobalt magnets for its excitation. As part of its normal operation, the converter regulates each output wave in frequency and in voltage providing the necessary voltage regulation for a permanent magnet (PM) generator. The cycloconverter is capable of reverse power flow and the PM generator has the necessary excitation at standstill to make it possible to run the system as a brushless starter. Attention is given to the phases of the development program, system operation, start mode operation, and test results. It is pointed out that the PM VSCF system offers a significant improvement in electrical generating system efficiency over presently used systems. G.R.

A82-11725 # Unsolved problems of nickel cadmium batteries. S. Gross (Boeing Aerospace Co., Seattle, WA). In: Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings. Volume 1. New York, American Society of Mechanical Engineers, 1981, p. 177-181. 8 refs.

A number of problems occurring with nickel cadmium battery systems are primarily important for aerospace applications, where reliable, long life is essential. Some of the problems are related to the design of plaques to obtain a large capacity and a long operational life. Other subjects investigated are nickel electrode morphology changes, nickel electrode cycling degradation, and the effects of cadmium migration. It is found that more work is needed for a better understanding of the various factors involved. The development of a computerized mathematical model of the nickel cadmium cell is

suggested. The effects produced by electrode additives are also discussed. G.R.

A82-11740 # High voltage surge and partial discharge test to evaluate aerospace equipment parts. W. G. Dunbar (Boeing Aerospace Co., Seattle, WA) and D. Schweickart (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). In: Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings. Volume 1. New York, American Society of Mechanical Engineers, 1981, p. 250-254.

Eight test articles were selected for high voltage evaluation to verify the specifications. The test articles represent critical components of a high-voltage, high-power airborne system. A description is presented of the findings of these tests in the case of the capacitors. Each capacitor was given preliminary tests to determine insulation resistance at 100 volts dc, and the capacity using a standard ASTM capacitance bridge at low voltage. It was found that the insulation resistance and capacitance test methods and parameters are acceptable. The partial discharge and dielectric withstanding voltage and surge test methods are acceptable, but the test parameters for airborne capacitors must be lower than those specified for commercial capacitors. G.R.

A82-11899 Increasing the lift:drag ratio of a flat delta wing. A. A. Mattick and J. L. Stollery (Cranfield Institute of Technology, Cranfield, Beds., England). *Aeronautical Journal*, vol. 85, Oct. 1981, p. 379-386.

Increases in the lift/drag (L/D) ratio attained by placing flaps on the upper surface of a flat, 60 deg, small aspect ratio delta wing are reported. The flaps were positioned along a ray from the vertex of the wing; their height, increasing from the vertex to the trailing edge, was a percentage of the semispan, and they were hinged at the lower edge. Position and heights were varied and lift and drag forces were measured over a range of angles of attack. The flaps were found to cause a lift force to act on themselves, up to a height of 6.1% of the semispan, by causing air from the primary vortex core to separate and form a vortex on the outboard side of the flaps. A maximum increase of 33% in the L/D was determined and it is noted that all the vertical flaps tested produced a positive thrust force. Graphs are provided of the derived aerodynamic ratios. M.S.K.

A82-11927 # Fast and accurate gyrocompass using strap-down tuned rotor gyros as a solution to combat helicopters navigation problems. P. Lloret, X. Lagarde, and G. Lavoipierre (Société d'Applications Générales d'Electricité et de Mécanique, Paris, France). In: Symposium Gyro Technology 1980; Proceedings of the Symposium, Stuttgart, West Germany, September 24, 25, 1980. Düsseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1981, p. 1.0-1.25.

Results of verification tests to determine if gyrocompass mechanization can be used to find true headings within 0.5 deg in less than two minutes for helicopter navigation are presented. A strapdown inertial-Doppler navigation system which uses a pair of two-axis tuned rotor gyroscopes is described. The high accuracy of mechanical gyroscopes is attributed to the repeatability of the thermal behavior of tuned rotor gyroscopes. The gyros were temperature measured externally and in the instrument block, and correlations were sought between temperatures and drift patterns. Although true correlations were necessarily synthetic, drift rates of 15 deg/hr were reduced to 0.5 deg/hr peak residual drifts, confirming the potential use of 0.5 deg accuracy, two minute true heading mechanical gyroscopes as a complement to magnetic headings. M.S.K.

A82-11932 # Design and development of a low cost servoed rate gyro for unmanned aircraft. D. R. McKenzie (Smiths Industries Aerospace and Defence Systems Co., Cheltenham, Glos., England). In: Symposium Gyro Technology 1980; Proceedings of the Symposium, Stuttgart, West Germany, September 24, 25, 1980. Düsseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1981, p. 14.0-14.56.

The development of a low cost rate gyro for use in unmanned vehicles is presented. The design parameters for the low weight gyro, which has an input range of plus or minus 50 deg/sec and can operate from a low voltage dc power source are outlined. A conventional design, comprising a spinning rotor on a gimbal with torque restraint and dynamic damping, was chosen to minimize cost and time; a

feedback approach was adopted to maintain performance stability. A rotational speed of 10,000 rpm with a polar moment of inertia of 20 g/sq cm was selected. The pick-off, torque motor, servoamplifier, and plastic molding are discussed and performance figures for 25 gyros are presented. A pulsed motor circuit was developed to maintain motor speed within 7% of the set value over the operating temperature range; elimination of a wheel speed control improved nonlinearity and reduced costs. Circuitry diagrams and schematics are provided. M.S.K.

A82-11933 # Design considerations for the direct digital control of dry-tuned gyroscope. S. N. Puri (Indian Space Research Organization, Vikram Sarabhai Space Centre, Trivandrum, India). In: Symposium Gyro Technology 1980; Proceedings of the Symposium, Stuttgart, West Germany, September 24, 25, 1980.

Düsseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1981, p. 15.0-15.25.

The use of direct digital processor control of dry-tuned gyros is examined. Direct control is implemented because of a finite processing time lag between input and output, and is aided by minimizing the computation time by compensating for the effects of rounding coefficients in the control algorithm. The minimum settling time is discussed analytically and a design is developed that reduces complexity in the control function, offers lower torque demands, and has acceptably small steady state error. A retarded response is mentioned, and the use of a digital processor is found to add delays in the rebalance loops, requiring specific positioning of zeroes in the determinant of the pulse transfer function. An example is given, noting that pick-off noise at the spin frequency or its harmonics can be eliminated by use of a notch filter. Finally, a compromise is viewed as possible if slightly increased overshoot and settling time are found acceptable with a prescribed computing delay. M.S.K.

A82-11934 Digital avionics - Promise and practice; Proceedings of the Joint Symposium, London, England, March 20, 1980. Symposium sponsored by the Royal Aeronautical Society and Institution of Electrical Engineers. London, Royal Aeronautical Society, 1981. 72 p.

Papers presented at the symposium provide an overview of the current status of digital avionic systems with emphasis on the practical experience in operating these systems, achievements and problems, and advanced technologies available. Topics discussed include: the influence of digital techniques on system architecture, certification of digital systems, the all digital military aircraft, and an airline's experience in the field. V.L.

A82-11937 # The all digital military aircraft. D. Roughton (British Aerospace Public, Ltd., Co., Brough, England). In: Digital avionics - Promise and practice; Proceedings of the Joint Symposium, London, England, March 20, 1980. London, Royal Aeronautical Society, 1981. 14 p.

Developments in avionic systems over the past two decades are reviewed. The main factor that emerges is the conflict between the increasing complexity required to meet operational demands and the need for simplicity of operation to ease the workload of the reduced aircrew. In future aircraft, as the number and type of systems continue to grow, system integration and system automation are essential to ensure that the pilot workload is kept at an acceptable level. V.L.

A82-11938 # The digital civil aircraft. J. F. Moore (British Aerospace Public, Ltd., Co., Aircraft Group Div., Bristol, England). In: Digital avionics - Promise and practice; Proceedings of the Joint Symposium, London, England, March 20, 1980. London, Royal Aeronautical Society, 1981. 16 p.

The development of digital avionics is reviewed with particular reference to application in civil aircraft. Examples of in-service systems in which digital technology has been already implemented are examined, including inertial navigation systems, aircraft integrated data systems/accident data recording, multiplexing systems, and the air intake control system of Concorde. Attention is given to the potential benefits of new applications, current developments, practical aspects, and implications of functional integration. Finally, future applications are discussed such as full digital engine control and flight controls (fly-by-wire system). V.L.

A82-11940 # The certification of digital systems. D. J. Hawkes (Civil Aviation Authority, London, England). In: Digital avionics - Promise and practice; Proceedings of the Joint Symposium, London, England, March 20, 1980. London, Royal Aeronautical Society, 1981. 12 p. 9 refs.

The present situation in the field of airworthiness certification of digital systems is reviewed and the future certification task is examined with emphasis on safety-critical applications. It is shown that the existing certification requirements are adequate for the new generation of digital systems. For the foreseeable future, the certification task will be very similar to that currently undertaken and will involve performance verification, environmental testing, and safety analyses. The certification task will be refined and judgement will be improved as the weaknesses and peculiarities of digital systems are exposed. V.L.

A82-11941 # Digital avionics systems - The RAF experience. B. J. Hunter (RAF, London, England). In: Digital avionics - Promise and practice; Proceedings of the Joint Symposium, London, England, March 20, 1980. London, Royal Aeronautical Society, 1981. 6 p.

The RAF's practical experience in operating digital avionic systems is reviewed with reference to a computer-based navigation and attack system that forms part of a pilot/aircraft control loop for navigation, weapon aiming, and flight direction installed on Jaguar aircraft. The system has proved to be flexible and reliable; modifications of the system can now be accomplished by a software, rather than hardware, change; and the first and second line testing has been reduced. The software maintenance practice and management are discussed in detail. V.L.

A82-11942 # Digital avionics: Promise and practice - An airlines experience in the field. J. E. Mills (British Airways, Hounslow, Middx., England). In: Digital avionics - Promise and practice; Proceedings of the Joint Symposium, London, England, March 20, 1980. London, Royal Aeronautical Society, 1981. 4 p.

The British Airways experience with digital avionic systems is reviewed with regard to the initial expectations, achievements, and maintenance and engineering problems encountered. It is shown that the introduction of digital systems into civil aviation did not produce the promised increase in reliability, the self test results being particularly disappointing. However, no maintenance problems of any great significance have been encountered. It is expected that the use of custom LSI and microprocessors will diminish problems previously associated with hardware and will provide improved reliability and more competent self test and monitoring, leading to improved first line servicing. V.L.

A82-11997 # The CIVIC - A concept in vortex induced combustion. II. J. R. Shekleton (Solar Turbines International, Turbomach Div., San Diego, CA). (*American Society of Mechanical Engineers, International Gas Turbine Conference, Houston, TX, Mar. 8-12, 1981, Paper 81-GT-12.*) *ASME Transactions, Journal of Engineering for Power*, vol. 103, Oct. 1981, p. 708-717. 34 refs.

The development of vortex induced combustion is reviewed, noting that the modelling is based on convective processes in unequally heated adjacent air masses. The aerodynamics of vortex flow are analytically examined, and reaction criteria in gas turbine and reciprocating engine vortex combustors are presented. Buoyant mixing to achieve fast, near constant volume combustion in diesel engines is described for two cases. Use of a rotating cup fuel injector in a 10 kW gas turbine to provide good atomization with viscous fluids, even in arctic conditions, is discussed, including a new design feature which avoids injecting the fuel mist into the swirl air. Test results and schematics are presented of various applications, stressing the ability of vortex induced combustion to display efficiencies with standard liquid fuels usually obtained only with natural gas. M.S.K.

A82-11999 * # Thermal expansion accommodation in a jet engine frame. M. H. Schneider (General Electric Co., Cincinnati, OH). (*American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, TX, Mar. 9-12, 1981.*) *ASME Transactions, Journal of Engineering for Power*, vol. 103, Oct. 1981, p. 776-780. Contract No. NAS3-20643.

A82-12021

Design advancements to enhance stress accommodation in gas turbine engine frames are described. Consideration is given to mechanical stiffness to maintain an adequate spring rate, and to thermal stresses in both ambient and transient modes. Noting that thermal stresses occur due to differing temperatures at different parts of the frame, the matching of the thermal expansion rates of different structural materials is emphasized. Adequate stiffness is necessary to avoid dynamic reactions leading to case cracking as a result of normal imbalances of moving parts. Stress and deflection analysis of a total frame concept using a three-dimensional finite element stress analysis computer program, with modelling of all frame components, is presented, and illustrations are provided.

M.S.K.

A82-12021 † **Jet fuel from carbon (Reaktivnoe toplivo iz uglia).** A. A. Krichko, M. K. Iulin, A. C. Arifulin, T. C. Nikiforova, and V. A. Puchkov (Akademiia Nauk SSSR, Institut Goriuchikh Iskopaemykh, Moscow, USSR). *Khimiia i Tekhnologiiia Topliv i Masel*, no. 9, 1981, p. 3-5. 8 refs. In Russian.

A jet fuel of the T-8V type has been obtained by isomerization and hydrogenation at 4 MPa of the hydrorefined 180-320 C fraction of a liquid-phase carbon hydrogenation product. The flow scheme and the material balance of the process are presented. V.L.

A82-12022 † **A protective additive for jet fuels (Zashchitnaia prisadka k reaktivnym toplivam).** O. P. Lykov, G. I. Shor, V. P. Lapin, V. V. Sashevskii, and L. I. Mosina (Moskovskii Institut Neftekhimicheskoi i Gazovoi Promyshlennosti, Moscow, USSR). *Khimiia i Tekhnologiiia Topliv i Masel*, no. 10, 1981, p. 37-40. 6 refs. In Russian.

A study has been carried out to investigate the protective action of an additive to jet fuels which consists of a mixture of dimers and trimers of synthetic fat acids. Results indicate that there exists a correlation between changes in the protective properties of the fuel as a function of the additive content, on the one hand, and changes in certain electrophysical characteristics of the fuel (e.g., conductivity, contact potential difference change, and electrifiability), on the other hand. V.L.

A82-12025 * **Design predictions for noise control in the cryogenic National Transonic Facility.** W. S. Lassiter (NASA, Langley Research Center, Hampton, VA). *Noise Control Engineering*, vol. 17, Sept.-Oct. 1981, p. 76-84. 6 refs.

Noise control in the National Transonic Facility - a cryogenic wind tunnel - has been examined in terms of acoustical design criteria, drive-fan noise and exhaust system noise. A duct lining with two layers of perforated sheeting and a gas-filled honeycomb core was selected for attenuating drive-fan noise. With the exception of attenuation peaks, attenuation of the lining was found to experimentally agree with predicted values at 20 C air temperatures. Exhaust system noise will be attenuated with a large muffler used in conjunction with a 6.1-m high acoustical enclosure. Fan noise from the fan-ejector system will be attenuated by fan silencers and the acoustic enclosure. S.C.S.

A82-12026 **Emerging technologies in aerospace structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980.** Conference sponsored by the American Society of Mechanical Engineers. Edited by J. R. Vinson (Delaware, University, Newark, DE). New York, American Society of Mechanical Engineers, 1980. 333 p. \$20.

Topics discussed include the emerging technologies in composite materials structures, in materials, and in structural dynamics, shock and impact. Particular attention is given to impact-initiated damage thresholds, adhesively bonded joints in composites, stress concentrations in bonded multilayer stiffened strips and base plates, and the fatigue life of coldworked holes. Consideration is also given to the response of nonlinear aircraft structural panels to high intensity noise, the dynamic numerical analysis of crack initiation, fast crack propagation and crack arrest, and the energy release rate of a penny-shaped crack at the fiber-end of a composite. J.F.

A82-12028 * # **Impact-initiated damage thresholds in composites.** A. V. Sharma (North Carolina Agricultural and Technical State University, Greensboro, NC). In: Emerging technologies in aerospace

structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980.

New York, American Society of Mechanical Engineers, 1980, p. 11-26. 10 refs. Grant No. NsG-1296.

An experimental investigation was conducted to study the effect of low velocity projectile impact on the sandwich-type structural components. The materials used in the fabrication of the impact surface were graphite-, Kevlar-, and boron-fibers with appropriate epoxy matrices. The testing of the specimens was performed at moderately low- and high-temperatures as well as at room temperature to assess the impact-initiated strength degradation of the laminates. Eleven laminates with different stacking sequences, orientations, and thicknesses were tested. The low energy projectile impact is considered to simulate the damage caused by runway debris, dropping of the hand tools during servicing, etc., on the secondary aircraft structures fabricated with the composite materials. The results show the preload and the impact energy combinations necessary to cause catastrophic failures in the laminates tested. A set of paired curves indicating the failure thresholds is shown separately for the tension- and compression-loaded laminates. The specific-strengths and -moduli for the various laminates tested are also given. (Author)

A82-12039 # **Coupled fluid/structure response predictions for soft body impact of airfoil configurations.** J. J. Engblom (United Technologies Corp., Government Products Div., West Palm Beach, FL). In: Emerging technologies in aerospace structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980.

New York, American Society of Mechanical Engineers, 1980, p. 209-223. 8 refs. Research supported by the United Technologies Corp.

Jet engine overhaul costs related to foreign object damages (FOD) are a significant concern in aircraft operations. Present FOD design systems, however, are not applicable to advanced airfoil configurations. An analytical design tool has therefore been developed to improve the FOD response prediction capability for the soft body impact of metal or composite fan blades, and is implemented by a finite element computer code. The basic approach involves coupling a fluid loading model with a structural model for the blade. Iterative effects are included in the solution, i.e., applied loads are a function of the structural response. Solutions include the effects of large displacement (geometric) and material (inelastic) nonlinearities. The code is also modified to treat the response of hybrid composite materials, demonstrating its capability to meet impact response predictions for complex metal or composite airfoil configurations. It is concluded that the analysis can be used to support the design of future high tip speed FOD-tolerant fan blades. J.F.

A82-12041 # **Response of nonlinear aircraft structural panels to high intensity noise.** C. Mei (Old Dominion University, Norfolk, VA). In: Emerging technologies in aerospace structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980.

New York, American Society of Mechanical Engineers, 1980, p. 245-272. 17 refs. Contract No. F49620-79-C-0169.

Design methods and design criteria for sonic fatigue prevention have been developed based on analytical and experimental techniques. This paper presents an analytical method for predicting the response of rectangular nonlinear structural panels subjected to broadband random acoustic excitation. The formulation is based on the Karman-Herrmann large deflection plate equations, a single-mode Galerkin approximation, the equivalent linearization method, and an iterative procedure. Both simply-supported and clamped-supported conditions with immovable or movable inplane edges are considered. Panel mean-square deflection, maximum mean-square stress, and equivalent linear frequency at various acoustic loadings are determined and presented in graphical form. The results obtained were shown to agree well with experimental ones, and suggestions for further research are given. J.F.

A82-12043 # **Crack growth evaluation of a method to convert real-time loads history to a simplified engineering spectra.** E. J. Ferko (Lockheed-Georgia Co., Marietta, GA). In: Emerging technologies in aerospace structures, design, structural dynamics and

materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980. New York, American Society of Mechanical Engineers, 1980, p. 285-294. 6 refs.

The random and independent nature of shear and axial stresses due to gust sources poses a complex problem for the structural analysis of cracks emanating from fastener holes in spanwise and beam-web splices of a transport aircraft wing. A practical engineering solution to the shear/axial stress interaction problem was developed for the C-5A wing, and a box beam test program was conducted to evaluate the solution. The evaluation was accomplished by comparing crack propagation rates generated by testing flight measured real time histories (RTH) with the engineering solution (referred to as the Equivalent Analytical Representation spectra). The baseline RTH spectra consisted of loads data recorded during dynamic response flight testing. The EAR spectra was derived from the aforementioned RTH data and was analytically developed utilizing peak counting methods and the empirical shear/axial stress interaction solution. Fractographic correlation of numerous cracks indicated that the EAR spectra adequately simulated the random nature of shear and axial stresses in the RTH data. (Author)

A82-12045 # Numerical treatment of helicopter rotor stability problems. R. Vepa and T. S. Balasubramanian (National Aeronautical Laboratory, Bangalore, India). In: Emerging technologies in aerospace structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980. New York, American Society of Mechanical Engineers, 1980, p. 307-319. 14 refs. Research supported by the Ministry of Defence.

The problem of calculating the Floquet transition matrix for parametric stability problems is considered. A new method of calculating the transition matrix with a minimum number of time steps is described. The method is shown to be extremely efficient for a wide class of helicopter stability problems, including flapping stability of a helicopter rotor, helicopter ground resonance with a nonisotropic rotor and pitch-flap-bending stability of a helicopter rotor in forward flight. The relationship of the method to the classical method of averaging is pointed out. (Author)

A82-12048 ACMA - Fact or fantasy. W. T. Mikolowsky and W. A. Garrett (Lockheed-Georgia Co., Marietta, GA). *Lockheed Horizons*, Fall 1981, p. 2-12.

The feasibility of the advanced civilian/military aircraft (ACMA) for use as both an advanced military airlift vehicle and a commercial airfreighter is discussed. A partnership in development between government and industry is expressed as necessary to reduce costs through larger production quantities, to increase emergency airlift capabilities in the Civil Reserve Air Fleet, and commercial maintenance of military aircraft. Design options and requirements are presented along with timetables, showing production delivery to commence in 1994. Topics such as commercial need, energy use, engine design, and financial planning are examined, with emphasis on system features that enhance the commercial attractiveness of the vehicle. A preliminary configuration shows a payload capability of 390,000 lbs with a fuel efficiency 50% better than that of the 747-200F. M.S.K.

A82-12049 History of flight testing the L-1011 TriStar jet transport. II - Testing highlights since initial certification of the L-1011-1. R. J. Gatineau (Lockheed-California Co., Palmdale, CA). *Lockheed Horizons*, Fall 1981, p. 14-29.

A82-12087 # Considerations and applications for the use of fluidics in aerospace controls. T. G. Sutton (AirResearch Manufacturing Company of Arizona, Phoenix, AZ). In: 20th Anniversary of Fluidics Symposium, Chicago, IL, November 16-21, 1980, Proceedings. New York, American Society of Mechanical Engineers, 1980, p. 73-79. 6 refs.

Fluidics technology has been considered for use in controls in aerospace environments in order to obtain reliable and cost-effective systems. While many applications involving fluidics have been in production for several years, there have been a number of failures while attempting to apply fluidics technology to aerospace applications. Because of this, fluidic techniques must be very carefully evaluated for any application before being considered as the most desirable technology to be used. An overview is given of design

parameters which must be given due consideration by the fluidic system designer. Included are the interfacing of the technology with other system components. Case histories of three fluidic control applications are cited. C.R.

A82-12100 Quantification of the thermal environment for externally carried aircraft stores and ordnance. H. Schafer and I. Barbe (U.S. Naval Weapons Center, China Lake, CA). *Journal of Environmental Sciences*, vol. 24, Sept.-Oct. 1981, p. 23-26.

Thermal testing procedures for aircraft external stores and ordnance are discussed, noting the importance of considering the entire range of possible thermal environments for each tested component. A method is proposed in which necessary parameters of environmental variables such as aircraft speed, altitude, air temperature, and amount of fuel available are considered in terms of percentiles. A Gaussian distribution is assumed for each environmental range, enabling for example, the elimination of extreme high and low flight speeds from average environment estimates. Use of the Arnold Research and Development Center standard atmosphere was found to be preferable for engineering considerations because of inherent biasing errors in the MIL-STD-210 hot and cold data atmosphere. Techniques of cross-correlating environmental percentiles are defined, and it is emphasized that thermal gradients cause the greatest hardware performance degradation. M.S.K.

A82-12107 # The dispersion of drop sizes in gas turbine fuel nozzle sprays. D. L. Markham (Ex-Cell-O Corp., Walled Lake, MI). In: Fluid mechanics of combustion systems; Proceedings of the Fluids Engineering Conference, Boulder, CO, June 22, 23, 1981. New York, American Society of Mechanical Engineers, 1981, p. 95-100. 6 refs.

The dispersion of drop sizes in sprays as produced by gas turbine fuel nozzles was studied by conducting a large number of tests on several fuel nozzle sprays using a Malvern ST1800 Particle and Droplet Size Distribution Analyzer. It is found that the size dispersion of a spray depends on the location where the spray cloud is sampled, nozzle type, and nozzle operating condition. It is concluded that to fully specify the drop size characteristics of a gas turbine fuel nozzle spray, not only must the mean drop size of the drop size distribution be reported, but also the drop size dispersion. P.T.H.

A82-12118 # Application of numerical modeling to gas turbine combustor development problems. G. J. Sturgess, S. A. Syed, and D. Sepulveda (United Technologies Corp., Commercial Products Div., East Hartford, CT). In: Fluid mechanics of combustion systems; Proceedings of the Fluids Engineering Conference, Boulder, CO, June 22, 23, 1981. New York, American Society of Mechanical Engineers, 1981, p. 24-250. 23 refs.

The effects of dome cooling air changes in an experimental combustor for a large, turbofan gas turbine engine are investigated by means of perturbation studies carried out with numerical modeling. Two geometrical configurations are examined at high engine power levels, and calculated changes in the flow fields are compared with evidence obtained from experimental engines. Changes in dome and liner pressure drops are observed with severe dome distress in one of the configurations. It is concluded that the combustor simulations are qualitatively correct and have satisfactory quantitative agreement without requiring exact geometrical representations. D.L.G.

A82-12120 * # On the prediction of swirling flowfields found in axisymmetric combustor geometries. D. L. Rhode, D. G. Lilley, and D. K. McLaughlin (Oklahoma State University, Stillwater, OK). In: Fluid mechanics of combustion systems; Proceedings of the Fluids Engineering Conference, Boulder, CO, June 22, 23, 1981. New York, American Society of Mechanical Engineers, 1981, p. 257-266. 32 refs. Grant No. NAG3-74.

The paper reports research restricted to steady turbulence flow in axisymmetric geometries under low speed and nonreacting conditions. Numerical computations are performed for a basic two-dimensional axisymmetrical flow field similar to that found in a conventional gas turbine combustor. Calculations include a staircase boundary representation of the expansion flow, a conventional k-epsilon turbulence model and realistic accommodation of swirl effects. A preliminary evaluation of the accuracy of computed flowfields is accomplished by comparisons with flow visualizations using neutrally-buoyant helium-filled soap bubbles as tracer particles.

Comparisons of calculated results show good agreement, and it is found that a problem in swirling flows is the accuracy with which the sizes and shapes of the recirculation zones may be predicted, which may be attributed to the quality of the turbulence model. D.L.G.

A82-12149 † **Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity.** R. M. Welch (Mainz, Universität, Mainz, West Germany), S. K. Cox (Colorado State University, Fort Collins, CO), and K. Ia. Kondrat'ev (Glavnaia Geofizicheskaiia Observatoriia, Leningrad, USSR). *Journal of Geophysical Research*, vol. 86, Oct. 20, 1981, p. 9795-9800. 28 refs. NSF Grants No. ATM-78-05743; No. ATM-77-22384.

A82-12170 † **Control of electromechanical actuator elements for flight vehicles (Upravlenie ispolnitel'nyimi elementami slediashchikh elektroprivodov letatel'nykh apparatov).** B. I. Petrov, V. V. Bal'bukh, N. P. Pappe, V. P. Pappe, V. A. Serdiuk, and V. G. Stebletsov. Moscow, Izdatel'stvo Mashinostroenie, 1981. 222 p. 40 refs. In Russian.

The control theory of electromechanical actuator elements is developed with particular reference to application in electrical flight control systems (e.g., for tactical missiles). Attention is given to the use of ac motors and dc motors in such systems, and to digital actuator systems. The limiting dynamic possibilities and energetic characteristics of electromechanical actuators are considered. B.J.

A82-12222 † **The enhancement of heat exchange in channels /2nd revised and enlarged edition/ (Intensifikatsiia teploobmena v kanalakh /2nd revised and enlarged edition/).** E. K. Kalinin, G. A. Dreitser, and S. A. Iarkho. Moscow, Izdatel'stvo Mashinostroenie, 1981. 208 p. 199 refs. In Russian.

An analysis is presented of various means for the enhancement of heat exchange in the heat exchange channels of flight vehicles. The factors governing the selection of heat exchange enhancement method are considered, and specific methods applicable to right channels and longitudinal flow around a bundle of tubes, and curved channels are indicated. Attention is then given to the methods and mechanisms of heat exchange enhancement in pipes, around pipe bundles and in circular channels, in two-dimensional and triangular channels, taking into account the effects of hydraulic resistance and the effectiveness of the various methods is evaluated. The enhancement of heat exchange in the presence of film boiling on the one hand and condensation on the other in channels is also examined.

A.L.W.

A82-12267 # **Validation studies of turbulence and combustion models for aircraft gas turbine combustors.** S. A. Syed and G. J. Sturgess (United Technologies Corp., Commercial Products Div., East Hartford, CT). In: Momentum and heat transfer processes in recirculating flows; Proceedings of the Winter Annual Meeting, Chicago, IL, November 16-21, 1980. New York, American Society of Mechanical Engineers, 1980, p. 71-89. 29 refs.

The paper describes work performed as part of a continuing program to explore computational fluid dynamics procedures and related turbulence and combustion models for application to the design, understanding, and development of aircraft gas turbine combustors. Validation studies were conducted using a finite difference procedure (TEACH) to solve the relevant steady, two-dimensional, elliptic transport equations for turbulent flow. The familiar two equation (k-epsilon) turbulence model was used. The combustion model was based on the dissipation rate of oxidant, fuel, and product containing eddies. It was concluded that for confined, nonreacting flows with reasonably well defined boundary conditions, the turbulence model predicts mean flow quantities to an accuracy of about 85 percent in regions of parabolic flow. The size of the recirculation zone is underpredicted by about 15-20 percent, and its strength is underpredicted by 20-25 percent. (Author)

A82-12318 † **Extending the limits of reliability theory.** H. Goldberg. New York, Wiley-Interscience, 1981. 275 p. 15 refs. \$32.50.

Aspects of probability and statistics are examined, taking into account the objective view of probability, the binomial distribution, the use of probability for prediction, the meaning of the reliability (survivor) function, questions of discrete and continuous distribution, time-to-failure distributions, and distributions found in the

reliability literature. Attention is given to the determination of the time-to-failure distribution of a component, the sources of component failure data, the real world of electronic component procurement, the time to first failure for new systems, and system survivor functions for certain component distributions. Redundancy and survivor functions of systems are considered along with questions related to renewal theory and mean time between failures, a Monte Carlo investigation of systems based on normal distributions, and subjects related to precision, confidence, and numbers tested. G.R.

A82-12323 † **Antenna theory and design.** W. L. Stutzman (Virginia Polytechnic Institute and State University, Blacksburg, VA) and G. A. Thiele (Dayton, University, Dayton, OH). New York, John Wiley and Sons, 1981. 608 p. 158 refs. \$30.95.

Antenna fundamentals and definitions are examined, taking into account electromagnetic fundamentals, the solution of Maxwell's equations for radiation problems, the ideal dipole, the radiation pattern, directivity and gain, reciprocity and antenna pattern measurements, antenna impedance and radiation efficiency, antenna polarization, antennas in communication links and radar, and the receiving properties of antennas. Some simple radiating systems are considered along with arrays, line sources, wire antennas, broadband antennas, moment methods, and aperture antennas. High-frequency methods and aspects of antenna synthesis are discussed, giving attention to geometrical optics, physical optics, wedge diffraction theory, the ray-fixed coordinate system, the cylindrical parabolic antenna, and linear array methods. G.R.

A82-12449 † **Commercial EMS considerations for small gas turbine engines.** R. Halliday (Pratt and Whitney of Canada, Ltd., Longueuil, Quebec, Canada). In: Aircraft gas turbine engine monitoring systems; Proceedings of the Aerospace Congress and Exposition, Los Angeles, CA, October 13-16, 1980. Congress and Exposition sponsored by the Society of Automotive Engineers. Warrendale, PA, Society of Automotive Engineers, Inc., 1981, p. 23-26.

It is shown that electronic automated engine monitoring systems (EMS) offer advantages over manual methods for power assurance, trend and limit exceedance monitoring, and low cycle fatigue and creep life recording. System cost, which is the main constraint on EMS for small gas turbines, is proportional to the number of parameters measured. Although EMS cost may preclude a full diagnostic capability, it may be reduced by 'piggy backing' with other systems, such as those for fuel control or flight monitoring. Future EMS are predicted to be part of modular, fully integrated systems employing multiplexing techniques. It is concluded that ARP 1587 is needed for that level of integration to be achieved. Among the parameters monitored by an EMS are turbine temperature, gas generator speed, free turbine speed, output torque, pressure altitude, and outside air temperature. O.C.

A82-12450 † **Further application and development of an engine usage/life monitoring system for military services.** R. Holl. In: Aircraft gas turbine engine monitoring systems; Proceedings of the Aerospace Congress and Exposition, Los Angeles, CA, October 13-16, 1980. Congress and Exposition sponsored by the Society of Automotive Engineers. Warrendale, PA, Society of Automotive Engineers, Inc., 1981, p. 27-30.

The Engine Usage Monitoring System (EUMS) which determines the rate and extent to which major and critical components of military engines are being consumed. Rapid development and limited funding constraints led to the production of the Mk I EUMS, which incorporates a Phillips-type magnetic tape cassette as the recording medium and serial digital data formatting and has shown good performance point recording accuracy and reliability. The Mk II development of the EUMS incorporates a microprocessor, a solid state memory, and associated large scale electronics miniaturization and integration. With the addition of a visual display unit, onboard computing/display facility requirements are also satisfied. A civil aviation application of the EUMS is projected on the strength of its basic simplicity and low cost. O.C.

A82-12495 † **Powder metallurgy superalloys - Aerospace materials for the 1980's; Proceedings of the Conference, Zurich, Switzerland, November 18-20, 1980. Volume 1.** Shrewsbury, Salop, England, MPR Publishing Services, Ltd., 1980. 237 p.

The conference focused on the latest advances in the powder metallurgy of superalloys, including developments in powder production, consolidation, and shape-making techniques, and applications. Papers are presented on the novel aspects for high-quality metal powder production equipment, oxide dispersion strengthened materials by mechanical alloying, potential for PM superalloys in aero engine application, HIP systems for superalloys, and electron-beam welding of PM nickel-base superalloys. V.L.

A82-12496 **Superclean superalloy powders by the rotating electrode process.** P. Loewenstein (Nuclear Metals, Inc., Concord, MA). In: Powder metallurgy superalloys - Aerospace materials for the 1980's; Proceedings of the Conference, Zurich, Switzerland, November 18-20, 1980. Volume 1. Shrewsbury, Salop, England, MPR Publishing Services, Ltd., 1980, p. 7, 7-1 to 7-28. 18 refs.

A REP (rotating electrode process) powder system with inert gas handling has been developed for the manufacture of 'superclean' superalloy powders for fatigue-critical turbine applications. The system employs a noncontaminating plasma arc source and input electrodes in the form of precision ground bars that are free from nonmetallic inclusions. The production capability of the superalloy powder facility is approximately 500,000 kg per year. V.L.

A82-12497 **Superalloy turbine components - Which is the superior manufacturing process, as-HIP, HIP plus Isoforge, or 'gatorizing' of extrusion consolidated billet.** J. Coyne, W. H. Coutts, C. Chen, and R. P. Roehm (Wyman-Gordon Co., North Grafton and Worcester, MA). In: Powder metallurgy superalloys - Aerospace materials for the 1980's; Proceedings of the Conference, Zurich, Switzerland, November 18-20, 1980. Volume 1. Shrewsbury, Salop, England, MPR Publishing Services, Ltd., 1980, p. 11, 11-1 to 11-31.

Identical parts of superalloys IN-100, René 95, MERL-76, AF-115, and Astroloy, which are being considered for turbine engine applications, have been produced by three different powder metallurgy techniques: as-HIP, HIP plus Isoforge, and gatorizing of extrusion-consolidated billet. The mechanical properties of parts produced by the different processes are found to be equivalent. Thus, the choice of a process should be based on factors other than the currently expected mechanical properties; namely, materials utilization, inspectability, and economics. V.L.

A82-12499 **Superalloy powder engine components; controls employed to assure high quality hardware.** J. E. Coyne, W. H. Everett, and S. C. Jain (Wyman-Gordon Co., North Grafton and Worcester, MA). In: Powder metallurgy superalloys - Aerospace materials for the 1980's; Proceedings of the Conference, Zurich, Switzerland, November 18-20, 1980. Volume 1. Shrewsbury, Salop, England, MPR Publishing Services, Ltd., 1980, p. 24, 24-1 to 24-27.

A program involving the production of several hundred turbine engine components from René 95 alloy is reviewed. Consideration is given to powder transportation and handling, development of stock acceptance tests and quality assurance program, precautions taken to avoid powder contamination in the process of handling prior to HIP'ing, and final testing. Examples of crack initiating defects and their effect on mechanical properties are included. V.L.

A82-12560 # **Lineup of the IM-series aircraft-derivative gas turbines.** *Ishikawajima-Harima Engineering Review*, vol. 21, July 1981, p. 279-285. 13 refs. In Japanese, with abstract in English.

In order to establish the reliability of the power turbines to be developed by IHI, extensive investigations are carried out, in particular, on the rotor assemblies. With engine test runs using actual IM5000 gas turbines, confirmation of the power turbine blade vibratory stress is carried out through the whole operating range. The measured stress levels reveal that they are far below the critical limits and that no detrimental resonance is to be expected. The same procedure is used with the IM2500 power turbine. In addition to analyses of the rotating parts, the various stationary parts are tested, especially the transient behavior of the casing for quick thermal response at the time of starting, stopping and emergency shutdown of the engine. C.R.

A82-12563 **Fuel conservation - DC-9 series 20/30/40.** *Society of Flight Test Engineers, Journal*, vol. 3, Sept. 1981, p. 2-17.

Operational performance penalties and approximate fuel costs associated with the aerodynamics, flight operations, fuel gage system and performance analysis aspects of the DC-9 Series 20, 30 and 40 aircraft are presented. Degradations in aerodynamic cleanliness, caused by the gradual deterioration of various seals, rigging adjustments and skin surface smoothness, are shown to lead to drag increases of less than 0.5%, which, however, represents a significant cost in view of the amount of fuel consumed. Flying off-optimum altitude or Mach number may result in excess fuel expenditures greater than those due to degraded aerodynamic cleanliness. Other operational factors with substantial influence on fuel use include fuel or aircraft weight, center of gravity, flight time, the use of automatic flight control systems, APU operation, engine starting times, takeoff procedures, climb speed, en route profile, descent profile, and approach maneuvers. The DC-9 fuel gage system has been designed to be as accurate as possible in all phases, in order to minimize the necessity of carrying excess fuel for a given flight. Finally, investigations of aircraft performance may be used to identify areas requiring correction through the comparison of the indicated performance level against a reference, the assessment of engine and airframe contributions, and the investigation of the most likely areas for correction - the external control surfaces and internal systems. S.C.S.

A82-12564 **Procedures and analysis techniques for determining static air minimum control speeds.** E. N. Bradfield (USAF, Flight Test Center, Edwards AFB, CA). *Society of Flight Test Engineers, Journal*, vol. 3, Sept. 1981, p. 18-48. 6 refs.

A method is presented which can be used to establish the minimum air speed required for the static lateral and directional control of a multiengine aircraft following the failure of one or more engines. Equations for the thrust moment and rudder pedal force coefficient in an asymmetrical force condition are derived from minimum directional control speed theory, and applied to the analysis of data obtained in climbs of the B-57 aircraft through a significant altitude band at minimum directional control speed with wings level and banked at various angles, and with a rudder power assist system both operational and inoperative. An analysis procedure is also presented for aircraft for which minimum control is defined by the lack of lateral, rather than directional control, such as STOL and powered-lift aircraft. These methods allow minimum control speed testing to be accomplished safely, without the necessity of flying at extreme low altitudes with an engine shut down, and permit extrapolation to off-standard-day conditions and various gross weights. S.C.S.

A82-12626 **National Aerospace Meeting, Treviso, PA, April 8-10, 1981, Proceedings.** Meeting sponsored by the Institute of Navigation. Washington, DC, Institute of Navigation, 1981. 190 p.

Papers are presented on such topics as all-digital GPS receiver mechanization, worldwide coverage of the Phase II Navstar satellite constellation, real-time missile tracking with GPS, navigation task partitioning in distributed-processing avionics systems, and memory requirements for future aerospace navigation systems. Consideration is also given to the simulation study of a hybrid strapdown attitude and heading reference system, a comparative study of strapdown algorithms, ring laser gyro navigator flight test results, and size effects in strapdown navigators. P.T.H.

A82-12630 # **Satellite geometry considerations for low cost GPS user equipment.** Y. Rosenthal (Intermetrics, Inc., Cambridge, MA). In: National Aerospace Meeting, Treviso, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 30-32. FAA-supported research.

The paper evaluates the geometrical properties of various GPS satellite configurations as seen by a low-cost user equipment designed for use by general aviation (GA). The GA user is equipped with one antenna which covers an 85-deg cone perpendicular to the plane of the aircraft. Therefore, when the aircraft banks, satellites which are above the horizon may be shadowed. Through a nominal turn at a bank angle of 25 deg, the identity of the visible satellites is changing rapidly. Hence, preselection of the best four satellites is impossible. Criteria for comparing 24 satellites from the GA user point of view is

presented, as well as some preliminary results which indicate the different results provided by different constellations. Results show that as far as GA is concerned, the coverage provided by various 24 satellite constellations is not of equal value. P.T.H.

A82-12634 # A solution to the static geometry problem for JTIDS relative navigation. R. Weiss (Intermetrics, Inc., Cambridge, MA) and P. Asher (USAF, Joint Program Office, Bedford, MA). In: National Aerospace Meeting, Trevoise, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 62-64.

The current JTIDS (Joint Technical Information Distribution System) relative navigation algorithm restricts the use of relative position data in order to maintain stability. In a static geometry situation, the position quality will be degraded. This paper proposes a solution to the static geometry problem which involves a second source that maintains a high position quality by constraining its covariance matrix. There are several ways to implement this situation, each of which must be evaluated in a simulation environment for scenarios involving transitions from static geometry to normal mode. P.T.H.

A82-12636 # Hard limited approaches to correlation velocity sensing. T. J. Lund, R. E. Chapman, and G. A. Murdock (Teledyne, Inc., Teledyne Ryan Electronics, San Diego, CA). In: National Aerospace Meeting, Trevoise, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 79-83. 6 refs.

Correlation velocity sensors determine velocity by measuring the time delay required for best correlation between signals gathered by two downward looking radar receiver antennas having known separation along the velocity axis being measured. This paper discusses a variation of this basic technique in which the received signals are hard limited such that correlation is only performed on the phase of the signal. The hard limiting approach avoids the need for AGC and allows the receiver outputs to be applied directly to a digital processor. Comparisons of correlation functions are presented for linear correlations on the total signal (phase and amplitude), amplitude only and phase only. It is shown that the correlation properties of hard limited signals are well suited to correlation velocity sensing. The results of simulations of the correlation velocity sensing process, which included a realistic terrain scattering model, are presented for various flight conditions and terrain types. The implementation of a hard limited correlation velocity sensor is discussed. (Author)

A82-12637 # Memory requirements for future navigation systems. R. Fedorak (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) and B. A. Zempolich (U.S. Navy, Naval Air Systems Command, Washington, DC). In: National Aerospace Meeting, Trevoise, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 84-89.

The paper examines current problems concerning memories used in aerospace navigation systems, identifies technical management concerns relative to various aspects of current use of specific memory technologies, and discusses memory requirements for future aerospace navigation systems. Particular attention is given to such aspects as nonvolatility, electrical reprogrammable memories, commonality of memory hardware between platforms, packaging, and memory capacity. MNOS EEPROM, MNOS 8K BORAM, MNOS EAROM, and bubble memories are considered. P.T.H.

A82-12638 # Omega station 10.2 kHz signal selection made easy. R. R. Gupta and R. S. Warren (Analytic Sciences Corp., Reading, MA). In: National Aerospace Meeting, Trevoise, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 90-103. 7 refs.

Recently developed Omega station signal coverage prediction diagrams for 10.2 kHz at eight representative diurnal and seasonal global times of the year provide the most complete presentation of Omega station signal coverage ever available to Omega users. This paper presents minimum and maximum coverage extremes characterized by the coverage diagrams for the eight representative coverage times of the year for two signal selection criteria. A simplified algorithm which yields a conservative determination of the coverage

is obtained by using the maximum coverage boundary. The range and bearing coordinates of minimum and maximum SNR boundaries for -20 dB and -30 dB are provided in tabular form for each Omega station. P.T.H.

A82-12639 # FAA acceptance tests on the NAVSTAR GPS Z-Set receiver. R. J. Esposito (FAA, Technical Center, Atlantic City, NJ). In: National Aerospace Meeting, Trevoise, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 104-107.

This paper describes FAA acceptance tests on the NAVSTAR GPS Z-Set receiver which were conducted in a USAF System Command C-141 aircraft over the instrumented range located at the Yuma Proving Ground. The Yuma laser tracking system computed a reference trajectory against which the GPS receiver solution was compared. Data from five flights, totalling over six hours, are presented with the objective of assessing Z-Set capabilities to meet civil aviation requirements for non-precision approaches. (Author)

A82-12640 # A navigation systems planning model. H. L. Solomon and A. R. Stephenson (Systems Control, Inc., Palo Alto, CA). In: National Aerospace Meeting, Trevoise, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 108-119.

The advent of Navstar/GPS has directed the attention of government decision-makers to the possibility of ultimately replacing or supplementing existing navigation systems with one or more alternative systems. To assist these decision-makers in evaluating these and other navigation policy alternatives, a navigation system cost/benefit model is being developed. A comprehensive data base is also being developed from which the appropriate information can be extracted by the model in response to navigation system implementation/decommissioning scenarios, as defined by the model users. The model will predict the user's annualized response to a stipulated scenario in terms of receiver purchases, thereby permitting navigation planners not only to consider operator costs but also the expected costs and benefits on either an individual or combined user group basis. The model's outputs will also be useful to individual user groups in assessing their position vis-a-vis navigation system policy alternatives. P.T.H.

A82-12641 # Simulation study of a hybrid strapdown attitude and heading reference system. D. B. Reid, B. N. McWilliam (Philip A. Lapp, Ltd., Toronto, Canada), and D. F. Liang (Defence Research Establishment, Ottawa, Canada). In: National Aerospace Meeting, Trevoise, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 139-147. 13 refs.

The aircraft attitude and heading reference system (AHRS) considered in this paper comprises a low-accuracy strapdown inertial measurement unit (IMU), a strapdown magnetometer triad, which provides reference heading information, and air data sensors from which barometric altitude and true airspeed measurements are derived. A variable-dimension U-D factorized Kalman filter is employed to estimate the AHRS error state from the redundant sensor data. Estimated errors are fed back into the system using a combination of continuous and impulsive control methods to bound the inertial attitude, heading, and velocity errors and reduce the rate of position error growth. A data compression algorithm is employed for smoothing of incoming measurement data to enable high-rate information to be incorporated into the filtering process at minimum computational cost. The system operates in three modes: normal AHRS mode, alignment (erection) mode and magnetics calibration mode, in which the U-D filter is utilized to estimate systematic errors in the sensed magnetic field during a ground 'swing' procedure. Initial results obtained by full-scale simulation indicate that, with a low-accuracy strapdown IMU, the system can achieve roll and pitch accuracies of about 5 arc minutes (RMS) and a heading accuracy of approximately .75 degree (RMS). (Author)

A82-12642 # The integrated inertial sensor assembly (IISA) - A redundant strapdown system for advanced aircraft navigation and flight control functions. M. S. Dipasquo (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). In: National Aerospace Meeting, Trevoise, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation,

1981, p. 153-162.

In order to achieve the benefits of an integrated inertial sensor assembly (IISA) for the next generation aircraft, the U.S. Navy has embarked on an advanced development program to demonstrate the IISA concept. This paper examines the requirements definition, the system concept formulation, and the design definition of the advanced development model (ADM) that will be used for concept validation in a later flight test program. P.T.H.

A82-12643 # Integrated satellite navigation and strapdown attitude and heading reference systems for civil air carriers. J. J. Hopkins (Navigation Development Services, Inc., Northridge, CA). In: National Aerospace Meeting, Trevese, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 163-170. 17 refs.

The potential of the integrated GPS navigator and the strap-down AHRS as a replacement for several existing avionics systems is investigated. Its application is discussed including the economic impact with regard to acquisition and maintenance. The system components and integration approach are described, and the expectations for favorable performance comparisons with its competition are presented. It is concluded that the economic and performance advantages are unmistakably outstanding. Consequently, to save costs and to safely handle increased traffic there is a strong likelihood that integrated GPS/AHRS will become the standard position, velocity, and attitude reference system for future civil aircraft. P.T.H.

A82-12644 # Ring Laser Gyro Navigator /RLGN/ flight test results. K. L. Bachman (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). In: National Aerospace Meeting, Trevese, PA, April 8-10, 1981, Proceedings. Washington, DC, Institute of Navigation, 1981, p. 171-178.

This paper describes a flight test program and the resultant navigation performance achieved on an Advanced Development Model (ADM) Ring Laser Gyro Navigator (RLGN) in Navy A-7E and P-3C aircraft. As the RLGN represents a significant departure from conventional gimballed inertial system technology, a brief functional system description is given highlighting key hardware and software design features. This is followed by a description of the A-7E flight test program, its objective, flight profiles, method of data acquisition, and analysis of results. The P-3C flight test program is discussed including a description of the flight test recording instrumentation, flight profiles, data reduction, and analysis of results. An indication of system reliability, maintenance, and calibration actions versus system design goals is given. Effects of high latitude on system alignment and navigation performance are also highlighted. (Author)

A82-12646 Kevlar composites; Proceedings of the Symposium, El Segundo, CA, December 2, 1980. Symposium sponsored by the Technology Conferences. El Segundo, CA, Technology Conferences, 1980. 96 p. \$24.

Papers presented cover Kevlar-49 properties and Kevlar/epoxy composite materials. Kevlar roles in the aerospace industry were noted in the design of the L-1011 Tristar components, in the materials processing for commercial aircraft, and applications in commuter aircraft; additional papers describe Kevlar use in life-saving equipment, for rocket motors, pressure vessels, and fuel tanks. Finally, the methods and tools necessary for using Kevlar are presented. D.H.K.

A82-12647 Seven years experience with Kevlar-49 in the Lockheed L-1011 Tristar. R. H. Stone (Lockheed-California Co., Burbank, CA). In: Kevlar composites; Proceedings of the Symposium, El Segundo, CA, December 2, 1980. El Segundo, CA, Technology Conferences, 1980, p. 25-43.

A history of the use of Kevlar-49 in aircraft structures is presented. The aramid fibers provide a 25-30% weight reduction over fiberglass with 1.5 times the stiffness, in addition to comparable tensile strength; compressive strength is lower, though acceptable. Aircraft parts were fabricated on fiberglass production equipment using epoxy resin prepregs and tested for durability, impact resistance, and flammability; all were found to be comparable to

fiberglass. Wing body sandwich fairings, underwing fillet panels, and aft engine fairings were built, tested for aerodynamic loads, and found acceptable in a NASA flight service program. The parts were then mounted on Lockheed L-1011's for use in commercial airline service; after 50,000 flying hours wear was equivalent to the use of fiberglass. Interior and exterior applications in aircraft, such as for rudder and trailing edge flaps, are discussed. D.H.K.

A82-12694 Wings in the sun - The evolution of Solar Challenger. M. Cowley. *Flight International*, vol. 119, June 13, 1981, p. 1865-1868.

The design, development and testing of the Solar Challenger aircraft are described, with attention to its lightweight structural design and photovoltaic cell array-powered electric propulsion system. The configuration features a cantilever wing and horizontal tail, whose upper surfaces support 236 sq ft of solar cells that are rated at 13% conversion efficiency. The main wing spar and fuselage boom are constructed by wrapping a carbon fiber tube with 1/4-in.-thick Nomex honeycomb, followed by two layers of Kevlar cloth. Flutter tests of the airframe have been conducted at speeds of up to 65 mph by mounting the tail, fin and wing on a van. The aircraft is designed for 100-mile flights at 5000-10,000 ft altitudes and 25-35 mph, but the nearly horizontal mounting of the solar cells restricts flight conditions to those with high sun angles, at midday. When the sun is low in the sky, as in winter, the Solar Challenger must fly due north to maximize insolation. O.C.

A82-12696 # Helicopter icing spray system - Improvements and flight experience. D. Belte (U.S. Army, Edwards AFB, CA). (*Canadian Aeronautics and Space Institute, Flight Test Symposium, Medley, Alberta, Canada, Mar. 31, Apr. 1, 1981.*) *Canadian Aeronautics and Space Journal*, vol. 27, 2nd Quarter, 1981, p. 93-106. 6 refs.

In 1979 improvements were made to the helicopter icing spray system used in icing qualification tests. The improvements were aimed at reducing drop diameter and eliminating ice formation on the spray boom. A Sonicore nozzle was selected to replace the original atomizers and the number of atomizers on the spray boom was tripled. The newly modified configuration was evaluated using a UH-1H helicopter. Measurements were made of drop size distribution and liquid water content. Spray cloud measurements showed great improvement over earlier characteristics, and the median volumetric diameter approached that of natural clouds. The types of ice formation also reflected the improvement in cloud quality. Since in-flight spray simulation cannot duplicate the 100% relative humidity of a natural icing cloud, a computer program was developed to define the evaporation effect on liquid water content. An expanded airspeed range was used for 1980-1981 tests and results were compiled for the UH-60A, UH-1H ice phobics, Bell Model 412 and Grumman OV-1D. S.C.S.

A82-12697 # Fractographic determination of fatigue crack growth rates in aircraft components. W. Wiebe and R. V. Dainty (National Aeronautical Establishment, Structures and Materials Laboratory, Ottawa, Canada). (*Canadian Aeronautics and Space Institute, Annual General Meeting, Montreal, Canada, May 11, 12, 1981.*) *Canadian Aeronautics and Space Journal*, vol. 27, 2nd Quarter, 1981, p. 107-117.

The application of electron fractography to the failure analysis of aircraft components is considered to be rewarding because it frequently permits the precise identification of the causes of component failure. Quantitatively, considerable effort has been devoted to the development of techniques specifically directed to the evaluation of fatigue crack growth rate information, both from service fatigue failures, and from components fractured during full-scale aircraft laboratory fatigue tests. Originally, the fractographic determination of crack growth rate data in these laboratory tests was relatively straightforward, since discrete numbers of load cycles were applied at each of the various load levels in the fatigue loading spectrum. However, recent use of computer-controlled random fatigue loading equipment has produced new problems associated with the identification and correlation of the randomly spaced fatigue striations on the fracture surface, and the derivation of crack growth rate data from them. The fractographic methods developed for the solution of these problems are described. (Author)

A82-12698

A82-12698 # SARSAT applications. W. R. McPherson (Defence Research Establishment, Ottawa, Canada). (*Canadian Aeronautics and Space Institute, Canadian Conference on Aeronautics, 1st, Ottawa, Canada, Oct. 20-22, 1980.*) *Canadian Aeronautics and Space Journal*, vol. 27, 2nd Quarter, 1981, p. 118-126.

The SARSAT system is designed to utilize satellite technology for the rapid detection and location of marine and air distress incidents. The system consists of (1) emergency beacons for small aircraft and boats operating at 406 MHz; (2) space components including on-board receivers and processors; and (3) a ground receiving station with related communication links. The system is expected to detect an emergency beacon within six hours of its activation with local accuracy to the order of 20 km at present, and 5 km or better for the 406 MHz test units. The first SAR instrumented spacecraft will be launched in mid-1982. Five countries are presently involved in the project, including the USSR COSPAS/SARSAT project and the SARSAT Investigator in Norway. S.C.S.

A82-12775 F-5G Tigershark. D. Richardson. *Flight International*, vol. 120, Oct. 17, 1981, p. 1144-1150.

Design features, production goals, and potential markets for the F-5G fighter are reviewed. The aircraft was developed as a counter to the MiG-23 and third generation MiG-21. A GE F404 turbofan engine was chosen, with space left in the redesigned fuselage to accommodate minor engine improvements. A Mach 2 top speed is noted, and an 8,000 hr service life with a 9 g limiting load is projected; fuel consumption is lower than in the F5-E, with more available thrust. Design changes affected the rear fuselage profile, added a carbon composite tailplane, spar, and vertical fin, thicker wing skins to withstand 9 g combat maneuvers, and a larger canopy for greater visibility, in addition to instrument console flexibility. Armament options are provided, with mounts capable of using non-US ordnance; performance characteristics, including the 16,400 lb thrust are given, along with estimated selling price and production schedules. Over 90% of the ground support equipment of the F5-E is mentioned as being compatible with the F-5G. M.S.K.

A82-12801 # The case for a defensive air-to-air fighter. W. Hill, Jr. (Rockwell International Corp., North American Aircraft Div., Los Angeles, CA). *Astronautics and Aeronautics*, vol. 19, Nov. 1981, p. 28-36.

An investigation is conducted regarding the approaches available to compensate for the imbalance of tactical air power which favors the Soviets/Warsaw Pact over the U.S./NATO forces, taking into account the constraints of the U.S. Air Force budget. One approach can be to increase the fighter procurement monies, by reducing other budget items, to buy large quantities of the expensive multimission fighter. However, in connection with budgetary considerations related to the urgency of other requirements, it appears that new aircraft the size and capability of the F-15 and F-16 cannot be obtained in quantities sufficient to gain parity with Soviet air forces. It is, therefore, proposed to employ a single-mission aircraft which, because of its simple design and low cost, can be built in quantity. This proposal is based on the recognition that an effective NATO interceptor does not need all the capabilities of the F-15 and F-16.

G.R.

A82-12803 * # Solution to the hidden-line problem. D. R. Hedgley (NASA, Flight Research Center, Edwards AFB, CA). *Astronautics and Aeronautics*, vol. 19, Nov. 1981, p. 51.

It is pointed out that realistic three-dimensional renderings of solid objects or surfaces by computers have long been needed. The NASA Dryden Flight Research Center will soon publish a report and the computer program on an algorithm that solves for hidden lines. The computer program is written in FORTRAN IV and its size is approximately $35N + 9500$ words, where N is the number of elements. A number of pictures are presented which were drawn by a computer using the algorithm. G.R.

A82-12804 # Parachute technology under pressure. E. A. Reed (U.S. Naval Material Command, Naval Air Development Center,

Warminster, PA). *Astronautics and Aeronautics*, vol. 19, Nov. 1981, p. 56-61, 22 refs.

A description is presented of advances in specific areas of parachute technology, taking into account developments occurring since 1975. It is pointed out that stress and parachute design analysis continue to have the same needs as in 1975. Some analytic work has related nonlinear elasticity, energy dissipation and textile weave to the propagation of step strain pulses due to snatch or impact loadings. Sophisticated computer programs exist for stress analysis of parachutes and for calculating their opening load. Attention is given to the improved performance of new textile materials, possibilities for improvements related to supersonic parachutes, aspects of parachute packing, and developments concerning ejection seats. G.R.

STAR ENTRIES

N82-10002# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Festigkeit.

MATHEMATICAL MODEL FOR THE MAINTENANCE PROGRAM OF MODERN JET AIRCRAFT

Rudolf Prinz, Hans-Christian Goetting, Karl-Heinz Galda (Deutsche Lufthansa A.G., Hamburg), and Juergen Kreth (Deutsche Lufthansa A.G., Hamburg) Oct. 1980 44 p refs In GERMAN; ENGLISH summary Report will also be announced as Translation (ESA-TT-724)

(DFVLR-FB-81-14) Avail: NTIS HC A03/MF A01; DFVLR, Cologne DM 10,40

Step-by-step escalation of structural inspection intervals based on long-term experience with a fleet of transport aircraft is described by a mathematical model. Fundamental to the model are statistical distributions of load and detectable crack length in a fatigue loaded component. Knowing realistic probabilities of failure enables the calculation of appropriate inspection intervals. Calculation procedure yields increasing intervals up to a maximum value and a decrease when approximating the mean value of detectable crack length. As to usual interval steps, the results show good agreement with practice. Restrictions and possible applications of the model are discussed. Author (ESA)

N82-10016# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).

STANDARD TESTS OF A RESEARCH MODEL ROTOR IN A WIND TUNNEL, INCLUDING MODEL SIMILARITY [STANDARD-ERPROBUNG DES FORSCHUNGS-MODELLROTORS IM WINDKANAL, EINSCHLIESSLICH MODELLVERGLEICHEN]

R. Stricker, V. Mikulla, and E. Allramseder Bonn Bundesministerium der Verteidigung 1979 93 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium der Verteidigung (BMVg-FBWT-79-16) Avail: NTIS HC A05/MF A01; Dokumentbw, Bonn DM 30

A wind tunnel test program was developed, as a basis the actual flight regime of the BO-105 helicopter. Operation of the test stand and calibration of measuring devices is described. The procedure for data reduction (digital programs) is given. Results include the parameters: mean and fluctuating components of rotor forces and moments; blade bending moments (flapping, lagging); and control forces. Control and static stability derivatives are also determined. The calculations done for comparison with measurements, using aerodynamic/aeroelastic/flight mechanic digital programs, show in almost all cases very good agreement with model test results. The correlation with flight test data of the BO-105 helicopter shows that model similarity according to the most important scaling laws is fulfilled to a high degree and that the results can be used for real comparison of various sizes of hingeless helicopter rotors. Author (ESA)

N82-10017# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Inst. fuer Experimentelle Stroemungsmechanik.

EXPERIMENTAL INVESTIGATIONS OF THE SEPARATED FLOW AROUND A RECTANGULAR WING

Hans Bippes, Michael Turk, and Klaus Jacob Oct. 1980 56 p refs In GERMAN; ENGLISH summary (DFVLR-FB-81-12) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 10

For the aspect ratios $\lambda = 3.1$ and 2.3 , pressure distributions over the whole span were measured at angles of attack up to α approximately = 27° . For selected cases, oil flow patterns were produced and velocity profiles behind the wing along with shear stresses at the surface were measured. Most of the model and the experiments were carried out at Re approximately = $2,100,000$ and M approximately = 0.17 . The model and the experiments are described. The results are

discussed and partly compared with results from a theoretical model. Author (ESA)

N82-10020# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

AIRCRAFT EXCRESCENCE DRAG

A. D. Young, J. H. Paterson, and J. Lloyd Jones, ed. Jul. 1981 172 p refs (AGARD-AG-264; ISBN-92-835-1392-4) Avail: NTIS HC A08/MF A01

A review was undertaken of the available data on the subject of the drag of excrescences on aircraft surfaces. Information from this review is summarized and presented in a way that is readily usable for prediction and design purposes. The basic characteristics of boundary layers are discussed and, where possible, the drag of excrescences is related to those characteristics. In particular, because the size of many types of surface imperfection is small in comparison with boundary layer thicknesses, the drag of such imperfections can be correlated in terms of the properties of inner regions of the boundary layer. Several previously published analyses of this type are highlighted and, where possible, extensions to other data sources or other types of excrescence are presented. The practical problems of applying these data in the varying velocity gradients existing on aircraft surface are treated and one section is devoted to the drag of auxiliary air inlet and exit openings. Gaps in existing data which offer opportunities for research effort are pointed out. J.M.S.

N82-10021*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.

ICING TUNNEL TEST OF A GLYCOL-EXUDING POROUS LEADING EDGE ICE PROTECTION SYSTEM ON A GENERAL AVIATION AIRFOIL Final Report

David L. Kohlman, William G. Schweikhard, and Alan E. Albright Sep. 1981 37 p refs

(Grant NAG3-71)

(NASA-CR-165444; KU-FRL-464-1)

Avail: NTIS HC A03/MF A01 CSCL 01C

Test results show that the system is very effective in preventing ice accretion (anti-ice mode) or removing ice from an airfoil. Minimum glycol flow rates required for antiicing are a function of velocity, liquid water content in the air, ambient temperature, and droplet size. Large ice caps were removed in only a few minutes using anti-ice flow rates, with the shed time being a function of the type of ice, size of the ice cap, angle of attack, and glycol flow rate. Wake surveys measurements show that no significant drag penalty is associated with the installation or operation of the system tested. T.M.

N82-10022# Committee on Science and Technology (U. S. House).

SPIN RECOVERY TRAINING

Washington GPO 1980 15 p Presented by the Subcomm. on Invest. and Oversight of the Comm. on Sci. and Technol., 96th Congr., 2nd Sess., Jul. 1980

(GPO-66-020) Avail: Subcommittee on Investigations and Oversight

The FAA policy of not requiring spin recovery training as a prerequisite for a private pilot license was examined in an effort to determine if such a requirement would result in a net savings of life. Only FAA remained adamant in defense of the no-spin training policy. All other witnesses, to varying degrees, expressed the need for spin and recovery training as a common sense safety requirement. It can be concluded without equivocation that experienced aviators overwhelmingly demand that aspiring pilots be trained to protect themselves and be able to recover from post stall gyrations, incipient spins, and spins. The subcommittee's recommendations that such training be required for licensing is discussed with emphasis on the development of a flight training manual and an implementation plan. A.R.H.

N82-10023# Naval Postgraduate School, Monterey, Calif. Dept. of Operations Research.

A PROPOSED FLIGHT SAFETY PROGRAM FOR THE KOREAN AIR FORCE M.S. Thesis

Chong Kwan Lee Mar. 1981 136 p refs

(AD-A102373) Avail: NTIS HC A07/MF A01 CSCL 05/1

Several methodologies relevant to the development of a safety program for the Korean Air Force were reviewed. Methodologies considered included: Control charts; System safety analysis; and

Critical incident technique. Data collection methods applicable to accident analysis were proposed. Recommendations for the incorporation of these methods into a safety program for the K.A.F. were developed. The safety program described in this thesis possesses the potential for reducing overall operational costs and maximizing aircraft availability. The end result of such a program can only serve to increase operational readiness and thereby maximize overall efficiency and military capability of the K.A.F. GRA

N82-10024# Research Inst. of National Defence, Stockholm (Sweden). Huvudavdelning 2.

LIGHTNING EFFECTS ON AIRCRAFT AND COMPOSITES. LITERATURE STUDY ON LIGHTNING STRIKES AND PROTECTION [VERKAN AV BLIXT I FLYGPLAN OCH KOMPOSITER. LITTERATURSTUDIE OEVER SKADOR OCH SKYDD]

Anita Alm Nov. 1980 102 p refs In SWEDISH (FOA-C-20388-F9) Avail: NTIS HC A06/MF A01

The frequency and different types of lightning strike on different parts of aircraft and several ways of protection against direct and indirect lightning effects were reviewed. Fiber composites, lightning damage and testing of lightning protection for modern aircraft material are studied by means of simulation techniques. Unshielded composite materials are damaged by lightning. With a correctly shaped lightning shield damage can be prevented. Author (ESA)

N82-10025# Societe Nationale Industrielle Aerospatiale, Paris (France).

COST REDUCTION IN AIR TRANSPORTATION

P. Lebouc 1980 21 p Presented at French Aerospace Week, Indonesia, 8-12 Dec. 1980 (SNIAS-811-150-101) Avail: NTIS HC A02/MF A01

Historical trends in costs are reviewed. By adopting fuel conservation policies, such as renewal of the jet fleet, adaptation of flight operation, and modification of air traffic control procedures, the airlines can limit the effect of expected fuel price increases. In parallel, productivity gains should keep at a constant level all the other costs of airline operations. Under the above conditions, growth of the industry seems to be certain even if fuel prices increase at a rate of 2 to 4% per year above inflation during the next 20 years. Author (ESA)

N82-10026# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Bonn (West Germany). Inst. fuer Flugmedizin.

DEVELOPMENT AND CONSTRUCTION OF PILOT EJECTOR SEATS IN GERMANY FROM 1938-1945

Siegfried Ruff Feb. 1981 110 p refs In GERMAN; ENGLISH summary (DFVLR-FB-81-04) Avail: NTIS HC A06/MF A01; DFVLR, Cologne DM 26

Pioneering research, leading to the development of an ejector seat for the Junkers Ju 88, is reviewed. Fundamentals in establishing human acceleration tolerances are discussed. The experimental simulation of shock induced acceleration is described, and human resistance is quantified. Exploitation and follow-up of accident related data are summarized, including investigations of the accelerations experienced with an aircraft out of control, e.g., shot down. The action of airspeed pressure on a person is considered, and experience gained with research aircraft is recounted. Measuring methods for technical and physiological parameters are indicated. The beginning of ejector seat development in England, Sweden, and the U.S. (1944-45) is also briefly reviewed in comparison. Author (ESA)

N82-10027# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

THE STATISTICAL THEORY OF RADIO DIRECTION FINDING

R. L. Holland Jun. 1981 47 p refs (Contract N00024-81-C-5301) (AD-A104156; JHU/APL/TG-1330) Avail: NTIS HC A03/MF A01 CSCL 17/3

The statistical theory of radio direction finding as it applied to three-dimensional geometrics is presented in this report. This theory is an extension of the two-dimensional theory presented by R. G. Stansfield in 1947. The theory has application in situations where airborne targets are maneuvering in three dimensions at

high speed, especially when the platforms with the direction finding equipment are also aircraft. Author (GRA)

N82-10028*# Wyle Labs., Inc., Huntsville, Ala.
EXPERIMENTAL MODAL ANALYSIS OF THE FUSELAGE PANELS OF AN AERO COMMANDER AIRCRAFT Final Report

David Geisler Sep. 1981 164 p refs Prepared in cooperation with Structural Dynamics Res. Corp., Cincinnati, Ohio (Contract NAS1-14693) (NASA-CR-165750; Rept-10568) Avail: NTIS HC A08/MF A01 CSCL 01C

The reduction of interior noise in light aircraft was investigated with emphasis the thin fuselage sidewall. The approach used is theoretical and involves modeling of the sidewall panels and stiffeners. Experimental data obtained from tests investigating the effects of mass and stiffness treatments to the sidewalls are presented. The dynamic characteristics of treated panels are contrasted with the untreated sidewall panels using experimental modal analysis techniques. The results include the natural frequencies, modal damping, and mode shapes of selected panels. Frequency response functions, data relating to the global fuselage response, and acoustic response are also presented. J.M.S.

N82-10029*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

V/STOL AIRCRAFT AND FLUID DYNAMICS

Leonard Roberts (Stanford Univ., Calif.) and Seth B. Anderson Oct. 1981 8 p refs (NASA-TM-81328; A-8730) Avail: NTIS HC A02/MF A01 CSCL 01C

The impact of military applications on rotorcraft and V/STOL aircraft design is summarized with respect to fixed-wing aircraft. The influence of the mission needs on the configurational design of V/STOL aircraft, the implications regarding some problems in fluid dynamics relating to propulsive flows, and their interaction with the aircraft and the ground plane, are also considered. Additional research in fluid dynamics that can contribute to an improvement in performance of V/STOL aircraft is suggested. B.W.

N82-10030*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

AN INVESTIGATION OF A STOPPABLE HELICOPTER ROTOR WITH CIRCULATION CONTROL

John D. Ballard, John L. McCloud, III, and T. J. Forsyth Aug. 1980 372 p refs (NASA-TM-81218; A-8278) Avail: NTIS HC A16/MF A01 CSCL 01C

A stoppable helicopter rotor with circulation control was investigated in the Ames 40 by 80 foot wind tunnel. The model was tested as a rotating wing, a fixed wing, and during transition start/stop sequences. The capability of the model's control system to maintain pitch and roll moment balance during the start/stop sequence, the ability of the blades to withstand the start/stop loads, the adequacy of the control system to maintain balance in the helicopter mode, and the control system capabilities in the fixed-wing mode were assessed. Time-history data of several start/stop sequences of the X-wing rotor, and the steady-state data relating to the model as both a rotor and as a fixed-wing aircraft are presented. In addition, stability data are presented which were acquired during open-loop and closed-loop tests of the hub moment feedback control system. J.M.S.

N82-10031*# National Aeronautics and Space Administration, Washington, D. C.

QUIET SHORT-HAUL RESEARCH AIRCRAFT FAMILIARIZATION DOCUMENT, REVISION 1

Joseph C. Eppel Sep. 1981 81 p refs (NASA-TM-81298; A-8601) Avail: NTIS HC A05/MF A01 CSCL 01C

The design features and general characteristics of the Quiet Short Haul Research Aircraft are described. Aerodynamic characteristics and performance are discussed based on predictions and early flight test data. Principle airplane systems, including the airborne data acquisition system, are also described. The aircraft was designed and built to fulfill the need for a national research facility to explore the use of upper surface blowing, propulsive lift technology in providing short takeoff and landing capability, and perform advanced experiments in various technical disciplines such as aerodynamics, propulsion, stability and control.

handling qualities, avionics and flight control systems, trailing vortex phenomena, acoustics, structure and loads, operating systems, human factors, and airworthiness/certification criteria. An unusually austere approach using experimental shop practices resulted in a low cost and high research capability. Author

N82-10032*# Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
COMPARATIVE STUDY OF FLARE CONTROL LAWS Final Report, 15 Dec. 1979 - 15 Oct. 1981
A. A. Nadkarni Oct. 1981 52 p refs
(Grant NsG-1480)
(NASA-CR-164903) Avail: NTIS HC A04/MF A01 CSCL 01C

The development of a digital, three dimensional, automatic control law designed to achieve an optimal transition of a B-737 aircraft between glide slope conditions and the desired final touchdown condition is presented. The digital control law is a time invariant, state estimate feedback law, and the design is capable of using the microwave landing system. Major emphasis is placed on the reduction of aircraft noise in communities surrounding airports, the reduction of fuel consumption, the reduction of the effects of adverse weather conditions on aircraft operations, and the efficient use of airspace in congested terminal areas. Attention is also given to the development of the capability to perform automatic flares from steep glide slopes to precise touchdown locations. B.W.

N82-10033# Aberdeen Univ. (Scotland). Dept. of Engineering.
APPLICATION OF NUMERICAL METHODS TO THE CALCULATION OF ELECTROSTATIC FIELDS IN AIRCRAFT FUEL TANKS Final Scientific Report, 1 Jul. 1980 - 30 Jun. 1981

J. R. Smith, P. Lees, and D. McAllister Aug. 1981 65 p refs
(Grant AF-AFOSR-0223-80; AF Proj. 2301; AF Proj. 3048)
(AD-A103270; EOARD-TR-81-9) Avail: NTIS HC A04/MF A01 CSCL 01/3

The solution of electrostatic field problems occurring during the refueling of aircraft fuel tanks containing explosion suppressant foams is discussed. A computational model of a fuel tank is set up, and the finite element method is used to calculate the electrostatic potential distribution within the tank. Author (GRA)

N82-10034# Boeing Military Airplane Development, Seattle, Wash.

LOW MAINTENANCE HYDRAULIC ACCUMULATOR Final Report, Aug. 1976 - Dec. 1980
E. C. Wagner and W. E. Willard Jun. 1981 65 p
(Contract F33615-76-C-2088; AF Proj. 3145)
(AD-A103947; AFWAL-TR-81-2031) Avail: NTIS HC A04/MF A01 CSCL 13/7

This report presents the results of a program to develop a low maintenance accumulator, compatible with current MS envelopes and competitive in cost with conventional accumulators. The purpose of the program was to select and develop a metal bellows configuration/concept to replace the conventional moving piston and seal of conventional accumulators. The selected bellows are of welded construction and welded in place to allow bellows movement identical to piston movement. The accumulator housing is of welded construction to eliminate all possible leak points. The program goal was to develop an accumulator to provide a ten year unserviced life. Test results indicate an accumulator design is possible to achieve a service life of 6 to 10 years based on installation on an F-16 aircraft. Author (GRA)

N82-10035# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottonbrunn (West Germany). Unternehmensbereich Flugzeuge.
A CFRP TAILERON FOR THE TORNADO: CONSTRUCTION AND PRODUCTION [CFK-TAILERON FUER DEN TORNADO: KONSTRUKTION UND FERTIGUNG]
L. Lemmer, W. Hartmann, and R. Guenther 1980 67 p In GERMAN Presented at Gastvortrag im KL 624, Mannheim, West Germany, 10-14 Nov. 1980
(MBB-FE-212/KFK/PUB/2) Avail: NTIS HC A04/MF A01

A CFRP lightweight structure, i.e., CFRP taileron, for the Tornado aircraft was developed. The CFRP taileron is interchangeable with the currently used metal horizontal stabilizer as far as geometry, function and durability are concerned while a 30% weight reduction is achieved with CFRP construction. The assembly of the CFRP taileron is detailed and results from static,

dynamic, and vibration testing of the structure are presented. A series production method is then outlined, including inspection and certification procedures. Author (ESA)

N82-10036# European Space Agency, Paris (France).
THEORETICAL INVESTIGATION OF THE INFLUENCE OF SPOILER DYNAMICS ON THE HANDLING QUALITIES OF AN AIRCRAFT WITH DIRECT LIFT CONTROL

Dieter Schafranek Jul. 1981 66 p refs Transl. into ENGLISH of "Theoretische Untersuchung ueber den Einfluss der Spoilerdynamik auf die Fliegbarkeit eines Flugzeugs mit direkter auftriebssteuerung" Rept. DFVLR-FB-80-07 DFVLR, Brunswick, 1980
Original report in GERMAN previously announced as N81-13975 (ESA-TT-681; DFVLR-FB-80-07) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 14,70

Theoretical parameters describing the pilot's workload during aircraft control pitch tracking and flight path tracking tasks on a transport aircraft equipped with spoiler direct lift control (DLC) were studied. The determined parameters are the necessary phase compensation and gain adaptation which the pilot must perform, and also the closed loop resonance. The influence of the DLC-gain factor, spoiler actuator rate, and spoiler deflection washout time constant on pilot workload is presented. Simulated time histories of pitch rate and normal acceleration response due to step type control inputs show the corresponding reactions of the various DLC-configurations which are essential for pitch control and flight path control. Direct lift control using spoilers is shown to be sensible for the aircraft in the test only if the pitching moment of the spoiler is completely compensated, the time constant for the spoiler deflection washout is not too small (greater than 5 seconds) and if the spoiler moves with more delay than the elevator. Author (ESA)

N82-10037*# Detroit Diesel Allison, Indianapolis, Ind.
PROPULSION STUDY FOR SMALL TRANSPORT AIRCRAFT TECHNOLOGY (STAT) Contractor Final Report

J. C. Gill, R. V. Earle, D. V. Staton, P. C. Stolp, D. S. Huelster, and B. A. Zolezzi 16 Dec. 1980 186 p refs
(Contract NAS3-21995)
(NASA-CR-165499; DDA-EDR-10470) Avail: NTIS HC A09/MF A01 CSCL 21E

Propulsion requirements were determined for 0.5 and 0.7 Mach aircraft. Sensitivity studies were conducted on both these aircraft to determine parametrically the influence of propulsion characteristics on aircraft size and direct operating cost (DOC). Candidate technology elements and design features were identified and parametric studies conducted to select the STAT advanced engine cycle. Trade off studies were conducted to determine those advanced technologies and design features that would offer a reduction in DOC for operation of the STAT engines. These features were incorporated in the two STAT engines. A benefit assessment was conducted comparing the STAT engines to current technology engines of the same power and to 1985 derivatives of the current technology engines. Research and development programs were recommended as part of an overall technology development plan to ensure that full commercial development of the STAT engines could be initiated in 1988. T.M.

N82-10038*# Detroit Diesel Allison, Indianapolis, Ind.
PROPULSION STUDY FOR SMALL TRANSPORT AIRCRAFT TECHNOLOGY (STAT), APPENDIX B Final Report [1980] 11 p refs

(Contract NAS3-21995)
(NASA-CR-165499-App-B; DDA-EDR-10470-App-B) Avail: NTIS HC A02/MF A01 CSCL 21E

Data are tabulated for two conceptual engines designed for small transport aircraft. These are the 1790 W (2400 shp) class engine and the 3579 kW (4800 shp) class engine for the 0.5 M sub N and 0.7 M sub N airplanes, respectively. All data points required to perform the STAT missions are provided including take-off, climb, cruise, loiter, and fuel allowances. The weight, dimensions, price, and maintenance costs are given as well as the installation criteria and equations used for adjusting horsepower for gearbox loss, and converting horsepower to thrust. Scaling equations are included. A.R.H.

N82-10039*# United Technologies Research Center, East Hartford, Conn.
DEVELOPMENT OF LOW MODULUS MATERIAL FOR USE

IN CERAMIC GAS PATH SEAL APPLICATIONS Final Report

H. E. Eaton and R. C. Novak Oct. 1981 83 p refs
(Contract NAS3-22134)
(NASA-CR-165469; R81-915188-13) Avail: NTIS
HC A05/MF A01 CSCL 21E

Three candidate materials were examined: Brunsbond (I Pad); plasma sprayed porous NiCrAlY; and plasma sprayed low modulus microcracked zirconia. Evaluation consisted of mechanical, thermophysical, and oxidation resistance testing along with optical microscopy and a feasibility demonstration of attaching the material to a suitable substrate. The goals of the program were the following: feasibility of fastening or depositing the low modulus system onto a broad range of substrate alloys; feasibility of depositing or forming the low modulus system to a thickness of 0.19 cm to 0.38 cm; potential to attain a modulus of elasticity in the range of 3.4 to 6.9 GPa (0.5 to 1.0 MSI), and an ultimate strength of 17.2 MPa (2.5 ksi); suitable thermal conductivity; and static oxidation life of at least 1000 hours at 1311 K. The results of the program indicate that all three systems offer attractive properties as a strain isolator material. T.M.

N82-10040*# General Electric Co., St. Petersburg, Fla. THERMAL-BARRIER-COATED TURBINE BLADE STUDY Final Report

P. A. Siemers and W. B. Hillig Aug. 1981 134 p refs
(Contract NAS3-21727)
(NASA-CR-165351; SRD-81-083) Avail: NTIS
HC A07/MF A01 CSCL 21E

The effects of coating TBC on a CF6-50 stage 2 high-pressure turbine blade were analyzed with respect to changes in the mean bulk temperature, cooling air requirements, and high-cycle fatigue. Localized spallation was found to have a possible deleterious effect on low-cycle fatigue life. New blade design concepts were developed to take optimum advantage of TBCs. Process and material development work and rig evaluations were undertaken which identified the most promising combination as ZrO₂ containing 8 w/o Y₂O₃ applied by air plasma spray onto a Ni22Cr-10Al-1Y bond layer. The bond layer was applied by a low-pressure, high-velocity plasma spray process onto the base alloy. During the initial startup cycles the blades experienced localized leading edge spallation caused by foreign objects. T.M.

N82-10041*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va. DETERMINATION OF AIRPLANE MODEL STRUCTURE FROM FLIGHT DATA BY USING MODIFIED STEPWISE REGRESSION

Vladislav Klein (Joint Inst. for Advancement of Flight Sciences, Hampton, Va.), James G. Batterson, and Patrick C. Murphy Oct. 1981 48 p refs
(NASA-TP-1916; L-14613) Avail: NTIS HC A03/MF A01 CSCL 01C

The linear and stepwise regressions are briefly introduced, then the problem of determining airplane model structure is addressed. The MSR was constructed to force a linear model for the aerodynamic coefficient first, then add significant nonlinear terms and delete nonsignificant terms from the model. In addition to the statistical criteria in the stepwise regression, the prediction sum of squares (PRESS) criterion and the analysis of residuals were examined for the selection of an adequate model. The procedure is used in examples with simulated and real flight data. It is shown that the MSR performs better than the ordinary stepwise regression and that the technique can also be applied to the large amplitude maneuvers. T.M.

N82-10042*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va. ESTIMATION OF AIRPLANE STABILITY AND CONTROL DERIVATIVES FROM LARGE AMPLITUDE LONGITUDINAL MANEUVERS

James G. Batterson Oct. 1981 43 p refs
(NASA-TM-83185; L-14524) Avail: NTIS HC A03/MF A01 CSCL 01C

The application of a modified stepwise regression algorithm to both a complete data string and to that same data partitioned into bins as a function of angle of attack was demonstrated. Results from the large-scale maneuver agree well with results from 20 maneuvers in which small perturbation from trim at various angles of attack were induced. T.M.

N82-10043*# Lear Siegler, Inc., Santa Monica, Calif. Astronics Div.

DEVELOPMENT AND EVALUATION OF AUTOMATIC LANDING CONTROL LAWS FOR LIGHT WING LOADING STOL AIRCRAFT

B. Feinreich, O. Degani, and G. Gevaert Jul. 1981 371 p refs
(Contract NAS2-9410)
(NASA-CR-166160) Avail: NTIS HC A16/MF A01 CSCL 01C

Automatic flare and decrab control laws were developed for NASA's experimental Twin Otter. This light wing loading STOL aircraft was equipped with direct lift control (DLC) wing spoilers to enhance flight path control. Automatic landing control laws that made use of the spoilers were developed, evaluated in a simulation and the results compared with those obtained for configurations that did not use DLC. The spoilers produced a significant improvement in performance. A simulation that could be operated faster than real time in order to provide statistical landing data for a large number of landings over a wide spectrum of disturbances in a short time was constructed and used in the evaluation and refinement of control law configurations. A longitudinal control law that had been previously developed and evaluated in flight was also simulated and its performance compared with that of the control laws developed. Runway alignment control laws were also defined, evaluated, and refined to result in a final recommended configuration. Good landing performance, compatible with Category 3 operation into STOL runways, was obtained. Author

N82-10044# Messerschmitt-Boelkow-Blohm G.m.b.H., Otto-brunn (West Germany).

ACTIVE CONTROL ELEMENTS ON THE TRANSONIC WING OF THE AIRBUS A-300 (ACTTA A). AIRBUS A-300 WITH REDUCED LONGITUDINAL STABILITY (ACTTA-C) [AKTIVE STEUERELEMENTE AM TRANSSONISCHEN FLUEGEL DES AIRBUS A300 (ACTTA A). AIRBUS A300 MIT REDUZIERTER LAENGSTABILITAET (ACTTA-C)]

H. G. Klug 1980 34 p In GERMAN Presented at 2nd Bundesministerium fuer Forschung und Technologie Statusseminar Luftfahrtforsch. und Luftfahrtechnol., Garmisch-Partenkirchen, West Germany, 8-9 Oct. 1980
Avail: NTIS HC A03/MF A01

Two projects concerned with the development and design optimization of the Airbus A-300 are reviewed. Studies related to active control are discussed. Investigations specific to gust loading and maneuver induced loading of the A-300 structure are emphasized. Results influence design criteria, e.g., open or closed loop control, sensor selection, etc. Reduced longitudinal stability of the A-300 is then considered as a tradeoff in favor of weight reduction through the use of lightweight materials. Wind tunnel and other simulation tests are described. Author (ESA)

N82-10045# European Space Agency, Paris (France). SYSTEM IDENTIFICATION OF THE LONGITUDINAL MOTION OF THE DFVLR HFB 320 RESEARCH AIRCRAFT WITH PARTICULAR CONSIDERATION OF CONTROL SURFACE EFFECTIVENESS

Ohad Rix Apr. 1981 55 p refs Transl. into ENGLISH of "Systemidentifizierung des DFVLR-Forschungsflugzeugs HFB 320 in der Laengsbewegung mit besonderer Beruecksichtigung der Steuerflaechenwirksamkeit" Rept. DFVLR-Mitt-79-66 DFVLR, Brunswick, Jul. 1979 Original report in GERMAN previously announced as N81-13971
(ESA-TT-666; DFVLR-Mitt-79-16) Avail: NTIS
HC A04/MF A01: DFVLR, Cologne DM 12

Analysis of the longitudinal motion of the DFVLR HFB-320 research aircraft by means of a maximum likelihood method is described. The control surface effectiveness of separately or simultaneously deflected DLC flaps and spoilers was determined. The flight test technique, and the influence of different mathematical models on the results obtained, are illustrated and discussed. Author (ESA)

N82-10046# European Space Agency, Paris (France). A CONTRIBUTION TO THE STABILIZATION OF FLIGHT VEHICLE PARACHUTE SYSTEMS

Christos Saliaris and Dieter Muenscher Jun. 1981 30 p refs Transl. into ENGLISH of "Beitrag zur Stabilisierung von Flugkoerper-Fallschirm-Systemen" Rept. Mitt-80-05 DFVLR, Brunswick.

Apr. 1980

(ESA-TT-679; DFVLR-Mitt-80-05) Avail: NTIS HC A03/MF A01; DFVLR, Cologne DM 8,30

The dynamic behavior of a parachute-load system moving in a plane is analyzed. A mathematical model is adopted and a system of nonlinear equations of motion is produced, which are then solved without linearization using a digital computer. Calculations are carried out using a modified guide surface parachute in order to investigate the effects of parachute size, distance between attachment point and canopy, and distance between the attachment point and the center of gravity of the load on the oscillation of the missile. Parameters influencing the variation of the pitch angle of the load with time are also studied. Increasing the canopy and moving the attachment point behind the center of gravity of the load results in better stabilization. The damping increases, i.e. the pitch angle of the load becomes smaller and the period of oscillation decreases. If the distance between the attachment point on the load and the center of the canopy base is varied, there is scarcely any detectable change to the period of oscillation. However, the damping is influenced by a change in this distance: it has a maximum when the distance is approximately that which is customarily used. Author (ESA)

N82-10047# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Elastomechanik und Aeroelastische Stabilitaet.

A METHOD FOR DETERMINATION OF THE AEROELASTIC BEHAVIOR OF AIRCRAFT WITH ACTIVE CONTROL SYSTEMS Ph.D. Thesis - Tech. Univ. Carolo-Wilhelmina Raymond Freymann Feb. 1981 128 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-719)

(DFVLR-FB-81-05) Avail: NTIS HC A07/MF A01; DFVLR, Cologne DM 26,30

An analytical method for the performance of dynamic calculations on servocontrolled aircraft, based on an extended formulation of the generalized aeroelastic equations is presented. The additional parameters introduced in the extended equations of motion are determined experimentally in a ground vibration test performed on a real aircraft structure as well as with help from an experimental-analytical method for determination of the transfer functions of the hydraulic actuators. The elaborated method is shown satisfactory by comparison of measured and calculated data resulting from investigations performed on a model wing structure with a rudder driven by a hydraulic actuator.

Author (ESA)

N82-10048# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

MULTI-VARIABLE ANALYSIS AND DESIGN TECHNIQUES Sep. 1981 168 p refs Presented at a Lecture Series held at Ankara, 28-29 Sep. 1981, Bolkesjo, Norway, 1-2 Oct. 1981, and Delft, The Netherlands, 5-6 Oct. 1981

(AGARD-LS-117) Avail: NTIS HC A08/MF A01

The basic theories and concepts involved in the design of advanced guidance and control systems employing state-space and multi-variable design methods are explained. The main topics reviewed include: (1) analysis and synthesis techniques; (2) application of observer and estimation principles; (3) computer-aided design and analysis methods; (4) system simulation techniques; and (5) tests evaluation and validation.

N82-10049# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.

THE NEED FOR MULTIVARIABLE DESIGN AND ANALYSIS TECHNIQUES

Rhall E. Pope In AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 10 p

Avail: NTIS HC A08/MF A01

Demand for higher accuracy, improved reliability/survivability, and more automation are placing increased emphasis on the control function for successful operation of aircraft weapon systems. Modifications to airframe designs directed at increased maneuverability and reduced weight are placing stringent on flight control systems. Fly-by-wire systems, particularly digital systems, provide the flexibility to not only accommodate but influence airframe design modifications and led to the control configured vehicle (CCV) concept. These advances in air, vehicle design and flight control system implementation are overwhelming

traditional design and analysis techniques. Stability and control design specification are inadequate in dealing with statistically unstable vehicles, multiple control loops and high dynamic coupling. Better control system design and analysis techniques are needed which address the multi-input closely coupled dynamic nature of today's and tomorrows aircraft weapon systems.

A.R.H.

N82-10050# Cambridge Univ. (England). Dept. of Engineering.

CHARACTERISTIC AND PRINCIPAL GAINS AND PHASES AND THEIR USE AS MULTIVARIABLE CONTROL DESIGN TOOLS

Alistair G. J. MacFarlane In AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 34 p refs

Avail: NTIS HC A08/MF A01

The key to the generalization of classical frequency-response design techniques to the multivariable case lies in the development of ways of suitably extending the concepts of gain and phase. It is shown how algebraic function theory can be used to generalise Nyquist diagram and Root-Locus diagram techniques for use with systems having many inputs and outputs. This is done in such a way that the main structural features of such diagrams can be related to state-space model parameters. The shortcomings of characteristic gains and phases (used in a generalised Nyquist approach) are then noted. An alternative way of introducing amplitude and phase information, via the polar decomposition of an operator, leads to the introduction of principal gains and principal phases. Their properties are examined and, in particular, it is shown how they may be used to characterise robustness. The use of these techniques for design purposes is discussed.

A.R.H.

N82-10051# Honeywell Systems and Research Center, Minneapolis, Minn.

MULTIVARIABLE DESIGN TECHNIQUES BASED ON SINGULAR VALUE GENERALIZATIONS OF CLASSICAL CONTROL

John C. Doyle In AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 15 p refs

Avail: NTIS HC A08/MF A01

Singular value analysis was used to generalize the fundamental feedback ideas from classical single loop control theory to multiloop systems. The classical view of measuring the benefit of feedback in terms of desensitizing the system to plant variations and disturbances is discussed. Uncertainty is shown to play a critical role in determining the way in which feedback may be used. Certain singular value plots, called sigma-plots, are introduced as natural and effective generalizations of Bode gain plots and form the basic tools for analysis of multiloop feedback systems. These tools provide reliable means for assessing the stability margins, bandwidth, and desensitizing effects of multiloop feedback systems. Examples of a two input oscillator and control of the rotors of the CH-47 helicopter are given to illustrate the use of the sigma-plots and their interpretations.

A.R.H.

N82-10052# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.

LIMITATIONS ON ACHIEVABLE PERFORMANCE OF MULTIVARIABLE FEEDBACK SYSTEMS

John C. Doyle In AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 9 p refs

Avail: NTIS HC A08/MF A01

The design tradeoffs that are the focus of classical single-loop theory were generalized to multiloop systems using singular value analysis techniques. The first tradeoff is algebraic between large loop gain for good sensitivity properties and small loop gain for stability margins. Another is the functional tradeoff imposed by the Bode gain/phase relations. These tradeoffs impose limitations on the achievable performance of any feedback design. The limitations caused by nonminimum phase zeros are also discussed. The problem of directionality in multiloop systems has no analog in single loop feedback systems is presented and analyzed.

A.R.H.

N82-10053# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.

LQG-BASED MULTIVARIABLE DESIGN: FREQUENCY DOMAIN INTERPRETATION

N82-10054

Gunter Stein *In* AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 9 p refs

Avail: NTIS HC A08/MF A01

The use of the Linear-Quadratic-Gaussian (LOG) methodology in designing feedback compensators which meet multivariable performance, stability, and stability robustness requirements expressed as singular value conditions in the frequency domain is demonstrated. A.R.H.

N82-10054# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.

LOG MULTIVARIABLE DESIGN TOOLS

Gunter Stein and Stephen Pratt *In* AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 16 p refs

Avail: NTIS HC A08/MF A01

The basic design algorithms needed for frequency domain oriented Linear-Quadratic-Gaussian feedback design are described and experimental interactive computer aided design package through which these algorithms can be effectively accessed is introduced. The algorithms and design package are illustrated with several flight control design examples for highly maneuverable aircraft. A.R.H.

N82-10055# Groningen Rijksuniversiteit (Netherlands). Mathematics Inst.

DESIGN OF HIGH INTEGRITY MULTIVARIABLE CONTROL SYSTEMS

J. C. Williams *In* AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 10 p refs

Avail: NTIS HC A08/MF A01

The notions of (almost) controlled and conditionally invariant subspaces of linear systems are explained and their application to the synthesis of feedback compensators for disturbance rejection and to robust controller is outlined. The disturbance rejection and the robust controller design problems are viewed as a procedure for designing a high integrity feedback control system. A.R.H.

N82-10056# Toronto Univ. (Ontario). Systems Control Group.

A GEOMETRIC APPROACH TO MULTIVARIABLE CONTROL SYSTEM SYNTHESIS

W. Murray Wonham *In* AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 21 p refs

Avail: NTIS HC A08/MF A01

Multivariable control is discussed with emphasis on Multivariable Control: fundamentals, disturbance decoupling and output stabilization, controllability subspaces, noninteracting control, and regulation and tracking in linear systems and structurally stable nonlinear regulation with step inputs. A version of the internal model principle for controlled sequential machines is included. A.R.H.

N82-10057# McGill Univ., Montreal (Quebec). Dept. of Electrical Engineering.

MULTIVARIABLES DESIGN: THE OPTIMIZATION OF APPROXIMATE INVERSES

G. Zames *In* AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 6 p refs

Avail: NTIS HC A08/MF A01

A mathematical framework for the analysis of sensitivity in multi-input-multi-output linear feedback systems is proposed, based on the concepts of a multiplicative seminorm and an approximate inverse. Many of the empirical results of classical control theory pertaining to the use of lead-lag networks can be deduced in this framework as solutions to well-posed mathematical optimization problems. Moreover, new classes of optimal filters for the reduction of sensitivity are introduced. A definition of optimal sensitivity to plant uncertainty is established. The multiplicative property of seminorms is used to obtain the following principle: for any specified a posteriori accuracy, there is a maximum of a priori plant uncertainty that can be tolerated, and a minimum of identification that is required. Author

N82-10058# McGill Univ., Montreal (Quebec). Dept. of Electrical Engineering.

FEEDBACK AND MINIMAX SENSITIVITY

George Zames and Bruce A. Francis (Waterloo Univ.) *In* AGARD Multi-Variable Analysis and Design Tech. Sep. 1981 8 p refs Sponsored in part by National Science and Engineering Research Council of Canada

(Grant NSF ECS-80-12-565)

Avail: NTIS HC A08/MF A01

Feedbacks that minimize the sensitivity function of a linear, single variable feedback system represented by its frequency responses were considered. Sensitivity is measured in a weighted H (infinity) norm. The single variable cases are studied. The results are extended to unstable plants, and explicit formulas for the general situation of a finite number of RHP plant zeros or poles are provided. The Q or 'approximate-inverse' parameterization of feedbacks that maintain closed-loop stability is extended to the case of unstable plants. The H (infinity) and Wiener-Hopf approaches are compared. A.R.H.

N82-10059*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

EVALUATION OF THE ACOUSTIC MEASUREMENT CAPABILITY OF THE NASA LANGLEY V/STOL WIND TUNNEL OPEN TEST SECTION WITH ACOUSTICALLY ABSORBENT CEILING AND FLOOR TREATMENTS Final Report

Mark A. Theobald May 1978 46 p refs

(Contract NAS1-14611)

(NASA-CR-165796; Rept-3820)

Avail: NTIS

HC A03/MF A01 CSCL 14B

The single source location used for helicopter model studies was utilized in a study to determine the distances and directions upstream of the model accurate at which measurements of the direct acoustic field could be obtained. The method used was to measure the decrease of sound pressure levels with distance from a noise source and thereby determine the Hall radius as a function of frequency and direction. Test arrangements and procedures are described. Graphs show the normalized sound pressure level versus distance curves for the glass fiber floor treatment and for the foam floor treatment. A.R.H.

N82-10062# Committee on Science and Technology (U.S. House).

AIRPORT AND AIRWAY IMPROVEMENT ACT OF 1981, PART 1

Washington GPO 1981 56 p Rept. to accompany H. R. 2643 Presented by the Comm. on Sci. and Technol. at the 97th Congr., 1st Sess., 19 Mar. 1981

(GPO-76-241-Pt-1) Avail: US Capitol, House Document Room

A bill authorizing appropriations to the FAA in the amount of \$85,000,000 for air traffic control, navigation, aviation weather, aviation medicine, and ATC computer modernization for FY-1981-1982 is presented. The Committee directs that funds be reprogrammed to permit completion of the Flight Level 290 and to expedite development of the Doppler weather radar (Nexrad). The request for a trust fund to support \$19.81 million of regulatory support research and development was denied. A.R.H.

N82-10063# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

AIR-BREATHING ENGINE TEST FACILITIES REGISTER

Joachim H. Krengel, comp. Jul. 1981 122 p

(AGARD-AG-269) Avail: NTIS HC A06/MF A01

A register was compiled, aimed at comprising the test facilities relevant for research and development in NATO countries. Included are test facilities being in use or under construction at the various research organizations, industrial firms, and universities. Test facilities and their technical data are given as far as the response to a questionnaire was received or open literature was available. Test engineers will be able to find whether a test facility suiting their specific demands already exists or may be easily adapted to their purposes. T.M.

N82-10107# European Space Agency, Paris (France).

FLIGHT TEST RESULTS OF THE MODEL SIMULATION CONTROLLER FOR THE HFB 320 FOR IN-FLIGHT SIMULATION OF THE A310 AIRBUS

Hans-Heinz Lange Apr. 1981 72 p refs Transl. into ENGLISH of 'Flugerprobung des modellfolgereglers fuer die HFB 320 zur Simulation des Airbus A 310 in Fluge' Rept. DFVLR-Mitt-79-13

DFVLR, Brunswick, 1979 Original report in GERMAN previously announced as N81-10078

(ESA-TT-660; DFVLR-Mitt-79-13) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 15,40

The onboard computer program which completes the model simulating control system is presented and its fundamental operations explained. The effect of nonlinearities is demonstrated by means of the results of ground simulation of the test aircraft, the control system and the simulated aircraft. The flight test results show the achieved quality of in-flight simulation of the modeled A310 aircraft. Examples of the ground simulation predictions of the overall aircraft and controller system behavior are cited. Author (ESA)

N82-10254# KVB, Inc., Irvine, Calif.

BASELINE DATA ON UTILIZATION OF LOW-GRADE FUELS IN GAS TURBINE APPLICATIONS. VOLUME 3: EMISSIONS EVALUATION Final Report

T. Sonnichsen Jun. 1981 108 p refs Sponsored in part by Electric Power Research Inst.

(EPRI Proj. 1079-3)

(DE81-903764; EPRI-AP-1882-Vol-3) Avail: NTIS HC A06/MF A01

A series of field tests was conducted on two residual-oil-fired gas turbine/heat recovery steam generators (HRSG) comprising a Westinghouse PACE 260-MW combined-cycle unit. Base load emission levels were determined. A series of tests was also made at reduced operating loads. Emission measurements included: (1) gaseous constituents measured by continuous monitoring instrumentation (O₂, CO₂, NO, NO sub x, and SO₂) and by wet chemistry methods (SO₃, aldehydes, and chlorides); and (2) particulate characteristics (mass loading, smoke spot number; submicron particle size, and particle morphology). Corrected NO sub x emissions at base load were 170 ppm and 200 ppm with and without HRSG afterburners in service, respectively. The NO sub x emissions decreased with water injection by 50% and were unchanged with the turbine wash. The NO sub x increased with load. DOE

N82-10286*# National Aeronautics and Space Administration, Pasadena Office, Calif.

SYNTHETIC APERTURE RADAR TARGET SIMULATOR Patent Application

Howard A. Zebker (JPL, California Inst. of Technology, Pasadena), Daniel N. Held (JPL, California Inst. of Technology, Pasadena), Richard M. Goldstein (JPL, California Inst. of Technology, Pasadena), and Thomas C. Bickler, inventors (to NASA) (JPL, California Inst. of Technology, Pasadena) Filed 17 Jul. 1981 15 p

(Contract NAS7-100)

(NASA-Case-NPO-15024-1; US-Patent-Appl-SN-284287) Avail: NTIS HC A02/MF A01 CSCL 171

A simulator for simulating the radar return, or echo, from a target seen by a SAR antenna mounted on a platform moving with respect to the target is described. It includes a first-in first-out memory which has digital information clocked in at a rate related to the frequency of a transmitted radar signal and digital information clocked out with a fixed delay defining range between the SAR and the simulated target, and at a rate related to the frequency of the return signal. An RF input signal having a frequency similar to that utilized by a synthetic aperture array radar is mixed with a local oscillator signal to provide a first baseband signal to provide a first baseband signal having a frequency considerably lower than that of the RF input signal. T.M.

N82-10326# Boeing Military Airplane Development, Seattle, Wash. Mechanical/Electrical Systems Technology Dept.

ADVANCED AIRCRAFT ELECTRICAL SYSTEM CONTROL TECHNOLOGY DEMONSTRATOR. PHASE 1: REQUIREMENTS ANALYSIS AND CONCEPTUAL DESIGN Interim Technical Report, 1 Sep. 1980 - 28 Feb. 1981

G. L. Dunn, P. J. Leong, and I. S. Mehdi Jul. 1981 103 p refs

(Contract F33615-80-C-2004; AF Proj. 3145)

(AD-A103922; D180-25927-2; AFWAL-TR-81-2058) Avail: NTIS HC A06/MF A01 CSCL 09/3

In Task 1, the requirements for the electrical power system and the integrated power system control were defined. In Task 2, three conceptual designs for the electrical power system were prepared. Each design incorporated a different data bus architecture,

integrated, hierarchical, and non-integrated dedicated. The three designs were evaluated for application to a two engine tactical aircraft. Processor and data bus loading were examined for each architecture. Based on the evaluation, the conceptual design based on the integrated architecture is recommended for preliminary design in Task 3, phase I. Author (GRA)

N82-10421# Shock and Vibration Information Center (Defense), Washington, D. C.

THE SHOCK AND VIBRATION DIGEST, VOLUME 13, NO. 9

Judith Nagle-Eshleman, ed. Sep. 1981 123 p refs

(AD-A105062) Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375; \$15.00/set CSCL 20/11

Structural dynamic problems inherent to design, analysis, and operation of rotating machinery were investigated. The following Space Shuttle related problems are discussed: analytical and experimental loads, and dynamics efforts; development of data systems and environmental testing programs; Space Shuttle thermal protection system and the Space Shuttle main engine; structural dynamics, dynamic testing, and vibration control.

N82-10452# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Inst. fuer Aeroelastic.

CALCULATION OF NATURAL MODES OF VIBRATION FOR ROTOR BLADES BY THE FINITE ELEMENT METHOD

Fritz Kiessling and Dieter Ludwig Jan. 1981 66 p refs In GERMAN; ENGLISH summary

(DFVLR-FB-81-07) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 14,20

The mass and stiffness matrices for a rotating blade are established by the finite element method. The formulation is based on the Lagrange function presented for combined flapwise bending, chordwise bending, and torsion of twisted nonuniform rotor blades. The element matrices were created by the nonnumeric computer program REDUCE by which it is possible to evaluate the formulas by symbolic manipulation. An ordering scheme was introduced to demonstrate which terms were simplified or neglected. As examples, eigenanalyses are performed for a nonrotating homogeneous beam and for the rotor blade of a wind energy converter. Author (ESA)

N82-10812# Hope Associates, Inc., Washington, D.C.

A COMPREHENSIVE BIBLIOGRAPHY OF LITERATURE ON HELICOPTER NOISE TECHNOLOGY Final Report

A. M. Carter, Jr. Jun. 1981 116 p

(Contract DTFA01-80-Y-10597)

(AD-A103331; FAA-EE-81-4) Avail: NTIS HC A06/MF A01 CSCL 20/1

This bibliography, covering the period 1975 through calendar 1980 also provides abstracts on literature that appear to make a significant contribution to the field of helicopter noise technology. The helicopter is recognized as a complex noise generator, with significant contributions from the rotors, the engine and the gearbox. Progress continues to be made in the noise areas of: (a) Formulations, math models and analytical procedures; (b) Noise prediction methodology; (c) Noise reduction techniques; and (d) Subjective response to helicopter noise. The body of information, data and knowledge has use in many applications, including the reduction of helicopter noise in a cost effective manner and in minimizing annoyance to the civil populace. GRA

N82-10959# Committee on Science and Technology (U. S. House).

NASA AUTHORIZATION, 1982: INDEX

Washington GPO 1981 316 p Hearings on H.R. 1257 before the Comm. on Sci. and Technol., 97th Congr., 1st Sess., No. 2, 1981

(GPO-84-713) Avail: Committee on Science and Technology

A subject and name index is presented to the testimony delivered, statements received, and questions raised in relation to NASA's budget requests, for program management, construction of facilities, and research and development. A.R.H.

N82-10981# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FINITE DIFFERENCE COMPUTATION OF THE STEADY TRANSONIC POTENTIAL FLOW AROUND AIRPLANES

N82-10982

Luo Shijun, Zheng Yuwen, Qian Hong, and Wang Dieqian *In its Recent Selected Papers of NW Polytech. Univ.*, pt. 1 (FTD-ID(RS)T-0259-81-Pt-1) 20 Aug. 1981 p 5-30 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 1 (Xian Shaanxi), 1979

Avail: NTIS HC A17/MF A01

The velocity potential equation was approximated by assuming that the perturbation velocity component in the transverse plane of the body is much smaller than the undistributed flow velocity, while the perturbation velocity component in the longitudinal direction may not be so. It was then solved with mixed schemes of finite differences. The boundary condition on wings (tails) and its wake were approximated similarly. Two numerical examples are included and the results agree well with known wind tunnel test results. T.M.

N82-10982# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SECOND ORDER APPROXIMATION THEORY OF AN ARBITRARY AEROFOIL IN COMPRESSIBLE POTENTIAL FLOW

Lin Chaoqiang *In its Recent Selected Papers of NW Polytech. Univ.*, pt. 1 (FTD-ID(RS)T-0259-81-Pt-1) 20 Aug. 1981 p 31-50 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 1 (Xian Shaanxi), 1979

Avail: NTIS HC A17/MF A01

The region outside an arbitrary airfoil is conformally transformed into the region outside a unit circle. The transformation functions are expanded into ascending power series and then only those terms up to and including the second order are retained. The resulting formulae are given analytically. The method is nearly an exact solution from the engineering point of view, even for an airfoil with thickness as much as 30 percent of the chord and with maximum camber as much as 10 percent of the chord. T.M.

N82-10983# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

AERODYNAMIC CALCULATIONS AND DESIGN OF SUBCRITICAL AEROFOILS

Lin Chaoqiang *In its Recent Selected Papers of NW Polytech. Univ.*, pt. 1 (FTD-ID(RS)T-0259-81-Pt-1) 20 Aug. 1981 p 51-64 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 1 (Xian Shaanxi), 1979

Avail: NTIS HC A17/MF A01

A method of calculating the velocity and pressure distribution on an airfoil of given geometrical profile at a given angle of attack in subcritical potential flow is described. Inversely, designing appropriate airfoil geometry and the corresponding angle of attack for a given pressure distribution is discussed. T.M.

N82-10984# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

AN AERODYNAMIC DESIGN METHOD FOR TRANSONIC AXIAL FLOW COMPRESSOR STAGE

Zhu Fangyan, Zhou Xinhai, Liu Songling, and Fan Feida *In its Recent Selected Papers of NW Polytech. Univ.*, pt. 1 (FTD-ID(RS)T-0259-81-Pt-1) 20 Aug. 1981 p 65-86 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 1 (Xian Shaanxi), 1979

Avail: NTIS HC A17/MF A01

The method is comprised of three main parts: the mean S sub 2 streamsurface calculation, the approximate calculation of S sub 1 streamsurface of revolution, and defining the blade element on the conical surface and stacking the blade airfoil sections. The method is unusual in that the calculation stations for making the S sub 2 streamsurface computations are curves, and particularly in that the airfoil parameters of blade are calculated on a plane tangent to the approximate streamsurface of revolution. On this tangential plane, two dimensional flow is used as basic model to calculate the Mach wave system on the suction surface of cascade entrance region. T.M.

N82-10994# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE AUTOMATIC MATRIX FORCE METHOD AND TECHNIQUES FOR HANDLING MORE COMPLEX COMPUTA-

TIONS WITH GIVEN COMPUTER CAPACITY

Yang Qingxiong *In its Recent Selected Papers of NW Polytech. Univ.*, pt. 1 (FTD-ID(RS)T-0259-81-Pt-1) 20 Aug. 1981 p 338-358 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 1 (Xian Shaanxi), 1979

Avail: NTIS HC A17/MF A01

The history of using the method for structural computation in domestic aeronautical engineering was reviewed. The development and application of the matrix method was examined. T.M.

N82-10995# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STRUCTURAL ANALYSIS OF FUSELAGES WITH CUTOUTS BY FINITE ELEMENT METHOD

G. Shoulian, Sun Can, Tang Xuunchun, and Ye Tiangi *In its Recent Selected Papers of NW Polytech. Univ.*, pt. 1 (FTD-ID(RS)T-0259-81-Pt-1) 20 Aug. 1981 p 359-378 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 1 (Xian Shaanxi), 1979

Avail: NTIS HC A17/MF A01

The rear part of a transport aircraft's fuselage was studied. It consists of two sections, the front section being a closed cylinder with a floor and the other section containing a large cutout. An idealized structure is considered to have 1950 degrees of freedom. In this analysis, three kinds of finite element were adopted: a flange element with various cross sections; a constant shear flow quadrilateral of arbitrary shape; and a beam element of various cross sections taking account of eccentricity of the nodes from the axes of moment and inertia. A factorization algorithm was adopted in the solution of the system of linear algebraic equations. T.M.

N82-10996# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MATRIX ANALYSIS OF WINGS

Xu Yuan, Zhu Runzhang, Jiang Jingqiang, and Cai Yuliu *In its Recent Selected Papers of NW Polytech. Univ.*, pt. 2 (FTD-ID(RS)T-0260-81-Pt-2) 28 Aug. 1981 p 76-111 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 2 (Xian Shaanxi), 1979

Avail: NTIS HC A18/MF A01

The plate-beam wing constructions are simplified either as plane stress or plate bending models. The triangular element matrix of a laminated plate is introduced as well as the element stiffness matrix of the beam of axially variable rectangular cross section. Two general computer calculation programs are also compiled. Calculations are shown for wings consisting of plates and beams, honeycomb core and solid wings. Compared to the experimental results, the errors in the nodal deflections are generally less than 5%. It is clear that the method adopted has finite accuracy and generality. R.C.T.

N82-11006# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INITIAL EXPERIMENTAL RESEARCH INTO THE RESPONSE OF TURBOJET ENGINE COMPRESSORS TO DISTORTION OF INTAKE PRESSURE

Chen Fu-qun, Tang Di-yi, Hu Zi-long, Id Wen-lan, Yu Jin-di, Wu Xin-yuan, Zhao Jue-liang, Lin Qi-xun, Wang Zong-yuan, Liu Si-hong et al *In its Recent Selected Papers of NW Polytech. Univ.*, pt. 2 (FTD-ID(RS)T-0260-81-Pt-2) 28 Aug. 1981 p 287-316 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 2 (Xian Shaanxi), 1979

Avail: NTIS HC A18/MF A01

The influence which distortions in intake pressure have on the stability and characteristics of the compressors of turbojet engines was investigated. The test bed of a turbojet engines with a nine stage compressor was used as a test bed. The first stage of the compressor was transonic. It was concluded that the capabilities of compressors of this type of turbojet engine are not only determined by the capabilities or characteristics of the compressor but also by the structural arrangement and actual situation of the other components in system of the compressor. Other significant conclusions are reported. R.C.T.

N82-11007# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A PRELIMINARY EXPERIMENTAL INVESTIGATION OF THE RESPONSE OF A TURBOJET ENGINE TO INLET PRESSURE DISTORTION

Chen Fu-qun, Tang Di-yi, Hu Zi-long, Id Wen-lan, Yu Jin-di, Wu Xin-yuan, Zhao Jue-liang, Lin Qi-xun, Wang Zong-yuan, and Liu Si-hong *In its Recent Selected Papers of NW Polytech. Univ., pt. 2 (FTD-ID(RS)T-0260-81-Pt-2) 28 Aug. 1981 p 317-346 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 2 (Xian Shaanxi), 1979*

Avail: NTIS HC A18/MF A01

Preliminary experimental results about the effect of inlet pressure distortion on the characteristics and instability of the axial compressor of a turbojet engine are presented. The experiments were conducted on the test bed on a turbojet engine with a 9-stage compressor, whose first stage is transonic. The tests were run for each of the following cases: (1) at 99% design speed with 180 deg triple-deck 36 mesh screen in front of the engine inlet, i.e., 3x36 mesh; (2) at 90% design speed with 180 deg single-deck 35 mesh screen, i.e., 1x36 mesh; (3) at 90% design speed with clean inlet; and (4) at 87% design speed with a decrease of about 12% of the first stage turbine nozzle exit area. R.C.T.

N82-11008# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

AN EXPERIMENTAL INVESTIGATION OF THE ROTATING STALL, SURGE AND WAKE BEHIND THE ROTOR FOR A SINGLE STAGE AXIAL COMPRESSOR

Zhang Weide, Zbang Changsheng, Liu Zhiwei, and Liu Jiafeng *In its Recent Selected Papers of NW Polytech. Univ., pt. 2 (FTD-ID(RS)T-0260-81-Pt-2) 28 Aug. 1981 p 347-370 refs Transl. into ENGLISH from Recent Selected Papers of NW Polytech. Univ., pt. 2 (Xian Shaanxi), 1979*

Avail: NTIS HC A18/MF A01

Dynamic tests were conducted in order to investigate the rotating stall, surge, and wake behind the rotor of a single stage axial compressor. The relationship between the rotating stall and the total turbulence behind the rotor caused by the wake was also studied. It was found that the waveform of the wake behind the rotor shows marked changes when rotating stall approaches. The wake induced degree of total turbulence increases sharply, and therefore may be used as a way to predict rotating stall. The total process of rotating stall and surge as well as the differences between the two and their connection were also compared. R.C.T.

N82-11013*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

EFFECTS OF VORTEX FLAPS ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF AN ARROW WING

Long P. Yip and Daniel G. Murri Nov. 1981 64 p refs (NASA-TP-1914; L-14575) Avail: NTIS HC A04/MF A01 CSCL 01B

Tests were conducted in the Langley 12-foot low-speed wind-tunnel to determine the longitudinal and lateral-directional aerodynamic effects of plain and tabbed vortex flaps on a flat-plate, highly swept arrow-wing model. Flow-visualization studies were made using a helium-bubble technique. Static forces and moments were measured over an angle-of-attack range from 0 deg to 50 deg for sideslip angles of 0 deg and + or - 4 deg. A.R.H.

N82-11014# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technol. Div.

ACTA MECHANICA SINICA

11 Sep. 1981 47 p refs Transl. into ENGLISH from Acta Mech. Sinica (China), no. 1, 1979 70-73

(AD-A105184; FTD-ID(RS)T-0704-81) Avail: NTIS HC A03/MF A01 CSCL 01/2

Various fluid dynamics problems are discussed including the computation of three-dimensional flow in turbomachinery, the design of wing root regions of aircraft wing-body combinations, and the diffraction and reflection of traveling shock waves.

N82-11015# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE ARBITRARY QUASI-ORTHOGONAL SURFACE METHOD FOR COMPUTING THREE-DIMENSIONAL FLOW IN TURBINE MACHINERY. 2. CALCULATION OF THE

THREE-DIMENSIONAL FLOW WITH THE S SUB 1-SURFACE TWISTED

Xin Xiao-Kang, Jiang Jin-Liang, and Zhu Shi-Can *In its Acta Mech. Sinica (FTD-ID(RS)T-0704-81) 11 Sep. 1981 p 1-19 refs Transl. into ENGLISH from Acta Mech. Sinica (China), no. 1, 1979*

Avail: NTIS HC A03/MF A01 CSCL 01/2

On the basis of the quasi-orthogonal surface method, a three-dimensional flow field solution of inviscid fluids in turbine machinery is obtained. This method, under the condition allowed by the storage of the computer, can calculate any shapes of S sub 1 and S sub 2 surfaces (including twisting S sub 1 surfaces) and obtain the shapes of space streamlines and the three-dimensional distribution of parameters such as velocity. The calculations for the two conditions of a centrifugal compressor with a small impeller (ϕ 110) indicate the relative value of the twist of the S sub 1 surface is about 3 to 10 percent. The S sub 1 surface shows a double twist like a twist drill from the inlet to the outlet. M.G.

N82-11016# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE PRINCIPLES AND METHODS FOR SHAPING THE WING ROOT REGIONS OF A WING-BODY COMBINATION AT TRANSONIC AND LOWER SUPERSONIC SPEEDS

Yang Tso Sheng, Tai Chia Tsun, Chen Ching Sung, and Fan I. Chia *In its Acta Mech. Sinica (FTD-ID(RS)T-0704-81) 11 Sep. 1981 p 20-35 refs Transl. into ENGLISH from Acta Mech. Sinica (China), no. 1, 1979*

Avail: NTIS HC A03/MF A01 CSCL 01/2

The principles and methods for the combined shaping of the wing root regions of a wing-body combination, in accordance with the requirements of area rule and shockless pressure field, are discussed. It is shown that the favorable non-midwing arrangement is able to reduce the amount of fuselage shaping required for the reduction of the zero lift wave drag of a wing-body combination. The combined shaping so designed may thus be realized more easily in structural arrangement. M.G.

N82-11024# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THEORETICAL INVESTIGATIONS AND EXPERIMENTAL RESEARCHES FOR HIGHER SUBSONIC TWO-DIMENSIONAL COMPRESSOR CASCADE

Yan Ru-qun and Qian Zhao-yan *In its J. of Eng. Thermophys. (Selected Articles) (FTD-ID(RS)T-0570-81) 16 Sep. 1981 p 1-34 refs Transl. into ENGLISH from Gongcheng Rewuli Xuebao (China), v. 2, no. 1, Feb. 1981 Presented at the 3rd Ann. All-China Thermophys. Eng. Technol. Conf., Gui Lin, China, Apr. 1980*

Avail: NTIS HC A05/MF A01 CSCL 21/5

Compressible turbulence flow boundary layer theory and several characteristic boundary layer parameters (momentum thickness, form factors, energy factors and other combinational parameters) were combined with simplified gas flow speed distributions in the boundary layers in the wake behind the blade cascade and used to deduce, on the basis of the research foundation accumulated in the past about the theory of blade cascade losses, a simplified equation for the calculation of total two-dimensional blade cascade pressure losses for subsonic and transonic speeds. With this equation, it is possible to calculate the two-dimensional blade cascade pressure losses in designed operational configurations and off-designed operational configurations. A graphical method for determining the corrected gas compressibility effect in the blade cascade of compressors under operating conditions involving higher subsonic and transonic speeds is also introduced. A.R.H.

N82-11025# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A THEORETICAL ANALYSIS OF THE STREAM SURFACE OF REVOLUTION WITH SUPERSONIC INLET FLOW IN A TRANSONIC AXIAL COMPRESSOR

Xu Jian-zhong, Jiang Zuo-ren, Yang Jin-sheng, Zhang Ying, and Du Zhuan-she *In its J. of Eng. Thermophys. (Selected Articles) (FTD-ID(RS)T-0570-81) 16 Sep. 1981 p 35-50 refs Transl. into ENGLISH from Gongcheng Rewuli Xuebao (China), v. 2, no. 1, Feb. 1981 Presented at the 3rd Ann. All-China Eng. Thermophys. and Technol. Conf., Gui Lin, China, Apr. 1980*

N82-11027

Avail: NTIS HC A05/MF A01 CSCL 21/5

Changes in the gas flow velocity triangle behind the shock waves being considered were studied in an effort to analyze the effect which shock waves have on gas flow. A planar oblique relationship formula was used to deduce the corresponding values of changes in velocity moment, pressure losses, and total pressure ratios. This explains the important phenomenon involved when the supersonic intake cross section shock waves of transonic compressors cause addition pressurization of gas flow (supercharging). Aerodynamic and thermodynamic analyses and calculations were then carried out on the tip cross sections of the rotors. The characteristic curve calculations for the shock waves in front of the blade cascades and for the intake areas of these cascades are examined. Passageway shock waves are also calculated. Results are discussed. A.R.H.

N82-11027# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A NEW METHOD OF COOLING TURBINE VANES

Gu Wei-zao, Zhang Yu-ming, and Xu Hong-kun *In its J. of Eng. Thermophys. (Selected Articles) (FTD-ID(RS)T-0570-81)* 16 Sep. 1981 p 65-71 refs Transl. into ENGLISH from Gongcheng Rewuli Xuebao (China), v. 2, no. 1, Feb. 1981 Presented at the 3rd Ann. All-China Eng. Thermophys. Technol. Conf., Gui Zhoy, China, Apr. 1980

Avail: NTIS HC A05/MF A01 CSCL 21/5

The combined use of an internal cooling process with strengthened blades and of additives to lessen heat transfer to the blades from fuel gasses is proposed as a means of increasing intake temperature in aircraft turbine engines. Topics covered include coarseness-strengthened heat exchange in the inner passageways of blades and the precipitation of silicon dioxide particles in fuel gases onto blade surfaces. Temperature calculations made for the first stage guide vanes of the MK202 engine are included. A.R.H.

N82-11033*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

WIND-TUNNEL RESULTS FOR A MODIFIED 17-PERCENT-THICK LOW-SPEED AIRFOIL SECTION

Robert J. McGhee and William D. Beasley Nov. 1981 87 p refs (NASA-TP-1919: L-14666) Avail: NTIS HC A05/MF A01 CSCL 01A

Wind-tunnel tests were conducted in the Langley low-turbulence pressure tunnel to evaluate the effects on performance of modifying a 17-percent-thick low-speed airfoil. The airfoil contour was altered to reduce the pitching-moment coefficient by increasing the forward loading and to increase the climb lift-drag ratio by decreasing the aft upper surface pressure gradient. The tests were conducted over a Mach number range from 0.07 to 0.32, a chord Reynolds number range 1.0×10^6 to the 6th power to 12.0×10^6 to the 6th power, and an angle-of-attack range from about -10 deg to 20 deg. Author

N82-11034# National Aerospace Lab., Tokyo (Japan).

NEW ESTIMATION METHOD FOR FLUTTER OR DIVERGENCE BOUNDARY FROM RANDOM RESPONSES AT SUBCRITICAL SPEEDS

Yuji Matsuzaki and Yasukatsu Ando Apr. 1981 15 p refs (NAL-TR-667T; ISSN-0389-4-10) Avail: NTIS HC A02/MF A01

A new technique for estimating the flutter or divergence boundary from responses due to turbulence at subcritical speeds is described. The boundary can be predicted without estimating or measuring the dampings and frequencies of the aeroelastic modes. The sampled time response is modeled by the mixed autoregressive moving average process. The orders and coefficients of both autoregressive and moving average parts of the process are determined with the aid of Akaike's estimation procedure. The stability boundary is estimated by using Jury's stability determinants which are expressed in terms of the autoregressive coefficients alone. The modal frequencies and dampings are also evaluated from the coefficients. The technique proposed has been applied with success to signals from a cantilever wing model tested in a low supersonic flow. Comparison between the actual and estimated flutter boundaries shows that an accurate estimation can be made from data obtained in a narrow range of the dynamic pressure which is sufficiently below the boundary. Author

N82-11035# National Aerospace Lab., Tokyo (Japan). First Airframe Div.

A STUDY ON NUMERICAL METHOD FOR EVALUATING SPANWISE INTEGRAL IN SUBSONIC LIFTING-SURFACE THEORY

Teruo Ichikawa Mar. 1981 22 p refs (NAL-TR-661T; ISSN-3989-4010) Avail: NTIS HC A02/MF A01

Two disputable points are discussed. The first point is the coincidence of each collocation section with one of the spanwise integration points. The second point is the relatively small, but undesirable, sharp variation of the regularized influence functions near the collocation sections. Two proposals for coping with these difficulties are made. Their effects are examined by computing the downwash at the surface of a steady rectangular wing subjected to a simple wing loading. It is shown that method 1, which avoids the coincidence, makes it possible, with no losses in accuracy, to greatly reduce the computing time in cases of oscillating wings. Further, it is shown that remarkable improvement in convergence with respect to the number of spanwise integration points is obtained by method 2 which distributes the spanwise integration points densely only near the collocation sections. T.M.

N82-11039*# North Carolina State Univ., Raleigh. Center for Sound and Vibration.

AIRCRAFT WING TRAILING-EDGE NOISE

Ronald L. Underwood and Thomas H. Hodgson 1981 145 p refs

(Grant NsG-1377)

(NASA-CR-164952) Avail: NTIS HC A07/MF A01 CSCL 01A

The mechanism and sound pressure level of the trailing-edge noise for two-dimensional turbulent boundary layer flow was examined. Experiment is compared with current theory. A NACA 0012 airfoil of 0.61 m chord and 0.46 m span was immersed in the laminar flow of a low turbulence open jet. A 2.54 cm width roughness strip was placed at 15 percent chord from the leading edge on both sides of the airfoil as a boundary layer trip so that two separate but statistically equivalent turbulent boundary layers were formed. Tests were performed with several trailing-edge geometries with the upstream velocity U sub infinity ranging from a value of 30.9 m/s up to 73.4 m/s. Properties of the boundary layer for the airfoil and pressure fluctuations in the vicinity of the trailing-edge were examined. A scattered pressure field due to the presence of the trailing-edge was observed and is suggested as a possible sound producing mechanism for the trailing-edge noise. T.M.

N82-11042*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

LOW SPEED TESTING OF THE INLETS DESIGNED FOR A TAMDEN-FAN V/STOL NACELLE

Robert C. Williams and Andres H. Ybarra (Vough Corp., Dallas) 1981 13 p refs Presented at the V/STOL Conf., Palo Alto, Calif., 7-9 Dec. 1981

(NASA-TM-82728; E-1031; AIAA-81-2627) Avail: NTIS HC A02/MF A01 CSCL 01A

An approximately 0.25 scale model of a tandem fan nacelle, designed for a subsonic V/STOL aircraft, was tested in a Lewis wind tunnel. Model variables included long and short aft inlet cowls and the addition of exterior strakes to the short inlet cowl. Inlet pressure recoveries and distortion were measured at pitch angles to 40 deg and at combinations of pitch and yaw to 30 deg. Airspeeds covered a range to 135 knots (69 m/sec). The short aft inlet with added strakes had the best aerodynamic performance and is considered suitable for the intended V/STOL application. T.M.

N82-11043*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

A SUMMARY OF V/STOL INLET ANALYSIS METHODS

Danny P. Hwang 1981 12 p refs Presented at the V/STOL Conf., Palo Alto, Calif., 7-9 Dec. 1981

(NASA-TM-82725; E-1027) Avail: NTIS HC A02/MF A01 CSCL 01A

Recent extensions and applications of the methods are emphasized. They include the specification of the Kutta condition for a slotted inlet, the calculation of suction and tangential blowing for boundary layer control, and the analysis of auxiliary inlet geometries at angles of attack. A comparison is made with

experiment for the slotted inlet. An optimum diffuser velocity distribution was developed. T.M.

N82-11046*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMPUTATION OF HIGH REYNOLDS NUMBER INTERNAL/EXTERNAL FLOWS

Michael C. Cline and Richard G. Wilmoth 1981 12 p refs
Presented at the 5th AIAA Computational Fluid Dyn. Conf., Palo Alto, Calif., 22-23 Jun. 1981
(Contract W-7405-eng-36)

(NASA-TM-84049; DE81-025343; LA-UR-81-1882;

CONF-810664-2) Avail: NTIS HC A02/MF A01 CSCL 01A

A general, user oriented computer program, called VNAP2, was developed to calculate high Reynolds number, internal/external flows. The VNAP2 program solves the two dimensional, time dependent Navier-Stokes equations. The turbulence is modeled with either a mixing-length, a one transport equation, or a two transport equation model. Interior grid points are computed using the explicit MacCormack Scheme with special procedures to speed up the calculation in the fine grid. All boundary conditions are calculated using a reference plane characteristic scheme with the viscous terms treated as source terms. Several internal, external, and internal/external flow calculations are presented. DOE

N82-11047# Federal Aviation Administration, Washington, D.C. Systems Research and Development Service.

THREAT ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS) SYMPOSIUM

22 Jul. 1981 177 p refs Symp. held at Washington, D.C., 22 Jul. 1981

(AD-A104563; FAA-RD-81-76) Avail: NTIS HC A09/MF A01 CSCL 01/4

The Federal Aviation Administration held a symposium on Threat Alert and Collision Avoidance System (TCAS) in Washington, D.C., July 22, 1981, which was attended by representatives of 68 organizations and 21 airlines. This report contains the news release announcing the new approach to providing protection against mid-air collisions, 10 presentations and the transcript of the panel discussion. The TCAS will provide a range of capabilities and costs which will meet the requirements of all airspace users. The least complex part of the system is designed for private pilots and would cost about \$2,500. The fully capable, or airline, version would cost between \$45,000 and \$50,000. This new concept represents a new capability which draws on all FAA has learned about collision avoidance in its past efforts, extends and simplifies FAA's efforts to date, provides new capabilities to all users, and is fully compatible with international standards and improvement activities on the Secondary Surveillance Radar (SSR). Author (GRA)

N82-11048# Lear Siegler, Inc., Grand Rapids, Mich. Instrument Div.

FLIGHT TRAJECTORY CONTROL INVESTIGATION Final Report, 15 May 1978 - 30 Oct. 1980

M. Bird and J. Karmarker Wright-Patterson AFB, Ohio AFWAL Mar. 1981 174 p refs

(Contract F33615-78-C-3607; AF Proj. 2403)

(AD-A104542; ID-O5R-1180; AFWAL-TR-81-3012) Avail: NTIS HC A08/MF A01 CSCL 17/9

Optimal control algorithms for four-dimensional guidance of a transport aircraft were investigated for feasibility. Cost function constraints on the optimal reference path generator appeared impossible to achieve and the optimal guidance algorithms do not achieve significant performance improvement without excessive increases in sophistication and cost of the onboard avionics computer. A modularized existing Mission Management system allows a three-phase flight test plan to demonstrate the operational capability of the existing classical integrated flight trajectory control algorithms. Author (GRA)

N82-11049# General Accounting Office, Washington, D. C. Community and Economics Development Div.

FAA MISSES OPPORTUNITIES TO DISCONTINUE OR REDUCE OPERATING HOURS OF SOME AIRPORT TRAFFIC CONTROL TOWERS Report to the Congress

1 Jun. 1981 39 p

(PB81-224214; CED-81-100) Avail: NTIS HC A03/MF A01 CSCL 17G

FAA is not adequately surveying or evaluating air traffic levels at 24 hour control towers to identify opportunities to reduce operating hours and save money. GRA

N82-11050*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

PARAMETRIC STUDY OF MICROWAVE-POWERED HIGH-ALTITUDE AIRPLANE PLATFORMS DESIGNED FOR LINEAR FLIGHT

Charles E. K. Morris, Jr. Nov. 1981 74 p refs

(NASA-TP-1918; L-14606) Avail: NTIS HC A04/MF A01 CSCL 01C

The performance of a class of remotely piloted, microwave powered, high altitude airplane platforms is studied. The first part of each cycle of the flight profile consists of climb while the vehicle is tracked and powered by a microwave beam; this is followed by gliding flight back to a minimum altitude above a microwave station and initiation of another cycle. Parametric variations were used to define the effects of changes in the characteristics of the airplane aerodynamics, the energy transmission systems, the propulsion system, and winds. Results show that wind effects limit the reduction of wing loading and the increase of lift coefficient, two effective ways to obtain longer range and endurance for each flight cycle. Calculated climb performance showed strong sensitivity to some power and propulsion parameters. A simplified method of computing gliding endurance was developed. S.L.

N82-11052*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.

ICING TUNNEL TESTS OF A COMPOSITE POROUS LEADING EDGE FOR USE WITH A LIQUID ANTI-ICE SYSTEM

David L. Kohlman Sep. 1981 21 p refs

(Grant NAG3-71)

(NASA-CR-164966; KU-FRL-464-3) Avail: NTIS HC A02/MF A01 CSCL 01C

The efficacy of liquid ice protection systems which distribute a glycol-water solution onto leading edge surfaces through a porous skin was demonstrated in tests conducted in the NASA Lewis icing research tunnel using a composite porous leading edge panels. The data obtained were compared with the performance of previously tested stainless steel leading edge with the same geometry. Results show: (1) anti-ice protection of a composite leading edge is possible for all the simulated conditions tested; (2) the glycol flow rates required to achieve anti-ice protection were generally much higher than those required for a stainless steel panel; (3) the low reservoir pressures of the glycol during test runs indicates that more uniform distribution of glycol, and therefore lower glycol flow rates, can probably be achieved by decreasing the porosity of the panel; and (4) significant weight savings can be achieved in fluid ice protection systems with composite porous leading edges. The resistance of composite panels to abrasion and erosion must yet be determined before they can be incorporated in production systems. A.R.H.

N82-11053*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SELECTED BIBLIOGRAPHY OF NACA-NASA AIRCRAFT ICING PUBLICATIONS

John J. Reinmann, comp. Aug. 1981 127 p

(NASA-TM-81651; E-668) Avail: NTIS HC E15/MF A01 CSCL 01C

A summary of NACA-NASA icing research from 1940 to 1962 is presented. It includes: the main results of the NACA icing program from 1940 to 1950; a selected bibliography of 132 NACA-NASA aircraft icing publications; a technical summary of each document cited in the selected bibliography; and a microfiche copy of each document cited in the selected bibliography. T.M.

N82-11054*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A COMPARISON OF THEORETICAL AND EXPERIMENTAL PRESSURE DISTRIBUTIONS FOR TWO ADVANCED FIGHTER WINGS

H. P. Haney (Vought Corp., Dallas) and R. M. Hicks Oct. 1981 87 p refs

(NASA-TM-81331; A-8741) Avail: NTIS HC A05/MF A01 CSCL 01C

A comparison was made between experimental pressure

distributions measured during testing of the Vought A-7 fighter and the theoretical predictions of four transonic potential flow codes. Isolated wind and three wing-body codes were used for comparison. All comparisons are for transonic Mach numbers and include both attached and separate flows. In general, the wing-body codes gave better agreement with the experiment than did the isolated wing code but, because of the greater complexity of the geometry, were found to be considerably more expensive and less reliable. Author

N82-11055# Computational Mechanics Consultants, Knoxville, Tenn.

A NUMERICAL THREE-DIMENSIONAL TURBULENT SIMULATION OF A SUBSONIC VSTOL JET IN A CROSS-FLOW USING A FINITE ELEMENT ALGORITHM Final Report, Sep. 1979 - Sep. 1980

A. J. Baker, J. A. Orzechowski, and P. D. Manhardt Jun. 1981 72 p refs

(Contract N62269-79-C-0295)

(AD-A104514; NADC-79021-60) Avail: NTIS HC A04/MF A01 CSCL 01/3

The purpose of this study, the results of which are reported herein, was to formulate a mathematical model of the basic VSTOL jet, and to validate its appropriateness by performing a series of computational experiments on the discrete analog (numerical) approximation to the mathematical description. Since the VSTOL jet problem is essentially steady, turbulent and fully three-dimensional, the mathematical description must be quite comprehensive. The approach selected was to utilize a continuity-constrained, finite element algorithm for solution of the parabolized form of the time-averaged, three-dimensional Navier-Stokes equations (3DPNS). The essential ingredients of this algorithmic description are presented and discussed. A production finite element computer code (COMOC:3DPNS) was utilized to conduct the computational experiments, and the description of problem definition and data deck preparation is contained at the end of the report. The key results of the computational experiments are discussed, regarding the basic causal mechanisms of the VSTOL jet, as well as results for confirmation test cases documenting viability of the constructed computational model. Author (GRA)

N82-11056# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

ROTORCRAFT ICING: STATUS AND PROSPECTS

Aug. 1981 136 p refs

(AGARD-AR-166; ISBN-92-835-1397-5) Avail: NTIS HC A07/MF A01

The impact of icing meteorological conditions on helicopter operations was examined, and methods for improving ice protection investigated.

N82-11057# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

OPERATIONAL ENVIRONMENT, METEOROLOGICAL CONDITIONS AND WEATHER FORECASTING

In its Rotorcraft Icing Aug. 1981 p 1-13 refs

Avail: NTIS HC A07/MF A01

Helicopter icing is a significant operational consideration for helicopters operating throughout Europe. Existing weather statistics demonstrate significant operational limitations during the winter months, and for as much as five percent of the time on a year-around basis. Unfortunately the existing meteorological data base is insufficient to describe the operating environment in which NATO rotorcraft must conduct flight. At present for design purposes, the United States Federal Air Regulation 25 Appendix C or the UK Icing Atmosphere are employed for determination of airworthiness release of helicopters. However, neither of these atmospheres adequately defines the operational environment. This condition is exacerbated by the fact that forecasting techniques are currently inadequate to allow unrestricted helicopter operations in icing conditions. Increased coordination among cloud physicists, forecasters, and helicopter icing specialists is needed - and ultimately a new icing atmosphere is required to better define the helicopter operational icing requirements. J.D.H.

N82-11058# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

TECHNOLOGY BASE FOR ICING INSTRUMENTATION AND MATHEMATICAL MODELLING

In its Rotorcraft Icing Aug. 1981 p 14-33 refs

Avail: NTIS HC A07/MF A01

The fundamental mechanisms of ice accretion and shedding from rotor airfoils are considered. It is felt that an opportunity exists to exploit a combination of two-dimensional model and three-dimensional model scale testing, measurement of ice release mechanisms, inclusion of heat transfer models, and consideration of icing simulation. These efforts should be aimed at development of analytical models verified by both laboratory and full-scale data which then can be used to better predict performance of rotors in icing conditions. Only with the above analytical basis can ice accretion and shedding characteristics become sufficiently predictable to permit the determination of what type of ice protection is necessary or, conversely, what degree of flight envelope release might be permitted with a given level of ice protection. Further improvement in research and development of operational icing sensors is recommended. J.D.H.

N82-11059# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

FACILITIES FOR DEVELOPMENT AND CLEARANCE

In its Rotorcraft Icing Aug. 1981 p 34-53

Avail: NTIS HC A07/MF A01

A catalog of all NATO icing test facilities was compiled. It is recommended that the Canadian National Research Council's small high speed icing tunnel is a one-of-a-kind facility that needs to be available to support analytical development recommended, and that the tunnel should be reactivated or replaced. A decision has been made to retain the Ottawa Spray Rig in operational status for the near future. Efforts underway at the NASA-Lewis Research Center regarding rehabilitation of the Icing Research Tunnel and considering a major new icing test facility are endorsed. The US Army Helicopter Icing Spray System Improvement Program is also supported by the Working Group and, as a recommendation for future discussion, the need for European airborne icing spray systems should be considered. A conclusion reached by the Working Group is that current full scale development and qualification facilities and procedures are extremely expensive and time consuming. J.D.H.

N82-11060# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

ICE PROTECTION SYSTEM TECHNOLOGY

In its Rotorcraft Icing Aug. 1981 p 54-99 refs

Avail: NTIS HC A07/MF A01

Deicing systems technology concepts are discussed. The conclusion is that electrothermal deicing systems are the only effective present system for broad application. However, it is noted that the cost of electrothermal deicing in terms of weight, power and expense is high, and provides an incentive for examination of alternatives. Therefore, additional work is clearly warranted on options such as ice phobics, fluid ice suppressant systems, pneumatic boots, vibratory surface systems, microwave and other hybrid systems concepts. It is recommended that the operational limitations of ice protected aircraft such as the Black Hawk and Puma, be explored with the ice protection systems deliberately turned off, so as to simulate an aircraft without (or with inoperative) ice protection. Only through such definition of the actual icing environment can a better estimation be made of the operational impact of icing conditions on helicopter flight operations. J.D.H.

N82-11061# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

PROPOSED STANDARD REQUIREMENTS AND PROCEDURES FOR ICING CLEARANCE

In its Rotorcraft Icing Aug. 1981 p 100-117

Avail: NTIS HC A07/MF A01

A set of proposed standard requirements and procedures for icing clearance is presented. It is felt that this clearance procedure constitutes a basis for NATO-wide icing clearance and should be adopted by the NATO military community as an interim approach. The opportunity also exists to consider this proposal for civil icing clearance. J.D.H.

N82-11062# Hughes Aircraft Co., El Segundo, Calif. Display Systems Lab.

STUDY AND DEVELOPMENT OF AN INTEGRATED HEAD-UP DISPLAY Final Report, 1 Jul. 1976 - 31 Aug. 1980

Michael N. Ernstoff Jun. 1981 112 p refs
(Contract F33615-76-C-1243; AF Proj. 2003)
(AD-A104337; HAC-D6210; AFWAL-TR-81-1042) Avail:
NTIS HC A06/MF A01 CSCL 14/5

The purpose of the Integrated Head-Up Display (I-HUD) program was to demonstrate the advantages associated with using a Liquid Crystal Matrix Display and Diffraction Optics combiner in the design and construction of a high brightness head-up display system. The program resulted in the design and fabrication of the I-HUD brassboard consisting of a pilot's display unit, built in a form factor similar to that of the production F16 HUD, and test support equipment. The following devices and modules were developed: A 350-by-350 pixel Liquid Crystal Matrix Display complete with custom LSI circuit drivers, a diffraction optics combiner, a diffraction optics diffusing screen, a specular mode projector, and custom lamp with a narrow band (green) spectral output. Although the completed I-HUD brassboard did not meet all of its design goals, it does demonstrate the feasibility of applying advanced technology to the designs of Head-Up Displays. The I-HUD program has succeeded in solving many of the fundamental design problems associated with this approach and stands as a milestone in the development of solid state display devices and the development of more highly reliable, cost effective Head-Up Displays. GRA

N82-11063# Panametrics, Inc., Waltham, Mass.
ADVANCED FUEL FLOWMETER FOR FUTURE NAVAL AIRCRAFT Final Report, Dec. 1977 - Apr. 1981

L. C. Lynnworth, N. E. Pedersen, J. E. Bradshaw, J. E. Matson, E. S. Johansson, and T. H. Nguyen 28 Jun. 1981 149 p refs

(Contract N62269-78-C-0069)
(AD-A104364; NADC-80254-60) Avail: NTIS
HC A07/MF A01 CSCL 21/4

A fuel mass flowmeter was developed with the objective of accurately measuring the mass flow rate \dot{M} of various fuels and their mixtures, for flow rates from 91 to 11,364 kg/hr (200 to 25,000 lb/hr). The delivered system included: (1) an area averaging zigzag flow velocimeter cell, in which the fuel was interrogated in opposite directions by an alternating sequence of ultrasonic pulses, to determine the area averaged flow velocity, \bar{V} ; (2) a densitometer based on the Clausius-Mosotti law, in which the fuel density ρ is determined; and (3) electronics which computed ρ and \bar{V} separately, and then generated a square wave output having a frequency proportional to the product of ρ and \bar{V} , namely $\dot{M} = \rho(\bar{V}A)$, where A = velocimeter cell cross sectional area. The transducers can operate beyond the temperature range -38 to +150 C, and the flow cell, with transducers, at pressures up to 1500 psig and in the 3-axis, 20 g, 5 to 2000 Hz vibration environment specified by MIL Std. 810-514.1, except for noise problems at a few discrete frequencies. GRA

N82-11064# General Electric Co., Binghamton, N.Y. Aircraft Equipment Div.

ELECTRONIC MASTER MONITOR AND ADVISORY DISPLAY SYSTEM, DATA TRANSMISSION STUDY Interim Report, Jun. 1979 - Aug. 1980

Aug. 1980 57 p refs
(Contract DAAK80-79-C-0270; DA Proj. 1L2-62202-AH-85)
(AD-A104243; ACS-12177; USAAVRADCOM-TR-79-0270-1; IR-1) Avail: NTIS HC A04/MF A01 CSCL 17/2

The development of nonmission-related status information is one area of rotary wing instrumentation which has not kept pace with the state of art. This includes raw data, discrete and summary status information related to the engine, transmission, rotor, fuel, hydraulic and electrical subsystems. The objective of this report is to define an efficient and cost effective data transmission method for an electronic master monitor and advisory display system (EMMADS). Several current standard and nonstandard data bus specifications which are applicable to the EMMADS system are introduced. Their tradeoff in terms of hardware, software and system considerations are compared. It should be noted that a typical standard bus specs addresses only the protocol and message formats, not the mechanization of the control algorithm. Hence there is a considerable variation

in implementation and cost even for the same bus standard. The materials represent a snapshot of the current state of the art technology. The use of optical fiber instead of conventional electrical cable (such as coaxial) as the transmission medium is also investigated based on the current technical reports. The problems of electromagnetic interference (EMI), and rejection techniques are mentioned. GRA

N82-11065# General Electric Co., Binghamton, N.Y. Aircraft Equipment Div.

ELECTRONIC MASTER MONITOR AND ADVISORY DISPLAY SYSTEM, HUMAN ENGINEERING SUMMARY REPORT Interim Report, Jun. 1979 - Jun. 1981

Jun. 1981 227 p refs
(Contract DAAK80-79-C-0270; DA Proj. 1L2-62202-AH-85)
(AD-A104244; ACS-12385; USAAVRADCOM-TR-79-0270-3; IR-3) Avail: NTIS HC A11/MF A01 CSCL 17/2

Information requirements, information handling formats, and the necessary display/control design criteria are discussed for a system being developed to integrate and display nonmission related information on the status of various subsystems on rotary wing aircraft. GRA

N82-11066# Los Alamos Scientific Lab., N. Mex. Electronics Div.

OUTSIDER'S LOOK AT FLIGHT INSTRUMENTATION

Arvid S. Lundy 1981 7 p refs Presented at the AIAA/SAE/ASME Joint Propulsion Conf., Colorado Springs, Colo., 27-29 Jul. 1981

(Contract W-7405-eng-36)
(DE81-025409; LA-UR-81-1748; CONF-810724-1) Avail:
NTIS HC A02/MF A01

Ideas and speculations on possible diagnostic instrumentation for use in missile flight testing are presented. Techniques for use in the development of flight instrumentation are recommended. DOE

N82-11067# National Aerospace Lab., Tokyo (Japan).
NEW MOLDING METHOD OF THREE-DIMENSIONAL HOLLOW PHOTOELASTIC MODEL AND CENTRIFUGAL STRESS ANALYSIS OF AIR COOLED TURBINE BLADE MODEL

Toyooki Yoshida, Katsutashi Matsusue, Kitao Takahara, and Ryosaku Hashimoto May 1981 17 p refs In ENGLISH; JAPANESE Summary
(NAL-TR-427T; ISSN-0389-4010) Avail: NTIS
HC A02/MF A01

A new molding method for a three dimensional hollow photoelastic model was invented and centrifugal stress analysis performed for air cooled turbine blade models to which the new method was applied. A distinctive feature of the molding method is the introduction of a copper coated wax core which forms a three dimensional hollow shape inside a model. The air cooled turbine photoelastic model with a coolant passage simulates the first stage rotor blade in the high temperature turbine full scale model HT-10H used at the NAL. The results of stress analysis cleared the critical regions and stress magnitude and thus they are of great aid to the successful development of a full scale turbine model. Author

N82-11068# Teledyne Continental Motors, Muskegon, Mich. General Products Div.

LIGHTWEIGHT DIESEL ENGINE DESIGNS FOR COMMUTER TYPE AIRCRAFT

Alex P. Brouwers Jul. 1981 70 p refs
(Contract NAS3-22149)
(NASA-CR-165470; Rept-995) Avail: NTIS HC A04/MF A01
CSCL 21E

Conceptual designs and performance of advanced technology lightweight diesel engines, suitable for commuter type aircraft power plants are defined. Two engines are discussed, a 1491 kW (2000 SHP) eight-cylinder engine and a 895 kW (1200 SHP) six-cylinder engine. High performance and related advanced technologies are proposed such as insulated cylinders, very high injection pressures and high compressor and turbine efficiencies. The description of each engine includes concept drawings, a performance analysis, and weight data. Fuel flow data are given for full and partial power up to 7620m altitude. The performance data are also extrapolated over a power range from 671 kW(900 SHP) to 1864 kW (2500 SHP). The specific fuel consumption of the 1491 kW (2000 SHP) engine is 182

N82-11069

g/hWh (.299 lb/HP) at cruise altitude, its weight 620 kg (1365 lb.) and specific weight .415 kg/kW (.683 lb/HP). The specific fuel consumption of the 895 kW (1200 SHP) engine is 187 g/hWh (.308 lb/HP) at cruise altitude, its weight 465 kg (1025 lb.) and specific weight .520 kg/kW (.854 lb/HP). R.J.F.

N82-11069# Naval Postgraduate School, Monterey, Calif. Dept. of Aeronautics.

SUBSONIC CASCADE WIND TUNNEL TESTS USING A COMPRESSOR CONFIGURATION OF DCA BLADES **M.S. Thesis**

Frank S. Cina Jun. 1981 210 p refs
(AD-A104597) Avail: NTIS HC A10/MF A01 CSCL 21/5

Tests are reported in which air incidence angle was varied to a cascade of 20 blades, 5 inches in chord with aspect ratio of 2.0 and solidity of 1.67. Preliminary blade element performance data were obtained using pneumatic probe surveys and surface pressures were also measured. Results of preparatory tests of a similar cascade of 15 C-series blades at a solidity of 1.28 are also included. Whereas the flow in the C-series blading cascade was always acceptable, the flow in the DCA blading cascade was not acceptable at negative incidence angles. A modification of the cascade inlet guide vanes is recommended which will guarantee periodic conditions and serve to generate more nearly uniform inlet flow at all test conditions. Author (GRA)

N82-11070*# Analytical Mechanics Associates, Inc., Hampton, Va.

AN INFLUENCE COEFFICIENT METHOD FOR THE APPLICATION OF THE MODAL TECHNIQUE TO WING FLUTTER SUPPRESSION OF THE DAST ARW-1 WING Final Report Samuel Pines Nov. 1981 49 p refs

(Contract NAS1-15593)
(NASA-CR-165772; AMA-81-25) Avail: NTIS
HC A03/MF A01 CSCL 01C

The methods used to compute the mass, structural stiffness, and aerodynamic forces in the form of influence coefficient matrices as applied to a flutter analysis of the Drones for Aerodynamic and Structural Testing (DAST) Aeroelastic Research Wing. The DAST wing was chosen because wind tunnel flutter test data and zero speed vibration data of the modes and frequencies exist and are available for comparison. A derivation of the equations of motion that can be used to apply the modal method for flutter suppression is included. A comparison of the open loop flutter predictions with both wind tunnel data and other analytical methods is presented. S.L.

N82-11071*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

AERACOUSTIC THEORY FOR NONCOMPACT WING-GUST INTERACTION

Rudolph Martinez and Sheila E. Widnall Oct. 1981 124 p refs
(Grant NsG-2142)

(FDRL-81-7) Avail: NTIS HC A06/MF A01 CSCL 01C

Three aeroacoustic models for noncompact wing-gust interaction were developed for subsonic flow. The first is that for a two dimensional (infinite span) wing passing through an oblique gust. The unsteady pressure field was obtained by the Wiener-Hopf technique; the airfoil loading and the associated acoustic field were calculated, respectively, by allowing the field point down on the airfoil surface, or by letting it go to infinity. The second model is a simple spanwise superposition of two dimensional solutions to account for three dimensional acoustic effects of wing rotation (for a helicopter blade, or some other rotating planform) and of finiteness of wing span. A three dimensional theory for a single gust was applied to calculate the acoustic signature in closed form due to blade vortex interaction in helicopters. The third model is that of a quarter infinite plate with side edge through a gust at high subsonic speed. An approximate solution for the three dimensional loading and the associated three dimensional acoustic field in closed form was obtained. The results reflected the acoustic effect of satisfying the correct loading condition at the side edge. R.J.F.

N82-11072# Boeing Military Airplane Development, Seattle, Wash. Advanced Airplane Branch.

AIRCRAFT DIGITAL INPUT CONTROLLED HYDRAULIC ACTUATION AND CONTROL SYSTEM Final Report, Aug. 1977 - Dec. 1980

Eugene T. Raymond and Curtiss W. Robinson Mar. 1981

214 p refs

(Contract F33615-77-C-2034; AF Proj. 3145)
(AD-A104263; AFWAL-TR-81-2012) Avail: NTIS
HC A10/MF A01 CSCL 09/2

The development of an Incremental digitally-controlled electrohydraulic incremental digitally-controlled electrohydraulic actuation system (DEHA) is reported. An electronic digital controller and a prototype DEHA unit, with an electric-stepper-motor-driven rotary distributor valve, two hydraulic drive motors, and a torque-summing gearbox, were assembled. Significant reductions in the hydraulic power normally required with a conventional geared hydraulic motor system, and some degree of hydraulic power recovery were obtained. Author (GRA)

N82-11073# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.

THEORY AND APPLICATIONS OF OPTIMAL CONTROL IN AEROSPACE SYSTEMS

Pieter Kant, ed. (National Aerospace Lab., Emmeloord, Netherlands) London Jul. 1981 283 p refs
(AGARD-AG-251; ISBN-92-835-1391-6) Copyright. Avail: NTIS HC A13/MF A01

The basic concepts of control theory were reviewed. Practical design techniques that were developed from the theory are presented. Design examples and practical applications in real systems are described. Major emphasis is on flight control of distributed parameter systems.

N82-11074# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.

AN OVERVIEW OF OPTIMAL CONTROL IN AEROSPACE SYSTEMS

Arthur E. Bryson, Jr. In AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 5 p refs

Avail: NTIS HC A13/MF A01

Optimal control started with the calculus of variations (COV). The digital computer made the calculus of variations a practical tool for synthesis of optimal control logic. Optimal control concepts and algorithms are used not only in the field of automatic control but also in fields of structural optimization, econometrics, and operations research. T.M.

N82-11075# Universite Catholique de Louvain (Belgium). **THEORY OF STOCHASTIC OPTIMAL CONTROL SOME BASIC NOTIONS**

In AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 19 p refs

Avail: NTIS HC A13/MF A01

The optimal control problem for stochastic systems is described in details. Several classes of policy are defined and compared. The corresponding solutions are deduced from Bellman's principle and discussed in connection with the concept of dual effect of the control. After the derivation of the optimal closed-loop solution for the linear quadratic Gaussian problem, several algorithms are proposed for the nonlinear problem and discussed in the perspective of their implementation in aerospace applications. T.M.

N82-11076# Princeton Univ., N. J. Flight Research Lab. **AN INTRODUCTION TO STOCHASTIC OPTIMAL CONTROL THEORY**

In AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 33 p refs

Avail: NTIS HC A13/MF A01

The design of control logic that commands a dynamic system to a desired output or that augments the system's stability is facilitated if objectives are expressed in a quantitative criterion, because the optimization of this criterion establishes a feasible design point for control. If the information which the control logic must use is uncertain or if the dynamic system is forced by random disturbances, only the expected value can be optimized. The methodology for design is based upon stochastic optimal control theory. After introducing the dynamic models of interest, optimal control and estimation are presented separately. Limitations of this approach are addressed, and the unified design of linear stochastic optimal controllers for analog and digital

implementations is described. The principal benefit of stochastic optimal control theory is that it provides an engineering framework within which practical control design can be accomplished for complex dynamic systems. T.M.

N82-11077# Royal Aircraft Establishment, Farnborough (England). Flight Systems Dept.
DESIGN CONSIDERATIONS FOR OPTIMAL FLIGHT CONTROL SYSTEMS

F. R. Gill *In* AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 21 p refs

Avail: NTIS HC A13/MF A01

Following a review of the several interacting factors affecting the design of control laws for any kind of flight control system (FCS), the modelling problem is discussed, including accuracy requirements for computer models of the aircraft, FCS, external disturbances and sensor noise. The state-of-the-art in designing the control and scheduling laws is surveyed and the limits of conventional control techniques are exposed. To overcome these limits, the use of selected nonlinear control techniques is discussed, including the concept of redundant adaptation with safeguards. T.M.

N82-11078*# Honeywell Systems and Research Center, Minneapolis, Minn. Systems and Control Technology Sect.
DESIGN TECHNIQUES FOR MULTIVARIABLE FLIGHT CONTROL SYSTEMS

In AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 33 p refs

(Contracts NAS4-2518; N00014-75-C-01444)

Avail: NTIS HC A13/MF A01 CSCL 01C

Techniques which address the multi-input closely coupled nature of advanced flight control applications and digital implementation issues are described and illustrated through flight control examples. The techniques described seek to exploit the advantages of traditional techniques in treating conventional feedback control design specifications and the simplicity of modern approaches for multivariable control system design. T.M.

N82-11079# Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen (West Germany).

PRACTICAL DESIGN AND REALIZATION OF A DIGITAL ADAPTIVE FLIGHT CONTROL SYSTEM

V. Krebs and U. Hartmann *In* AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 22 p refs Sponsored in part by the West German Ministry of Defense

Avail: NTIS HC A13/MF A01

A new approach for the design and the practical realization of a digital adaptive command and stability system is proposed. The control law for the longitudinal motion of the aircraft is obtained by state vector feedback using the MIL-F-8785 B handling qualities requirements. The design principle is based on decoupling of the angle of attack and pitch rate on the one hand and the pole allocation method for the eigenvalues of the control system on the other hand. Since the necessary gain factors contain unknown and variable aircraft parameters, an on-line fading-memory least squares algorithm for the estimation of these parameters is used. Only conventional aircraft sensors (rate gyros and accelerometers) and an airborne digital computer are necessary. Hybrid simulations of the complete system as well as flight test results demonstrate the efficiency of the concept. T.M.

N82-11080# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).

CONTROL LAW DESIGN FOR TRANSPORT AIRCRAFT FLIGHT TASKS

Volkmar Adam and Hagen Leyendecker *In* AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 13 p refs

Avail: NTIS HC A13/MF A01

An integrated digital flight control system was developed. The primary objective of the program was, both to improve the manual control of the aircraft assisted by control systems, and to develop new control and display systems. In addition, automation is to be provided for loner flight phases which are to be optimized with respect to fuel consumption, flight time, or

other criteria. Aspects of the control law design and flight test experience with the integrated digital flight control system are described. DOE

N82-11081# Purdue Univ., Lafayette, Ind. School of Aeronautics and Astronautics.

CONTROL DESIGN OF FLEXIBLE SPACECRAFT

Robert E. Skelton *In* AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 28 p refs

Avail: NTIS HC A13/MF A01

When compared to other large scale systems, flexible spacecraft have some peculiarities which can make control more difficult. Emphasis is placed upon the time domain and suboptimal linear quadratic gaussian (LOG) methods, with special attention given to the effects of modeling errors. These effects are discussed in light of the model reduction problem, stability, and control design. Stability, controllability and observability computations are reduced to their simplest form possible to provide insight and to facilitate the location of sensors and actuators. The techniques of modal cost analysis are used to identify the critical parameters and the critical models of the structure. In the final stage of design, component cost analysis reveals which states of the optimal dynamical controller should be deleted to produce a reduced controller which is compatible with the on-line computer software limitations. T.M.

N82-11082*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
OPTIMUM CLIMB AND DESCENT TRAJECTORIES FOR AIRLINE MISSIONS

Heinz Erzberger *In* AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 15 p refs

Avail: NTIS HC A13/MF A01 CSCL 01C

The characteristics of optimum fixed-range trajectories whose structure is constrained to climb, steady cruise, and descent segments are derived by application of optimal control theory. The performance function consists of the sum of fuel and time costs, referred to as direct operating cost (DOC). The state variable is range to go and the independent variable is energy. In this formulation a cruise segment always occurs at the optimum cruise energy for sufficiently large range. At short ranges (400 n. mi. and less), a cruise segment may also occur below the optimum cruise energy. The existence of such a cruise segment depends primarily on the fuel flow vs thrust characteristics and on thrust constraints. If thrust is a free control variable along with airspeed, it is shown that such cruise segments will not generally occur. If thrust is constrained to some maximum value in climb and to some minimum in descent, such cruise segments generally will occur. T.M.

N82-11083*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

APPLICATION OF NONLINEAR SYSTEMS INVERSES TO AUTOMATIC FLIGHT CONTROL DESIGN: SYSTEM CONCEPTS AND FLIGHT EVALUATIONS

George Meyer and Luigi Cicolani *In* AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 29 p refs

Avail: NTIS HC A13/MF A01 CSCL 01C

A practical method for the design of automatic flight control systems for aircraft with complex characteristics and operational requirements, such as the powered lift STOL and V/STOL configurations, is presented. The method is effective for a large class of dynamic systems requiring multi-axis control which have highly coupled nonlinearities, redundant controls, and complex multidimensional operational envelopes. It exploits the concept of inverse dynamic systems, and an algorithm for the construction of inverse is given. A hierarchic structure for the total control logic with inverses is presented. The method is illustrated with an application to the Augmentor Wing Jet STOL Research Aircraft equipped with a digital flight control system. Results of flight evaluation of the control concept on this aircraft are presented. T.M.

N82-11084*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

MANAGEMENT OF REDUNDANCY IN FLIGHT CONTROL SYSTEMS USING OPTIMAL DECISION THEORY

In AGARD Theory and Appl. of Optimal Control in Aerospace

Systems Jul. 1981 12 p refs

Avail: NTIS HC A13/MF A01 CSCL 01C

The problem of using redundancy that exists between dissimilar systems in aircraft flight control is addressed. That is, using the redundancy that exists between a rate gyro and an accelerometer--devices that have dissimilar outputs which are related only through the dynamics of the aircraft motion. Management of this type of redundancy requires advanced logic so that the system can monitor failure status and can reconfigure itself in the event of one or more failures. An optimal decision theory was tutorially developed for the management of sensor redundancy and the theory is applied to two aircraft examples. The first example is the space shuttle and the second is a highly maneuvering high performance aircraft--the F8-C. The examples illustrate the redundancy management design process and the performance of the algorithms presented in failure detection and control law reconfiguration. T.M.

N82-11087# Systems Control, Inc., Palo Alto, Calif.
DEVELOPMENT OF MULTIVARIABLE CONTROLLERS FOR AIRCRAFT TURBINE ENGINES

Ronald L. DeHoff, Stephen M. Rock, and Muhammed M. Akhter
In AGARD Theory and Appl. of Optimal Control in Aerospace Systems Jul. 1981 12 p refs

Avail: NTIS HC A13/MF A01

A model reference structure is discussed which is shown to be a flexible framework within which digital control programs of a wide variety of function and complexity can be formulated. The development of the plant reference model is discussed and trade-offs between accuracy and complexity presented. The techniques used to produce optimized, feed-forward state, control and output trajectories are presented. The well-known methods of regulator synthesis using quadratic performance functions are briefly reviewed and the results of several successful applications of this methodology are summarized. T.M.

N82-11089 Royal Aircraft Establishment, Bedford (England).
 Library.

ADAPTATION OF A TURBINE TEST FACILITY TO HIGH-TEMPERATURE RESEARCH

J. Francois, Y. LeBot, J. Michard, and P. Deguest Dec. 1980
 30 p refs Transl. into ENGLISH from AGARD Conf. Proc. No. 229, Ankara, Sept.

(RAE-Lib-Trans-2064: BR78650) Copyright. Avail: Issuing Activity

A facility for research on a high temperature (1800 K) and high pressure (4.5 bar) turbine stage is described. The turbine operates in a realistic engine environment and is comprehensively instrumented to permit wide variation of mainstream and coolant flow parameters. The development of robust probes for the measurement of turbulence and temperature fluctuations and optical pyrometry techniques is described. Results of studies of nozzle guide vane heat transfer coefficients, metal temperatures and film cooling efficiency are presented together with rotor blade surface temperature distributions. The MINOS rig confirmed the validity of turbine design prediction methods by providing performance data to correlate theory, scale model testing and gas turbine engine testing. T.M.

N82-11212# Naval Surface Weapons Center, White Oak, Md.
 Research and Technology Dept.

POLYURETHANE FOAMS FOR AIRCRAFT SHOCK MOUNTS. 3: VIBRATION DAMPING BY POLYETHER FOAMS Progress Report, Sep. 1979 - Jun. 1980

James V. Duffy Jul. 1981 38 p refs

(AD-A104496: NSWC/TR-80-343)

Avail: NTIS

HC A03/MF A01 CSCL 11/9

The objective of this program was to develop flexible foam systems which would meet the specifications outlined in MIL-F-81334B(AS). The vibration damping and mechanical properties of a series of foams based on mixtures of poly(oxytetramethylene) glycol and poly(oxypropylene) polyol were determined. The effect of polyol ratio, foam density, surfactant type and unit loading on vibration output transmissibility for these systems is reported. Author (GRA)

N82-11224*# Lockheed-California Co., Burbank.
EXPERIMENTAL STUDY OF FUEL HEATING AT LOW TEMPERATURES IN A WING TANK MODEL, VOLUME 1 Final Report

Francis J. Stockemer Aug. 1981 75 p refs

(Contract NAS3-21977)

(NASA-CR-165391: LR-29935-Vol-1)

Avail: NTIS

HC A04/MF A01 CSCL 21D

Scale model fuel heating systems for use with aviation hydrocarbon fuel at low temperatures were investigated. The effectiveness of the heating systems in providing flowability and pumpability at extreme low temperature when some freezing of the fuel would otherwise occur is evaluated. The test tank simulated a section of an outer wing tank, and was chilled on the upper and lower surfaces. Turbine engine lubricating oil was heated, and recirculating fuel transferred the heat. Fuels included: a commercial Jet A; an intermediate freeze point distillate; a higher freeze point distillate blended according to Experimental Referee Broadened Specification guidelines; and a higher freeze point paraffinic distillate used in a preceding investigation. Each fuel was chilled to selected temperature to evaluate unpumpable solid formation (holdup). Tests simulating extreme cold weather flight, without heating, provided baseline fuel holdup data. Heating and recirculating fuel increased bulk temperature significantly; it had a relatively small effect on temperature near the bottom of the tank. Methods which increased penetration of heated fuel into the lower boundary layer improved the capability for reducing holdup. S.L.

N82-11228# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio. Fuels and Lubrication Div.

JET FUEL LOCKS TO SHALE OIL: THE 1980 TECHNOLOGY REVIEW

Herbert R. Lander May 1981 156 p refs Proceedings of Conf. held at Cincinnati, 19-20 Nov. 1980

(AF Proj. 2480)

(AD-A104414: AFWAL-TR-81-2063)

Avail: NTIS

HC A08/MF A01 CSCL 11/4

The progress of several Air Force shale oil related programs is reported. Three shale oil processing studies evaluating the yield, cost, and quality of JP-4 and JP-8 turbine fuel produced from whole crude shale oil are discussed. Details of a fourth program that produced 11,300 gallons of specification JP-4 from Geokinetics shale oil are reported. Some of this jet fuel was tested in Air Force Fuel Mainburner/Turbine Effects Programs and was shown to behave very similar to petroleum derived JP-4. An additional study concentrated on developing hydrotreating catalysts that would more efficiently convert shale oil into aviation turbine fuel. Author (GRA)

N82-11230*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Products Div.

AN ASSESSMENT OF THE USE OF ANTIMISTING FUEL IN TURBOFAN ENGINES Final Report, Sep. 1979 - Nov. 1980

A. Fiorentino, R. DeSaro, and T. Franz Jun. 1981 53 p refs (Contract NAS3-22045)

(NASA-CR-165258; AD-A104673; PWA-5697-29;

FAA-CT-81-58) Avail: NTIS HC A04/MF A01 CSCL 21/4

An evaluation was made on the effects of using antimisting kerosene (AMK) on the performance of the components from the fuel system and the combustor of a current in-service JT8D aircraft engine. The objectives were to identify problems associated with using antimisting kerosene and to determine the extent of shearing or degradation required to allow the engine components to achieve satisfactory operation. The program consisted of a literature survey and a test program which evaluated the antimisting kerosene fuel in laboratory and bench component testing, and assessed the performance of the combustor in a high pressure facility and in an altitude relight/cold ignition facility. Performance of the fuel pump and control system was evaluated in an open loop simulation. Thus far, results of the program would not preclude the use of antimisting kerosene in a jet engine application. GRA

N82-11232# Naval Postgraduate School, Monterey, Calif. Dept. of Aeronautics.

AN INVESTIGATION OF THE COMBUSTION PROCESS IN SOLID FUEL RAMJETS M.S. Thesis

William Vernon Goodwin Jun. 1981 58 p refs

(AD-A104603) Avail: NTIS HC A04/MF A01 CSCL 21/4

An experimental investigation was conducted into four areas of the solid fuel ramjet combustion process: (1) the effects of near-wall turbulent mixing and equivalence ratio on combustion efficiency, (2) the effects of bypass air on combustion efficiency, (3) the combustion process in a cylindrically perforated fuel grain with a twin side-dump/dome configuration, and (4) the comparison of experimental radial temperature profiles to computer generated radial profiles. Polymethylmethacrylate fuel grains were burned in a ramjet motor and a thrust stand. Combustion efficiencies were determined and compared for different configurations. It was found to be insensitive to variations in the mixture ratio and to near-wall mixing. Bypass air was found to adversely affect the combustion efficiency both in stable and unstable combustion environments. The twin side-dump/dome configuration was unable to sustain combustion for all conditions investigated. Theoretical radial temperature profiles were found to have larger near wall gradients than were measured experimentally. Author (GRA)

N82-11313# New Mexico Univ., Albuquerque. Engineering Research Inst.

DESIGN OF AIRPORT PAVEMENTS FOR EXPANSIVE SOILS Final Report

R. Gordon McKeen Jan. 1981 198 p refs
(Contract F29601-76-C-0051)
(AD-A104660; NMERI-AP-37; FAA-RD-81-25) Avail: NTIS HC A09/MF A01 CSCL 08/13

Expansive soil subgrades exhibit volume changes with variation in moisture condition. These changes result in differential movement of airport pavements resting on these soils. Special design procedures must be used to account for the expansive soil activity during equilibration. In addition, special precautions are required to protect the subgrade from moisture variation with climate. Measurement of soil suction is a key step in quantifying moisture-induced soil behavior. Procedures are outlined for suction characterization of the soil and for estimating the in situ differential movement likely to occur under the pavement. Once the wavelength and amplitude characteristics of the differential movement are obtained, design calculations to select the thickness and materials for the pavement may proceed. GRA

N82-11339*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

GENERAL AVIATION AIRCRAFT ANTENNAS FOR THE GLOBAL POSITIONING SYSTEM

Melvin C. Gilreath and J. S. Chatterjee Oct. 1981 37 p refs
(NASA-TM-83212) Avail: NTIS HC A03/MF A01 CSCL 17G

Several antenna designs that utilize the NAVSTAR Global Positioning System in a low-cost system for general aviation aircraft were evaluated. Experimental investigations were made of crossed-dipoles, various types of crossed-slots, and microstrip antennas with modifications to improve their coverage. Principal plane radiation patterns for several of these antennas were measured on a one-seventh scale model of a Gates Lear Jet. R.J.F.

N82-11354# Edgerton, Germeshausen and Grier, Inc., Albuquerque, N. Mex.

SYSTEM SAFETY PROGRAM PLAN Final Report, 31 Mar. - 8 Aug. 1980

A. J. Bonham 8 Aug. 1980 79 p refs
(Contract DNA001-80-C-0177)
(AD-A104557; AG-1446; DNA-5467F) Avail: NTIS HC A05/MF A01 CSCL 12/12

This document, System Safety Program Plan, is the implementing document covering the safety aspects of performing an EMP Test on the A7E aircraft in the HPD (Horizontally Polarized Dipole), VPD (Vertically Polarized Dipole), and NWEF hangar facilities at Kirtland AFB, New Mexico. GRA

N82-11391*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AMPLIFIED CROSSFLOW DISTURBANCES IN THE LAMINAR BOUNDARY LAYER ON SWEEP WINGS WITH SUCTION

J. Ray Dagenhart Nov. 1981 90 p refs
(NASA-TP-1902; L-14423) Avail: NTIS HC A05/MF A01 CSCL 20D

Solution charts of the Orr-Sommerfeld equation for stationary

crossflow disturbances are presented for 10 typical velocity profiles on a swept laminar flow control wing. The critical crossflow Reynolds number is shown to be a function of a boundary layer shape factor. Amplification rates for crossflow disturbances are shown to be proportional to the maximum crossflow velocity. A computer stability program called MARIA, employing the amplification rate data for the 10 crossflow velocity profiles, is constructed. This code is shown to adequately approximate more involved computer stability codes using less than two percent as much computer time while retaining the essential physical disturbance growth model. Author

N82-11491*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

INTEGRATED ANALYSIS OF ENGINE

Christos C. Chamis 1981 24 p refs Presented at the Ann. Meeting of the ASME, Washington, D.C., 16-21 Nov. 1981
(NASA-TM-82713; E-995) Avail: NTIS HC A02/MF A01 CSCL 20K

The need for light, durable, fuel efficient, cost effective aircraft requires the development of engine structures which are flexible, made from advanced materials (including composites), resist higher temperatures, maintain tighter clearances and have lower maintenance costs. The formal quantification of any or several of these requires integrated computer programs (multi-level and/or interdisciplinary analysis programs interconnected) for engine structural analysis/design. Several integrated analysis computer programs are under development at Lewis Research Center. These programs include: (1) COBSTRAN-Composite Blade Structural Analysis, (2) CODSTRAN-Composite Durability Structural Analysis, (3) CISTRAN-Composite Impact Structural Analysis, (4) STAEBL-StruTailoring of Engine Blades, and (5) ESMOSS-Engine Structures Modeling Software System. Three other related programs, developed under Lewis sponsorship, are described. Author

N82-11498# Army Engineer Waterways Experiment Station, Vicksburg, Miss. Geotechnical Lab.

STRUCTURAL ANALYSIS COMPUTER PROGRAMS FOR RIGID MULTICOMPONENT PAVEMENT STRUCTURES WITH DISCONTINUITIES, WESLIQID AND WESLAYER. REPORT 1: PROGRAM DEVELOPMENT AND NUMERICAL PRESENTATIONS Technical Report, 1 Oct. 1978 - 30 Sep. 1979

Yu T. Chou May 1981 150 p refs
(DA Proj. 4A7-62719-AT-40)
(AD-A104545; WES/TR/GL-81-6-1) Avail: NTIS HC A07/MF A01 CSCL 13/13

This study was conducted to develop finite element computer programs to calculate stresses and deflections in rigid pavements with cracks and joints subjected to loads and temperature warping, as well as in the supporting subgrade soil. The joints are connected by dowel bars or other load transfer devices. The slabs can have full or partial loss of subgrade support over designed regions of the slabs. Multiple-wheel loads can be handled and the number of wheels is not limited. Two programs were developed, one called WESLIQID and the other WESLAYER. The former is for pavements on liquid foundations and the latter is for linear layered elastic solids. Variable slab thicknesses and moduli of subgrade reaction are incorporated in the WESLIQID program, and any number of slabs arrayed in an arbitrary pattern can be handled. Because of larger computer storage requirement and computational complexity, the WESLAYER program is limited to two slabs. GRA

N82-11514*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

RADAR MAPPING, ARCHAEOLOGY, AND ANCIENT LAND USE IN THE MAYA LOWLANDS

R. E. W. Adams (Cambridge Univ.), W. E. Brown, Jr., and T. Patrick Culbert (Arizona Univ.) 31 Mar. 1981 27 p refs
(Contract NAS7-100)
(NASA-CR-164931) Avail: NTIS HC A03/MF A01 CSCL 08B

Data from the use of synthetic aperture radar in aerial survey of the southern Maya lowlands suggest the presence of very large areas drained by ancient canals for the purpose of intensive cultivation. Preliminary ground checks in several very limited areas confirm the existence of canals and raised fields. Excavations and ground surveys by several scholars provide valuable comparative information. Taken together, the new data suggest

N82-11636

that Late Classic period Maya civilization was firmly grounded in large-scale and intensive cultivation of swampy zones. A.R.H.

N82-11636*# National Aeronautics and Space Administration, Washington, D. C.

EFFECTS OF AIRCRAFT NOISE ON THE EQUILIBRIUM OF AIRPORT RESIDENTS: TESTING AND UTILIZATION OF A NEW METHODOLOGY

Jacques Francois Sep. 1981 34 p Transl. into ENGLISH of "RepercuSSION du Bruit des Avions sur l'Equilibre des Riverains des Aeroports: Test et Mise au Point d'une Methodologie Nouvelle" Paris, Aug. 1977 p 1-134 Transl. was announced as N81-27692 Transl. Scientific Translation Service, Santa Barbara, Calif. Original doc. prep. by IFOP/ETMAR (Contract NASw-3542)

(NASA-TM-76628) Avail: NTIS HC A03/MF A01 CSCL 13B

The focus of the investigation is centered around two main themes: an analysis of the effects of aircraft noise on the psychological and physiological equilibrium of airport residents; and an analysis of the sources of variability of sensitivity to noise. The methodology used is presented. Nine statistical tables are included, along with a set of conclusions. T.M.

N82-11859*# United Technologies Research Center, East Hartford, Conn.

HELICOPTER ROTOR TRAILING EDGE NOISE Final Report

Robert H. Schlinker and Roy K. Amier Washington NASA Nov. 1981 150 p refs

(Contract NAS1-15730)

(NASA-CR-3470) Avail: NTIS HC A07/MF A01 CSCL 20A

A two dimensional section of a helicopter main rotor blade was tested in an acoustic wind tunnel at close to full-scale Reynolds numbers to obtain boundary layer data and acoustic data for use in developing an acoustic scaling law and testing a first principles trailing edge noise theory. Results were extended to the rotating frame coordinate system to develop a helicopter rotor trailing edge noise prediction. Comparisons of the calculated noise levels with helicopter flyover spectra demonstrate that trailing edge noise contributes significantly to the total helicopter noise spectrum at high frequencies. This noise mechanism is expected to control the minimum rotor noise. In the case of noise radiation from a local blade segment, the acoustic directivity pattern is predicted by the first principles trailing edge noise theory. Acoustic spectra are predicted by a scaling law which includes Mach number, boundary layer thickness and observer position. Spectrum shape and sound pressure level are also predicted by the first principles theory but the analysis does not predict the Strouhal value identifying the spectrum peak. A.R.H.

N82-11860*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

SEL AND EPNL NOISE DURATION COEFFICIENTS FOR THE 747 AND T-38 AIRCRAFT

William L. Willshire, Jr. Sep. 1981 12 p refs

(NASA-TM-83214) Avail: NTIS HC A02/MF A01 CSCL 20A

Duration coefficient were calculated for Boeing 747 and T-38 airplanes for sound exposure level (SEL) and effective perceived noise level (EPNL) scales. The measured SEL duration coefficients were 8.4 for the Boeing 747 and 5.5 for the T-38 result was in good agreement with a previous result for a similar F-5 airplane. In EPNL, the duration coefficients were 7.2 for the Boeing 747 and 5.7 for the T-38. The difference in the results between the two airplanes is believed to be due to their different engine noise source spectra. The difference in the Boeing 747 results in the two different metric was due to the different frequency weighting of A-weighted sound pressure level, used in SEL, and tone-corrected perceived noise level, used in EPNL, when applied to the 747 spectra. B.W.

N82-12023# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE KERNEL FUNCTION COLLOCATION METHOD IN STEADY SUBSONIC FLOW FOR WING WITH CONTROL SURFACES

Chen Jing Song *In its Acta Mech. Sinica* (Selected Articles) (FTD-ID(RS)T-0705-81) 15 Sep. 1981 p 35-50 refs Transl. into ENGLISH from Acta Mech. Sinica (China), no. 2, 1979

Avail: NTIS HC A05/MF A01 CSCL 20/4

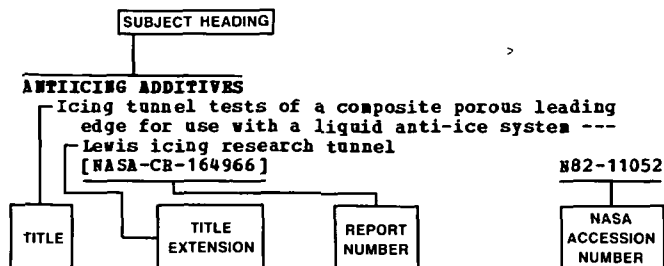
The forms of the lift distribution function for wings with control surfaces in steady subsonic flow are analyzed. Methods for treating kernel singularities of linear integral equations and singularities of the lift distribution function are discussed and the numerical solution to the integral equation is given. These methods may be used to calculate the lift distribution of the wing by itself or of the wing with partial or full control surfaces on both the leading and trailing edges. The numerical values agree well with experimental data and have the same accuracy as those given by other theories. As compared with the vortex lattice method, the computational storage requirement for this method is smaller and the computational time is less. The numerical computation may be carried out on smaller computers.

SUBJECT INDEX

AERONAUTICAL ENGINEERING/A Continuing Bibliography (Suppl. 145)

FEBRUARY 1982

Typical Subject Index Listing



The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of the document content, a title extension is added, separated from the title by hyphens. The NASA or AIAA accession number is included in each entry to assist the user in locating the abstract in the abstract section of this supplement. If applicable, a report number is also included as an aid in identifying the document.

A

A-7 AIRCRAFT

- A comparison of theoretical and experimental pressure distributions for two advanced fighter wings
[NASA-TM-81331] N82-11054
- System safety tests program plan --- electromagnetic pulse testing of the A-7E aircraft
[AD-A104557] N82-11354

A-300 AIRCRAFT

- Active control elements on the transonic wing of the Airbus A-300 (ACTTA A). Airbus A-300 with reduced longitudinal stability (ACTTA-C) --- advanced control transonic transport aircraft (ACCTA); design considerations N82-10044

ABSORBERS (MATERIALS)

- Evaluation of the acoustic measurement capability of the NASA Langley V/STOL wind tunnel open test section with acoustically absorbent ceiling and floor treatments
[NASA-CR-165796] N82-10059

AC GENERATORS

- 60 KVA ADP permanent magnet VSCF starter generator system - Generator system performance characteristics A82-11721

ACCIDENT PREVENTION

- A proposed flight safety program for the Korean Air Force
[AD-A102373] N82-10023
- Lightning effects on aircraft and composites. Literature study on lightning strikes and protection --- advanced composite materials
[FOA-C-20388-P9] N82-10024

ACCUMULATORS

- Low maintenance hydraulic accumulator
[AD-A103947] N82-10034

ACOUSTIC EMISSION

- Acoustic emission - An emerging technology for assessing fatigue damage in aircraft structure A82-11149

ACOUSTIC FATIGUE

- Response of nonlinear aircraft structural panels to high intensity noise A82-12041

ACOUSTIC MEASUREMENTS

- Effects of vane/blade ratio and spacing on fan noise
[AIAA PAPER 81-2033] A82-10457

ACOUSTIC PROPAGATION

- SEL and EPNL noise duration coefficients for the 747 and T-38 aircraft
[NASA-TM-83214] N82-11860

ACOUSTIC PROPERTIES

- Evaluation of the acoustic measurement capability of the NASA Langley V/STOL wind tunnel open test section with acoustically absorbent ceiling and floor treatments
[NASA-CR-165796] N82-10059

ACTIVE CONTROL

- Active control elements on the transonic wing of the Airbus A-300 (ACTTA A). Airbus A-300 with reduced longitudinal stability (ACTTA-C) --- advanced control transonic transport aircraft (ACCTA); design considerations N82-10044
- A method for determination of the aeroelastic behavior of aircraft with active control systems
[DFVLR-FB-81-05] N82-10047

ACTUATORS

- Control of electromechanical actuator elements for flight vehicles --- Russian book A82-12170
- Aircraft digital input controlled hydraulic actuation and control system
[AD-A104263] N82-11072

ADAPTIVE CONTROL

- Control laws for adaptive wind tunnels A82-10985
- Practical design and realization of a digital adaptive flight control system N82-11079

ADDITIVES

- Rheological behavior of progressively shear-thickening solutions --- aircraft fuel polymer additives for fire protection in survivable crashes A82-11177
- A protective additive for jet fuels A82-12022

AERIAL PHOTOGRAPHY

- Three navigation systems and their costs of acquiring remote sensing data A82-10049

AEROACOUSTICS

- Helicopter rotor trailing edge noise
[AIAA PAPER 81-2001] A82-10455
- Design predictions for noise control in the cryogenic National Transonic Facility A82-12025
- Aeroacoustic theory for noncompact wing-gust interaction
[PDR-81-7] N82-11071

AERODYNAMIC BALANCE

- Development of new lifting parachute designs with increased trim angle
[AIAA PAPER 81-1921] A82-10407

AERODYNAMIC BRAKES

- Aeroballistic characteristics of sonobuoy parachute decelerators limited to a length of three feet
[AIAA PAPER 81-1950] A82-10425

AERODYNAMIC CHARACTERISTICS

- Experimental study of subsonic and transonic flows past a wing A82-10363
- Aerodynamics and performance of cruciform parachute canopies
[AIAA PAPER 81-1919] A82-10405
- Development of new lifting parachute designs with increased trim angle
[AIAA PAPER 81-1921] A82-10407

- Propfan installation aerodynamics of a supercritical swept wing transport configuration [AIAA PAPER 81-1563] A82-10466
- Calculation of aerodynamic characteristics of jet flapped airplane A82-11459
- Comparative study of flare control laws [NASA-CR-164903] N82-10032
- Effects of vortex flaps on the low-speed aerodynamic characteristics of an arrow wing [NASA-TP-1914] N82-11013
- A numerical three-dimensional turbulent simulation of a subsonic VSTOL jet in a cross-flow using a finite element algorithm [AD-A104514] N82-11055
- AERODYNAMIC COEFFICIENTS**
- The effects of flexibility on the steady-state performance of small ribbon parachute models [AIAA PAPER 81-1923] A82-10408
- Determination of airplane model structure from flight data by using modified stepwise regression [NASA-TP-1916] N82-10041
- Wind-tunnel results for a modified 17-percent-thick low-speed airfoil section [NASA-TP-1919] N82-11033
- AERODYNAMIC CONFIGURATIONS**
- The principles and methods for shaping the wing root regions of a wing-body combination at transonic and lower supersonic speeds N82-11016
- Aeroacoustic theory for noncompact wing-gust interaction [FDRL-81-7] N82-11071
- AERODYNAMIC DRAG**
- Reductions in parachute drag due to forebody wake effects [AIAA PAPER 81-1939] A82-10417
- Aircraft excrescence drag [AGARD-AG-264] N82-10020
- AERODYNAMIC FORCES**
- Increasing the lift:drag ratio of a flat delta wing A82-11899
- An influence coefficient method for the application of the modal technique to wing flutter suppression of the DAST ARW-1 wing [NASA-CR-165772] N82-11070
- AERODYNAMIC HEATING**
- In-situ calibration of flight heat transfer instrumentation [ASME PAPER 81-ENAS-13] A82-10901
- AERODYNAMIC INTERFERENCE**
- Effects of vane/blade ratio and spacing on fan noise [AIAA PAPER 81-2033] A82-10457
- AERODYNAMIC LOADS**
- Nonlinear prediction of subsonic aerodynamic loads on wings and bodies at high angles of attack A82-11359
- AERODYNAMIC NOISE**
- Helicopter rotor trailing edge noise [AIAA PAPER 81-2001] A82-10455
- Aircraft wing trailing-edge noise [NASA-CR-164952] N82-11039
- AERODYNAMIC STABILITY**
- Experimental determination of parachute apparent mass and its significance in predicting dynamic stability [AIAA PAPER 81-1920] A82-10406
- Numerical treatment of helicopter rotor stability problems A82-12045
- An investigation of a stoppable helicopter rotor with circulation control --- ames 40 by 80 foot wind tunnel [NASA-TN-81218] N82-10030
- AERODYNAMIC STALLING**
- A microprocessor-based data acquisition system for stall/spin research [AIAA 81-2177] A82-10126
- Spin recovery training --- licensing requirement [GPO-66-020] N82-10022
- An experimental investigation of the rotating stall, surge and wake behind the rotor for a single stage axial compressor N82-11008
- AERODYNAMICS**
- Control laws for adaptive wind tunnels A82-10985
- The CIVIC - A concept in vortex induced combustion. II [ASME PAPER 81-GT-12] A82-11997
- Aerodynamic calculations and design of subcritical aerofoils N82-10983
- AEROELASTICITY**
- A method for determination of the aeroelastic behavior of aircraft with active control systems [DFVLR-PB-81-05] N82-10047
- AERONAUTICAL ENGINEERING**
- NASA Authorization, 1982: Index [GPO-84-713] N82-10959
- The automatic matrix force method and techniques for handling more complex computations with given computer capacity N82-10994
- AEROSOLS**
- Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity A82-12149
- AEROSPACE ENGINEERING**
- Emerging technologies in aerospace structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980 A82-12026
- Powder metallurgy superalloys - Aerospace materials for the 1980's; Proceedings of the Conference, Zurich, Switzerland, November 18-20, 1980. Volume 1 A82-12495
- NASA Authorization, 1982: Index [GPO-84-713] N82-10959
- Theory and applications of optimal control in aerospace systems [AGARD-AG-251] N82-11073
- An overview of optimal control in aerospace systems N82-11074
- AEROSPACE INDUSTRY**
- Kevlar composites; Proceedings of the Symposium, El Segundo, CA, December 2, 1980 A82-12646
- AEROSPACE MEDICINE**
- Airport and Airway Improvement Act of 1981, part 1 [GPO-76-241-PT-1] N82-10062
- AEROSPACE SYSTEMS**
- Theory and applications of optimal control in aerospace systems [AGARD-AG-251] N82-11073
- An overview of optimal control in aerospace systems N82-11074
- AEROSPACE TECHNOLOGY TRANSFER**
- Considerations and applications for the use of fluidics in aerospace controls A82-12087
- AEROTHERMODYNAMICS**
- Design analysis of high temperature transparent windshields for high performance aircraft [ASME PAPER 81-ENAS-5] A82-10893
- Quantification of the thermal environment for externally carried aircraft stores and ordnance A82-12100
- AIR BAG RESTRAINT DEVICES**
- Air bag impact attenuation system for the AQM-34V remote piloted vehicle [AIAA PAPER 81-1917] A82-10403
- AIR BREATHING ENGINES**
- Air-breathing engine test facilities register [AGARD-AG-269] N82-10063
- AIR CONDITIONING EQUIPMENT**
- Towards minimum power for environmental control in transport aircraft [ASME PAPER 81-ENAS-4] A82-10892
- AIR COOLING**
- Air-film cooling returns to ramjets [ASME PAPER 81-ENAS-8] A82-10896
- Thermal and flow analysis of a convection, air-cooled ceramic coated porous metal concept for turbine vanes [ASME PAPER 81-HT-48] A82-10952
- Application of numerical modeling to gas turbine combustor development problems A82-12118

- AIR FLOW**
Application of numerical modeling to gas turbine combustor development problems A82-12118
- AIR INTAKES**
Low speed testing of the inlets designed for a tandem-fan V/STOL nacelle --- conducted in the Lewis 10 by 10 foot wind tunnel [NASA-TM-82728] N82-11042
- AIR NAVIGATION**
Three navigation systems and their costs of acquiring remote sensing data A82-10049
Navigation task partitioning in distributed-processing avionics systems A82-10646
Discrete address beacon, navigation and landing system A82-10650
Fast and accurate gyrocompass using strapdown tuned rotor gyros as a solution to combat helicopters navigation problems A82-11927
National Aerospace Meeting, Trevoise, PA, April 8-10, 1981, Proceedings A82-12626
Satellite geometry considerations for low cost GPS user equipment A82-12630
A solution to the static geometry problem for JTIDS relative navigation A82-12634
Memory requirements for future navigation systems A82-12637
A navigation systems planning model A82-12640
The integrated inertial sensor assembly /IISA/ - A redundant strapdown system for advanced aircraft navigation and flight control functions A82-12642
Integrated satellite navigation and strapdown attitude and heading reference systems for civil air carriers A82-12643
Ring Laser Gyro Navigator /RLGN/ flight test results A82-12644
- AIR TRAFFIC CONTROL**
Performance analysis of enroute air traffic control computers in the National Airspace System [AIAA 81-2203] A82-10140
FAA developing new collision avoidance, data acquisition and transmission systems A82-10396
Discrete address beacon, navigation and landing system A82-10650
Airport and Airway Improvement Act of 1981, part 1 [GPO-76-241-PT-1] N82-10062
FAA misses opportunities to discontinue or reduce operating hours of some airport traffic control towers [PB81-224214] N82-11049
- AIR TRANSPORTATION**
Cost reduction in air transportation --- energy conservation [SNIAS-811-150-101] N82-10025
- AIRBORNE EQUIPMENT**
Instrumented aircraft verification of clear-air radar detection of low-level wind shear A82-10221
A mathematical model of an over-sea airborne UHF radio link A82-11406
High voltage surge and partial discharge test to evaluate aerospace equipment parts A82-11740
- AIRBORNE SURVEILLANCE RADAR**
Airborne weather radar and severe weather penetration A82-10219
- AIRBORNE/SPACEBORNE COMPUTERS**
KC-135 Avionics Modernization Hot Bench [AIAA 81-2105] A82-10081
HiMAT onboard flight computer system architecture and qualification [AIAA 81-2107] A82-10082
Synchronous fault-tolerant flight control systems [AIAA 81-2109] A82-10083
- The Space Shuttle vehicle checkout involving flight avionics software [AIAA 81-2141] A82-10100
Bridging the gap from aircraft to space computers [AIAA 81-2142] A82-10101
Airborne associative processor /ASPRO/ --- for early warning radar surveillance, command, and control applications [AIAA 81-2145] A82-10104
Controlling the software/hardware interface for the validation of avionics systems --- in flight control systems [AIAA 81-2159] A82-10116
A microprocessor-based data acquisition system for stall/spin research [AIAA 81-2177] A82-10126
Performance analysis of enroute air traffic control computers in the National Airspace System [AIAA 81-2203] A82-10140
Interoperability testing of decentralized command, control, communications and intelligence /C3I/ systems [AIAA 81-2205] A82-10143
Navigation task partitioning in distributed-processing avionics systems A82-10646
Memory requirements for future navigation systems A82-12637
Ring Laser Gyro Navigator /RLGN/ flight test results A82-12644
- AIRCRAFT ACCIDENT INVESTIGATION**
Downbursts and microbursts - An aviation hazard --- downdrafts beneath thunderstorms A82-10214
Airborne weather radar and severe weather penetration A82-10219
A note on fatal aircraft accidents involving metal fatigue A82-11400
- AIRCRAFT ACCIDENTS**
Relationships between naval aviation safety and pilot flight experience A82-11031
SARSAT applications A82-12698
- AIRCRAFT ANTENNAS**
General aviation aircraft antennas for the global positioning system [NASA-TM-83212] N82-11339
- AIRCRAFT COMMUNICATION**
A mathematical model of an over-sea airborne UHF radio link A82-11406
- AIRCRAFT COMPARTMENTS**
Experimental modal analysis of the fuselage panels of an Aero Commander aircraft [NASA-CR-165750] N82-10028
- AIRCRAFT CONFIGURATIONS**
Analysis of augmented aircraft flying qualities through application of the Neal-Smith criterion [AIAA PAPER 81-1776] A82-10462
V/STOL aircraft and fluid dynamics [NASA-TM-81328] N82-10029
- AIRCRAFT CONSTRUCTION MATERIALS**
The application of improved aluminium alloys and steels in aircraft structures A82-10305
Sophisticated aircraft structure developments - Combat aeroplanes A82-10309
On the use of carbon composites in slat and stabilizer construction A82-11468
Powder metallurgy superalloys - Aerospace materials for the 1980's; Proceedings of the Conference, Zurich, Switzerland, November 18-20, 1980. Volume 1 A82-12495
Kevlar composites; Proceedings of the Symposium, El Segundo, CA, December 2, 1980 A82-12646
Seven years experience with Kevlar-49 in the Lockheed L-1011 Tristar A82-12647

AIRCRAFT CONTROL

Controlling the software/hardware interface for the validation of avionics systems --- in flight control systems
 [AIAA 81-2159] A82-10116
 Use of Space Shuttle technology in conventional aircraft
 [AIAA 81-2176] A82-10125
 Analysis of augmented aircraft flying qualities through application of the Neal-Smith criterion
 [AIAA PAPER 81-1776] A82-10462
 Improving the MLS through enhanced cockpit displays
 A82-10649
 Procedures and analysis techniques for determining static air minimum control speeds
 A82-12564
 Simulation study of a hybrid strapdown attitude and heading reference system
 A82-12641
 Theoretical investigation of the influence of spoiler dynamics on the handling qualities of an aircraft with direct lift control
 [ESA-TT-681] N82-10036
 Estimation of airplane stability and control derivatives from large amplitude longitudinal maneuvers
 [NASA-TM-83185] N82-10042
 Control law design for transport aircraft flight tasks
 N82-11080

AIRCRAFT DESIGN

Integration of computer graphics design with analytical models --- for aircraft design
 [AIAA 81-2134] A82-10096
 Use of Space Shuttle technology in conventional aircraft
 [AIAA 81-2176] A82-10125
 Design aspects of non rigid airship envelopes
 A82-10306
 Some possibilities for composite light aircraft construction
 A82-10307
 Light aircraft structural design in non-metallics - Use of composite honeycomb for light aircraft
 A82-10308
 Analytical determination of undercarriage retraction kinematics
 A82-10364
 The balloon and the airship technological heritage
 [AIAA PAPER 81-1912] A82-10401
 Air bag impact attenuation system for the AQM-34V remote piloted vehicle
 [AIAA PAPER 81-1917] A82-10403
 Analysis of augmented aircraft flying qualities through application of the Neal-Smith criterion
 [AIAA PAPER 81-1776] A82-10462
 How large should a commuter transport be
 [AIAA PAPER 81-1732] A82-10463
 Optimization of the principal design parameters of a passenger aircraft
 A82-10816
 Towards minimum power for environmental control in transport aircraft
 [ASME PAPER 81-ENAS-4] A82-10892
 Design analysis of high temperature transparent windshields for high performance aircraft
 [ASME PAPER 81-ENAS-5] A82-10893
 Calculation of aerodynamic characteristics of jet flapped airplane
 A82-11459
 Design and development of a low cost servoed rate gyro for unmanned aircraft
 A82-11932
 Response of nonlinear aircraft structural panels to high intensity noise
 A82-12041
 Crack growth evaluation of a method to convert real-time loads history to a simplified engineering spectra --- for aircraft structural analysis
 A82-12043
 ACMA - Fact or fantasy --- Advanced Civilian/Military Aircraft
 A82-12048
 P-5G Tigershark
 A82-12775
 The case for a defensive air-to-air fighter
 A82-12801

Solution to the hidden-line problem
 A82-12803
 V/STOL aircraft and fluid dynamics
 [NASA-TM-81328] N82-10029
 Quiet short-haul research aircraft familiarization document, revision 1
 [NASA-TM-81298] N82-10031
 Active control elements on the transonic wing of the Airbus A-300 (ACTTA A). Airbus A-300 with reduced longitudinal stability (ACTTA-C) --- advanced control transonic transport aircraft (ACTTA); design considerations
 N82-10044
 Acta mechanica sinica
 [AD-A105184] N82-11014
 The principles and methods for shaping the wing root regions of a wing-body combination at transonic and lower supersonic speeds
 N82-11016
 New estimation method for flutter or divergence boundary from random responses at subcritical speeds
 [NAL-TR-667T] N82-11034
 Design techniques for multivariable flight control systems
 N82-11078

AIRCRAFT ENGINES

Design considerations for duty cycle, life and reliability of small limited life engines
 [AIAA PAPER 81-1402] A82-10465
 Air-film cooling returns to ramjets
 [ASME PAPER 81-ENAS-8] A82-10896
 One reason for the onset of high-frequency self-excited oscillations --- in combustion chambers of aircraft engines
 A82-11448
 Basic problem of aircraft gasturbine engine analytic design. II
 A82-11463
 Coupled fluid/structure response predictions for soft body impact of airfoil configurations --- ice and bird impact on aircraft engines
 A82-12039
 History of flight testing the L-1011 TriStar jet transport. II - Testing highlights since initial certification of the L-1011-1
 A82-12049
 Considerations and applications for the use of fluidics in aerospace controls
 A82-12087
 The enhancement of heat exchange in channels /2nd revised and enlarged edition/ --- Russian book
 A82-12222
 Validation studies of turbulence and combustion models for aircraft gas turbine combustors
 A82-12267
 Commercial EMS considerations for small gas turbine engines --- automated engine monitoring systems
 A82-12449
 Further application and development of an engine usage/life monitoring system for military services
 A82-12450
 Superclean superalloy powders by the rotating electrode process
 A82-12496
 Superalloy turbine components - Which is the superior manufacturing process, as-HIP, HIP plus Isoforge, or 'gatorizing' of extrusion consolidated billet
 A82-12497
 Lineup of the IM-series aircraft-derivative gas turbines
 A82-12560
 Propulsion study for Small Transport Aircraft Technology (STAT), Appendix B
 [NASA-CR-165499-APP-B] N82-10038
 A new method of cooling turbine vanes
 N82-11027
 Lightweight diesel engine designs for commuter type aircraft
 [NASA-CR-165470] N82-11068
 Development of multivariable controllers for aircraft turbine engines
 N82-11087
 Integrated analysis of engine
 [NASA-TM-82713] N82-11491

AIRCRAFT EQUIPMENT

A new APU for medium place aircraft environmental control systems
[ASME PAPER 81-ENAS-1] A82-10889

Air-freon integrated environmental conditioning system for trainer subsonic aircraft
[ASME PAPER 81-ENAS-33] A82-10920

New separators for battery systems A82-11715

Sealed lead-acid batteries for aircraft applications A82-11716

A hidden advantage of permanent magnet electrical generating systems A82-11720

60 KVA ADP permanent magnet VSCF starter generator system - Generator system performance characteristics A82-11721

Design and development of a low cost servoed rate gyro for unmanned aircraft A82-11932

Digital avionics - Promise and practice; Proceedings of the Joint Symposium, London, England, March 20, 1980 A82-11934

The all digital military aircraft A82-11937

The digital civil aircraft A82-11938

Low maintenance hydraulic accumulator [AD-A103947] N82-10034

Advanced aircraft electrical system control technology demonstrator. Phase 1: Requirements analysis and conceptual design [AD-A103922] N82-10326

Threat Alert and Collision Avoidance System (TCAS) Symposium [AD-A104563] N82-11047

Polyurethane foams for aircraft shock mounts. 3: Vibration damping by polyether foams [AD-A104496] N82-11212

AIRCRAFT FUEL SYSTEMS

Application of numerical methods to the calculation of electrostatic fields in aircraft fuel tanks [AD-A103270] N82-10033

Advanced fuel flowmeter for future naval aircraft [AD-A104364] N82-11063

Experimental study of fuel heating at low temperatures in a wing tank model, volume 1 [NASA-CR-165391] N82-11224

AIRCRAFT FUELS

Fuel for future transport aircraft [ASME PAPER 81-HT-80] A82-10965

Rheological behavior of progressively shear-thickening solutions --- aircraft fuel polymer additives for fire protection in survivable crashes A82-11177

Fuel conservation - DC-9 series 20/30/40 A82-12563

Experimental study of fuel heating at low temperatures in a wing tank model, volume 1 [NASA-CR-165391] N82-11224

AIRCRAFT HAZARDS

Detection and display of wind shear and turbulence A82-10222

Selected bibliography of NACA-NASA aircraft icing publications [NASA-TN-81651] N82-11053

System safety program plan --- electromagnetic pulse testing of the A-7E aircraft [AD-A104557] N82-11354

AIRCRAFT HYDRAULIC SYSTEMS

Fluid power technology for the '80s --- Book A82-10851

High-efficiency hydraulic power transfer units for multisystem aircraft A82-10853

'Quiet please' --- aircraft hydraulic systems noise reduction A82-10854

AIRCRAFT INSTRUMENTS

The evolution of airborne weather avoidance radar toward a calibrated remote rain gauge using REACT --- Bain Echo Attenuation Compensation Hardware A82-10225

Problems relating to the classical rate-gyro A82-10497

Optical sensors for displacement measurement A82-11407

Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity A82-12149

Commercial EHS considerations for small gas turbine engines --- automated engine monitoring systems A82-12449

Further application and development of an engine usage/life monitoring system for military services A82-12450

Hard limited approaches to correlation velocity sensing A82-12636

AIRCRAFT MAINTENANCE

Digital avionics: Promise and practice - An airlines experience in the field A82-11942

Mathematical model for the maintenance program of modern jet aircraft --- crack detection; inspection intervals [DFVLR-FB-81-14] N82-10002

AIRCRAFT MANEUVERS

Real-time, on-line digital simulation of optimum maneuvers of supersonic aircraft [AIAA 81-2178] A82-10127

Estimation of airplane stability and control derivatives from large amplitude longitudinal maneuvers [NASA-TN-83185] N82-10042

AIRCRAFT MODELS

Determination of airplane model structure from flight data by using modified stepwise regression [NASA-TP-1916] N82-10041

AIRCRAFT NOISE

'Quiet please' --- aircraft hydraulic systems noise reduction A82-10854

Model helicopter rotor impulsive noise A82-11300

Experimental modal analysis of the fuselage panels of an Aero Commander aircraft [NASA-CR-165750] N82-10028

Aeroacoustic theory for noncompact wing-gust interaction [FDRL-81-7] N82-11071

Effects of aircraft noise on the equilibrium of airport residents: Testing and utilization of a new methodology [NASA-TN-76628] N82-11636

Helicopter rotor trailing edge noise --- noise prediction [NASA-CR-3470] N82-11859

AIRCRAFT PARTS

Implementation of AVRADCOM MM&T --- for military aircraft parts production engineering A82-10545

Fatigue life of lugs under service loading - Test results and predictions A82-11685

AIRCRAFT PERFORMANCE

An airport wind shear detection and warning system using Doppler radar A82-10220

Design challenges of high performance aircraft POD EOCM cooling systems --- Electro-Optical/Countermeasure [ASME PAPER 81-ENAS-6] A82-10894

Ideal and simulated performance of an aircraft in the terrain following mission A82-11302

On the question of trailing airplane motion A82-11470

Fuel conservation - DC-9 series 20/30/40 A82-12563

Quiet short-haul research aircraft familiarization document, revision 1 [NASA-TN-81298] N82-10031

AIRCRAFT PILOTS

Relationships between naval aviation safety and pilot flight experience A82-11031

AIRCRAFT PRODUCTION

Automated Paint and Process Line /APPL/ --- for aircraft production [AIAA 81-2166] A82-10120

- Development of aircraft production engineering discipline at IIT, Bombay
A82-11317
- AIRCRAFT RELIABILITY**
The certification of digital systems
A82-11940
- AIRCRAFT SAFETY**
FAA developing new collision avoidance, data acquisition and transmission systems
A82-10396
- Test Pilots' Aviation Safety Workshop, U.S. Naval Postgraduate School, Monterey, CA, February 25-28, 1981, Proceedings
A82-10500
- Electrical ground testing of aircraft antistatic protection
A82-10822
- AIRCRAFT SPIN**
Spin recovery training --- licensing requirement [GPO-66-020]
N82-10022
- AIRCRAFT STABILITY**
On computing Floquet transition matrices of rotorcraft
A82-11225
- A note on fatal aircraft accidents involving metal fatigue
A82-11400
- Numerical treatment of helicopter rotor stability problems
A82-12045
- Estimation of airplane stability and control derivatives from large amplitude longitudinal maneuvers [NASA-TM-83185]
N82-10042
- AIRCRAFT STRUCTURES**
The application of improved aluminium alloys and steels in aircraft structures
A82-10305
- Some possibilities for composite light aircraft construction
A82-10307
- Sophisticated aircraft structure developments - Combat aeroplanes
A82-10309
- Analytical determination of undercarriage retraction kinematics
A82-10364
- The balloon and the airship technological heritage [AIAA PAPER 81-1912]
A82-10401
- Design analysis of high temperature transparent windshields for high performance aircraft [ASME PAPER 81-ENAS-5]
A82-10893
- Acoustic emission - An emerging technology for assessing fatigue damage in aircraft structure
A82-11149
- Fatigue substantiation of non-linear structures
A82-11224
- Dynamic response of aircraft structure to gun shock loads
A82-11314
- Emerging technologies in aerospace structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980
A82-12026
- Impact-initiated damage thresholds in composites
A82-12028
- Response of nonlinear aircraft structural panels to high intensity noise
A82-12041
- Quantification of the thermal environment for externally carried aircraft stores and ordnance
A82-12100
- Fractographic determination of fatigue crack growth rates in aircraft components
A82-12697
- Aircraft excrescence drag [AGARD-AG-264]
N82-10020
- A method for determination of the aeroelastic behavior of aircraft with active control systems [DFVLR-FB-81-05]
N82-10047
- Finite difference computation of the steady transonic potential flow around airplanes
N82-10981
- AIRCRAFT SURVIVABILITY**
Lightning effects on aircraft and composites. Literature study on lightning strikes and protection --- advanced composite materials [FOA-C-20388-P9]
N82-10024
- AIRCRAFT WAKES**
Strong matching method for computing transonic viscous flows including wakes and separations - Lifting airfoils
A82-10821
- AIRFOIL PROFILES**
The use of the Weber method for minicomputer-assisted numerical analysis of airfoils
A82-10362
- Strong matching method for computing transonic viscous flows including wakes and separations - Lifting airfoils
A82-10821
- Wind tunnel tests on airfoils in tandem cascade
A82-10987
- Coupled fluid/structure response predictions for soft body impact of airfoil configurations --- ice and bird impact on aircraft engines
A82-12039
- Wind-tunnel results for a modified 17-percent-thick low-speed airfoil section [NASA-TP-1919]
N82-11033
- Aeroacoustic theory for noncompact wing-gust interaction [FDRL-81-7]
N82-11071
- AIRFOILS**
Icing tunnel test of a glycol-exuding porous leading edge ice protection system on a general aviation airfoil --- conducted in the Lewis Research Center icing research tunnel [NASA-CR-165444]
N82-10021
- Second order approximation theory of an arbitrary aerofoil in compressible potential flow
N82-10982
- Aerodynamic calculations and design of subcritical aerofoils
N82-10983
- Matrix analysis of wings
N82-10998
- AIRFRAME MATERIALS**
Lightning effects on aircraft and composites. Literature study on lightning strikes and protection --- advanced composite materials [FOA-C-20388-P9]
N82-10024
- AIRFRAMES**
Development of aircraft production engineering discipline at IIT, Bombay
A82-11317
- Design techniques for multivariable flight control systems
N82-11078
- AIRLINE OPERATIONS**
How large should a commuter transport be [AIAA PAPER 81-1732]
A82-10463
- Optimum climb and descent trajectories for airline missions
N82-11082
- AIRPORT TOWERS**
FAA misses opportunities to discontinue or reduce operating hours of some airport traffic control towers [PB81-224214]
N82-11049
- AIRPORTS**
An airport wind shear detection and warning system using Doppler radar
A82-10220
- Airport and Airway Improvement Act of 1981, part 1 [GPO-76-241-PT-1]
N82-10062
- Design of airport pavements for expansive soils [AD-A104660]
N82-11313
- Effects of aircraft noise on the equilibrium of airport residents: Testing and utilization of a new methodology [NASA-TM-76628]
N82-11636
- AIRSHIPS**
Design aspects of non rigid airship envelopes
A82-10306
- The balloon and the airship technological heritage [AIAA PAPER 81-1912]
A82-10401
- AIRSEED**
Comparison of simulation and experimental data for a gliding parachute in dynamic flight [AIAA PAPER 81-1924]
A82-10409
- Procedures and analysis techniques for determining static air minimum control speeds
A82-12564

- ALUMINUM ALLOYS**
The application of improved aluminium alloys and steels in aircraft structures
A82-10305
- AMPLIFICATION**
Characteristic and principal gains and phases and their use as multivariable control design tools --- generalizing Nyquist and root-locus diagram techniques
N82-10050
- ANALYSIS (MATHEMATICS)**
Multi-variable analysis and design techniques [AGARD-LS-117]
N82-10048
- ANGLE OF ATTACK**
Nonlinear prediction of subsonic aerodynamic loads on wings and bodies at high angles of attack
A82-11359
Estimation of airplane stability and control derivatives from large amplitude longitudinal maneuvers [NASA-TM-83185]
N82-10042
Aerodynamic calculations and design of subcritical aerofoils
N82-10983
- ANTENNA DESIGN**
Antenna theory and design --- Book
A82-12323
General aviation aircraft antennas for the global positioning system [NASA-TM-83212]
N82-11339
- ANTENNA RADIATION PATTERNS**
Antenna theory and design --- Book
A82-12323
- ANTIICING ADDITIVES**
Icing tunnel tests of a composite porous leading edge for use with a liquid anti-ice system --- Lewis icing research tunnel [NASA-CR-164966]
N82-11052
- ANTIMISTING FUELS**
An assessment of the use of antimisting fuel in turbofan engines [NASA-CR-165258]
N82-11230
- ANTI-SHIP MISSILES**
Air-film cooling returns to ramjets [ASME PAPER 81-ENAS-8]
A82-10896
- APPROXIMATION**
Multivariable design: The optimization of approximate inverses
N82-10057
Second order approximation theory of an arbitrary aerofoil in compressible potential flow
N82-10982
- ARCHAEOLOGY**
Radar mapping, archaeology, and ancient land use in the Maya lowlands [NASA-CR-164931]
N82-11514
- ARCHITECTURE (COMPUTERS)**
HiMAT onboard flight computer system architecture and qualification [AIAA 81-2107]
A82-10082
Airborne associative processor /ASPRO/ --- for early warning radar surveillance, command, and control applications [AIAA 81-2145]
A82-10104
- AREA NAVIGATION**
Use of Space Shuttle technology in conventional aircraft [AIAA 81-2176]
A82-10125
Discrete address beacon, navigation and landing system
A82-10650
- ARMED FORCES (FOREIGN)**
A proposed flight safety program for the Korean Air Force [AD-A102373]
N82-10023
- ARROW WINGS**
Effects of vortex flaps on the low-speed aerodynamic characteristics of an arrow wing [NASA-TP-1914]
N82-11013
- ASTROIONICS**
Memory requirements for future navigation systems
A82-12637
- ATMOSPHERIC CIRCULATION**
Multiple Doppler radar observations of PBL structure
A82-10292
- ATMOSPHERIC ELECTRICITY**
Electrical ground testing of aircraft antistatic protection
A82-10822
- ATMOSPHERIC SCATTERING**
Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity
A82-12149
- ATMOSPHERIC SOUNDING**
Limiting payload deceleration during ground impact [AIAA PAPER 81-1918]
A82-10404
- ATMOSPHERIC TURBULENCE**
Downbursts and microbursts. - An aviation hazard --- downdrafts beneath thunderstorms
A82-10214
Detection and display of wind shear and turbulence
A82-10222
- ATTITUDE CONTROL**
Simulation study of a hybrid strapdown attitude and heading reference system
A82-12641
- AUTOMATIC CONTROL**
Problems relating to the classical rate-gyro
A82-10497
Application of nonlinear systems inverses to automatic flight control design: System concepts and flight evaluations
N82-11083
- AUTOMATIC FLIGHT CONTROL**
HiMAT onboard flight computer system architecture and qualification [AIAA 81-2107]
A82-10082
Controlling the software/hardware interface for the validation of avionics systems --- in flight control systems [AIAA 81-2159]
A82-10116
Ideal and simulated performance of an aircraft in the terrain following mission
A82-11302
The digital civil aircraft
A82-11938
- AUTOMATIC LANDING CONTROL**
Development and evaluation of automatic landing control laws for light wing loading STOL aircraft [NASA-CR-166160]
N82-10043
- AUTOMATIC TEST EQUIPMENT**
Air supply system bite for Boeing 767 airplane --- Built-In-Test-Equipment [ASME PAPER 81-ENAS-7]
A82-10895
Commercial EMS considerations for small gas turbine engines --- automated engine monitoring systems
A82-12449
- AUTOMATION**
Automated Paint and Process Line /APPL/ --- for aircraft production [AIAA 81-2166]
A82-10120
- AUXILIARY POWER SOURCES**
A new APU for medium place aircraft environmental control systems [ASME PAPER 81-ENAS-1]
A82-10889
- AVIONICS**
KC-135 Avionics Modernization Hot Bench [AIAA 81-2105]
A82-10081
Bridging the gap from aircraft to space computers [AIAA 81-2142]
A82-10101
Controlling the software/hardware interface for the validation of avionics systems --- in flight control systems [AIAA 81-2159]
A82-10116
Closed loop environmental control systems for fighter aircraft [ASME PAPER 81-ENAS-2]
A82-10890
Design challenges of high performance aircraft POD BOCM cooling systems --- Electro-Optical/Countermeasure [ASME PAPER 81-ENAS-6]
A82-10894
Sealed lead-acid batteries for aircraft applications
A82-11716
Applications of finite element method in aerospace power systems design
A82-11717
Advanced aircraft electric power system
A82-11718
Variable speed constant frequency /VSCF/ electrical system cuts cost of ownership
A82-11719
Digital avionics - Promise and practice; Proceedings of the Joint Symposium, London, England, March 20, 1980
A82-11934

- The all digital military aircraft A82-11937
- The digital civil aircraft A82-11938
- Digital avionics systems - The RAF experience A82-11941
- Digital avionics: Promise and practice - An airlines experience in the field A82-11942
- Memory requirements for future navigation systems A82-12637
- The integrated inertial sensor assembly /IISA/ - A redundant strapdown system for advanced aircraft navigation and flight control functions A82-12642
- F-5G Tigershark A82-12775
- Electronic master monitor and advisory display system, data transmission study [AD-A104243] N82-11064
- AWACS AIRCRAFT**
- Airborne associative processor /ASPRO/ --- for early warning radar surveillance, command, and control applications [AIAA 81-2145] A82-10104
- AXIAL STRESS**
- Crack growth evaluation of a method to convert real-time loads history to a simplified engineering spectra --- for aircraft structural analysis A82-12043
- AXISYMMETRIC FLOW**
- On the prediction of swirling flowfields found in axisymmetric combustor geometries A82-12120
- B**
- BALLISTICS**
- Aeroballistic characteristics of sonobuoy parachute decelerators limited to a length of three feet [AIAA PAPER 81-1950] A82-10425
- BALLOON FLIGHT**
- A new thermal and trajectory model for high altitude balloons [AIAA PAPER 81-1926] A82-10411
- BALLOON-BORNE INSTRUMENTS**
- Limiting payload deceleration during ground impact [AIAA PAPER 81-1918] A82-10404
- BALLOONS**
- The balloon and the airship technological heritage [AIAA PAPER 81-1912] A82-10401
- BEAMS (SUPPORTS)**
- Matrix analysis of wings N82-10998
- BELLOWS**
- Low maintenance hydraulic accumulator [AD-A103947] N82-10034
- BENDING FATIGUE**
- Matrix analysis of wings N82-10998
- BIBLIOGRAPHIES**
- Selected bibliography of NACA-NASA aircraft icing publications [NASA-TM-81651] N82-11053
- BIT SYNCHRONIZATION**
- Synchronous fault-tolerant flight control systems [AIAA 81-2109] A82-10083
- BLADE SLAP NOISE**
- Model helicopter rotor impulsive noise A82-11300
- BODY-WING AND TAIL CONFIGURATIONS**
- Experimental study of empennage snap-through vibrations A82-11471
- BODY-WING CONFIGURATIONS**
- Acta mechanica sinica [AD-A105184] N82-11014
- The principles and methods for shaping the wing root regions of a wing-body combination at transonic and lower supersonic speeds N82-11016
- BOEING 747 AIRCRAFT**
- SEL and EPNL noise duration coefficients for the 747 and T-38 aircraft [NASA-TM-83214] N82-11860
- BOEING 767 AIRCRAFT**
- Air supply system bite for Boeing 767 airplane --- Built-In-Test-Equipment [ASME PAPER 81-ENAS-7] A82-10895
- BOUNDARY LAYER CONTROL**
- Developments in boundary layer Thrust Vector Control A82-10855
- New estimation method for flutter or divergence boundary from random responses at subcritical speeds [NAL-TR-667T] N82-11034
- Amplified crossflow disturbances in the laminar boundary layer on swept wings with suction [NASA-TP-1902] N82-11391
- BOUNDARY LAYER FLOW**
- Multiple-scale turbulence modeling of free turbulent flows [ASME PAPER 81-PE-20] A82-10934
- BOUNDARY LAYER SEPARATION**
- A summary of V/STOL inlet analysis methods [NASA-TN-82725] N82-11043
- BOUNDARY LAYERS**
- Aircraft excrescence drag [AGARD-AG-264] N82-10020
- Aircraft wing trailing-edge noise [NASA-CR-164952] N82-11039
- BRAKES (FOR ARRESTING MOTION)**
- Aeroballistic characteristics of sonobuoy parachute decelerators limited to a length of three feet [AIAA PAPER 81-1950] A82-10425
- C**
- C-135 AIRCRAFT**
- KC-135 Avionics Modernization Hot Bench [AIAA 81-2105] A82-10081
- CALIBRATING**
- In-situ calibration of flight heat transfer instrumentation [ASME PAPER 81-ENAS-13] A82-10901
- CANOPIES**
- Aerodynamics and performance of cruciform parachute canopies [AIAA PAPER 81-1919] A82-10405
- Experimental determination of parachute apparent mass and its significance in predicting dynamic stability [AIAA PAPER 81-1920] A82-10406
- Theoretical analysis of parachute inflation including fluid kinetics [AIAA PAPER 81-1925] A82-10410
- The net-skirt to a parachute canopy as a device to prevent inversion [AIAA PAPER 81-1927] A82-10412
- Stress measurements in a ribbon parachute canopy during inflation and at steady state [AIAA PAPER 81-1944] A82-10420
- Stress measurements in bias constructed parachute canopies during inflation and at steady-state [AIAA PAPER 81-1945] A82-10421
- CAPACITORS**
- High voltage surge and partial discharge test to evaluate aerospace equipment parts A82-11740
- CARBON FIBER REINFORCED PLASTICS**
- Sophisticated aircraft structure developments - Combat aeroplanes A82-10309
- On the use of carbon composites in slat and stabilizer construction A82-11468
- A CFRP taileron for the Tornado: Construction and production --- horizontal stabilizer [MBB-PE-212/KFK/PUB/2] N82-10035
- CARGO AIRCRAFT**
- ACMA - Fact or fantasy --- Advanced Civilian/Military Aircraft A82-12048
- CASCADE FLOW**
- Wind tunnel tests on airfoils in tandem cascade A82-10987
- End losses in turbine cascades with porous cooling A82-11434
- Theoretical investigations and experimental researches for higher subsonic two-dimensional compressor cascade N82-11024

- Subsonic cascade wind tunnel tests using a compressor configuration of DCA blades [AD-A104597] N82-11069
- CEILINGS (ARCHITECTURE)**
Evaluation of the acoustic measurement capability of the NASA Langley V/STOL wind tunnel open test section with acoustically absorbent ceiling and floor treatments [NASA-CR-165796] N82-10059
- CENTRAL AMERICA**
Radar mapping, archaeology, and ancient land use in the Maya lowlands [NASA-CR-164931] N82-11514
- CERAMICS**
Development of low modulus material for use in ceramic gas path seal applications [NASA-CR-165469] N82-10039
- CERTIFICATION**
The certification of digital systems A82-11940
- CHANNEL NOISE**
Tangential sensitivity of EW receivers A82-11020
- CIRCULATION CONTROL ROTORS**
An investigation of a stoppable helicopter rotor with circulation control --- ams 40 by 80 foot wind tunnel [NASA-TN-81218] N82-10030
- CIVIL AVIATION**
The digital civil aircraft A82-11938
Digital avionics: Promise and practice - An airlines experience in the field A82-11942
- CLEAR AIR TURBULENCE**
Instrumented aircraft verification of clear-air radar detection of low-level wind shear A82-10221
- COAL LIQUEFACTION**
Jet fuel from carbon A82-12021
- COAL UTILIZATION**
Jet fuel from carbon A82-12021
- COLLISION AVOIDANCE**
FAA developing new collision avoidance, data acquisition and transmission systems A82-10396
Threat Alert and Collision Avoidance System (TCAS) Symposium [AD-A104563] N82-11047
- COMBUSTION CHAMBERS**
One reason for the onset of high-frequency self-excited oscillations --- in combustion chambers of aircraft engines A82-11448
The CIVIC - A concept in vortex induced combustion. II [ASME PAPER 81-GT-12] A82-11997
Application of numerical modeling to gas turbine combustor development problems A82-12118
On the prediction of swirling flowfields found in axisymmetric combustor geometries A82-12120
Validation studies of turbulence and combustion models for aircraft gas turbine combustors A82-12267
- COMBUSTION PHYSICS**
An investigation of the combustion process in solid fuel ramjets [AD-A104603] N82-11232
- COMBUSTION STABILITY**
One reason for the onset of high-frequency self-excited oscillations --- in combustion chambers of aircraft engines A82-11448
- COMMAND AND CONTROL**
Interoperability testing of decentralized command, control, communications and intelligence /C3I/ systems [AIAA 81-2205] A82-10143
- COMMERCIAL AIRCRAFT**
ACHA - Fact or fantasy --- Advanced Civilian/Military Aircraft A82-12048
Lightweight diesel engine designs for commuter type aircraft [NASA-CR-165470] N82-11068
- COMMUNICATION NETWORKS**
Interoperability testing of decentralized command, control, communications and intelligence /C3I/ systems [AIAA 81-2205] A82-10143
A solution to the static geometry problem for JTIDS relative navigation A82-12634
Omega station 10.2 kHz signal selection made easy A82-12638
- COMPONENT RELIABILITY**
Extending the limits of reliability theory --- Book A82-12318
- COMPOSITE MATERIALS**
Some possibilities for composite light aircraft construction A82-10307
Light aircraft structural design in non-metallics - Use of composite honeycomb for light aircraft A82-10308
Emerging technologies in aerospace structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980 A82-12026
Impact-initiated damage thresholds in composites A82-12028
Lightning effects on aircraft and composites. Literature study on lightning strikes and protection --- advanced composite materials [FOA-C-20388-P9] N82-10024
- COMPOSITE STRUCTURES**
Composite main rotor tubular braided A82-10547
Development of the Triflex rotor head A82-11222
Icing tunnel tests of a composite porous leading edge for use with a liquid anti-ice system --- Lewis icing research tunnel [NASA-CR-164966] N82-11052
- COMPRESSIBILITY EFFECTS**
Theoretical investigations and experimental researches for higher subsonic two-dimensional compressor cascade N82-11024
- COMPRESSIVE STRENGTH**
Seven years experience with Kevlar-49 in the Lockheed L-1011 Tristar A82-12647
- COMPRESSOR BLADES**
An aerodynamic design method for transonic axial flow compressor stage N82-10984
Subsonic cascade wind tunnel tests using a compressor configuration of DCA blades [AD-A104597] N82-11069
- COMPUTATIONAL FLUID DYNAMICS**
The use of the Weber method for minicomputer-assisted numerical analysis of airfoils A82-10362
Theoretical analysis of parachute inflation including fluid kinetics [AIAA PAPER 81-1925] A82-10410
Strong matching method for computing transonic viscous flows including wakes and separations - Lifting airfoils A82-10821
Multiple-scale turbulence modeling of free turbulent flows [ASME PAPER 81-PE-20] A82-10934
Control laws for adaptive wind tunnels A82-10985
Calculation of aerodynamic characteristics of jet flapped airplane A82-11459
Validation studies of turbulence and combustion models for aircraft gas turbine combustors A82-12267
Acta mechanica sinica [AD-A105184] N82-11014
The arbitrary quasi-orthogonal surface method for computing three-dimensional flow in turbine machinery. 2. Calculation of the three-dimensional flow with the $S_{\text{sub } 1}$ -surface twisted N82-11015

- Computation of high Reynolds number internal/external flows
[NASA-TM-84049] N82-11046
- COMPUTER DESIGN**
Bridging the gap from aircraft to space computers
[AIAA 81-2142] A82-10101
Airborne associative processor /ASPRO/ --- for early warning radar surveillance, command, and control applications
[AIAA 81-2145] A82-10104
- COMPUTER GRAPHICS**
Integration of computer graphics design with analytical models --- for aircraft design
[AIAA 81-2134] A82-10096
Improving the MLS through enhanced cockpit displays
A82-10649
Solution to the hidden-line problem
A82-12803
- COMPUTER PROGRAMS**
The Space Shuttle vehicle checkout involving flight avionics software
[AIAA 81-2141] A82-10100
Controlling the software/hardware interface for the validation of avionics systems --- in flight control systems
[AIAA 81-2159] A82-10116
The certification of digital systems
A82-11940
Digital avionics systems - The RAF experience
A82-11941
Flight test results of the model simulation controller for the HFB 320 for in-flight simulation of the A310 airbus
[ESA-TT-660] N82-10107
Computation of high Reynolds number internal/external flows
[NASA-TM-84049] N82-11046
Integrated analysis of engine
[NASA-TM-82713] N82-11491
Structural analysis computer programs for rigid multicomponent pavement structures with discontinuities, WESLIQID and WESLAYER. Report 1: Program development and numerical presentations
[AD-A104545] N82-11498
- COMPUTER STORAGE DEVICES**
Memory requirements for future navigation systems
A82-12637
- COMPUTER SYSTEMS DESIGN**
KC-135 Avionics Modernization Hot Bench
[AIAA 81-2105] A82-10081
Synchronous fault-tolerant flight control systems
[AIAA 81-2109] A82-10083
Navigation task partitioning in distributed-processing avionics systems
A82-10646
- COMPUTER SYSTEMS SIMULATION**
Performance analysis of enroute air traffic control computers in the National Airspace System
[AIAA 81-2203] A82-10140
- COMPUTERIZED DESIGN**
Integration of computer graphics design with analytical models --- for aircraft design
[AIAA 81-2134] A82-10096
Solution to the hidden-line problem
A82-12803
Multi-variable analysis and design techniques
[AGARD-LS-117] N82-10048
Characteristic and principal gains and phases and their use as multivariable control design tools --- generalizing Nyquist and root-locus diagram techniques
N82-10050
LQG multivariable design tools
N82-10054
The automatic matrix force method and techniques for handling more complex computations with given computer capacity
N82-10994
- COMPUTERIZED SIMULATION**
A new thermal and trajectory model for high altitude balloons
[AIAA PAPER 81-1926] A82-10411
Ideal and simulated performance of an aircraft in the terrain following mission
A82-11302
Application of numerical modeling to gas turbine combustor development problems
A82-12118
- CONCRETE STRUCTURES**
Structural analysis computer programs for rigid multicomponent pavement structures with discontinuities, WESLIQID and WESLAYER. Report 1: Program development and numerical presentations
[AD-A104545] N82-11498
- CONFERENCES**
Test Pilots' Aviation Safety Workshop, U.S. Naval Postgraduate School, Monterey, CA, February 25-28, 1981, Proceedings
A82-10500
Digital avionics - Promise and practice; Proceedings of the Joint Symposium, London, England, March 20, 1980
A82-11934
Emerging technologies in aerospace structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980
A82-12026
Powder metallurgy superalloys - Aerospace materials for the 1980's; Proceedings of the Conference, Zurich, Switzerland, November 18-20, 1980. Volume 1
A82-12495
National Aerospace Meeting, Treviso, PA, April 8-10, 1981, Proceedings
A82-12626
Kevlar composites; Proceedings of the Symposium, El Segundo, CA, December 2, 1980
A82-12646
The Shock and Vibration Digest, volume 13, no. 9
[AD-A105062] N82-10421
- CONGRESSIONAL REPORTS**
Spin recovery training --- licensing requirement
[GPO-66-020] N82-10022
Airport and Airway Improvement Act of 1981, part 1
[GPO-76-241-PT-1] N82-10062
- CONSTRUCTION**
Development and construction of pilot ejector seats in Germany from 1938-1945
[DFVLR-PB-81-04] N82-10026
A CFRP taileron for the Tornado: Construction and production --- horizontal stabilizer
[MBB-FE-212/KFK/PUB/2] N82-10035
- CONTROL BOARDS**
Electronic master monitor and advisory display system, human engineering summary report
[AD-A104244] N82-11065
- CONTROL EQUIPMENT**
Considerations and applications for the use of fluidics in aerospace controls
A82-12087
Management of redundancy in flight control systems using optimal decision theory
N82-11084
- CONTROL STABILITY**
Characteristic and principal gains and phases and their use as multivariable control design tools --- generalizing Nyquist and root-locus diagram techniques
N82-10050
Design of high integrity multivariable control systems
N82-10055
- CONTROL SURFACES**
On the kernel function collocation method in steady subsonic flow for wing with control surfaces
N82-12023
- CONTROL THEORY**
Design considerations for the direct digital control of dry-tuned gyroscope
A82-11933
Control of electromechanical actuator elements for flight vehicles --- Russian book
A82-12170
Theory and applications of optimal control in aerospace systems
[AGARD-AG-251] N82-11073
An introduction to stochastic optimal control theory
N82-11076
- CONTROLLABILITY**
Theoretical investigation of the influence of spoiler dynamics on the handling qualities of an aircraft with direct lift control
[ESA-TT-681] N82-10036

CONTROLLERS

- Multi-variable analysis and design techniques
[AGARD-LS-117] N82-10048
The need for multivariable design and analysis
techniques N82-10049
Feedback and minimax sensitivity N82-10058
Development of multivariable controllers for
aircraft turbine engines N82-11087

COOLING

- End losses in turbine cascades with porous cooling
A82-11434

COOLING SYSTEMS

- Design challenges of high performance aircraft POD
EOCM cooling systems ---
Electro-Optical/Countermeasure
[ASME PAPER 81-ENAS-6] A82-10894

CORES

- New molding method of three-dimensional hollow
photoelastic model and centrifugal stress
analysis of air cooled turbine blade model
[NAL-TR-427T] N82-11067

CORRELATION

- Hard limited approaches to correlation velocity
sensing A82-12636

CORROSION PREVENTION

- A protective additive for jet fuels
A82-12022

COST REDUCTION

- Variable speed constant frequency /VSCF/
electrical system cuts cost of ownership
A82-11719
ACMA - Fact or fantasy --- Advanced
Civilian/Military Aircraft A82-12048
Cost reduction in air transportation --- energy
conservation N82-10025
[SNIAS-811-150-101]
FAA misses opportunities to discontinue or reduce
operating hours of some airport traffic control
towers N82-11049
[PB81-224214]

CONVLINGS

- Low speed testing of the inlets designed for a
tandem-fan V/STOL nacelle --- conducted in the
Lewis 10 by 10 foot wind tunnel N82-11042
[NASA-TM-82728]

CRACK PROPAGATION

- Acoustic emission - An emerging technology for
assessing fatigue damage in aircraft structure
A82-11149
Crack growth evaluation of a method to convert
real-time loads history to a simplified
engineering spectra --- for aircraft structural
analysis A82-12043
Fractographic determination of fatigue crack
growth rates in aircraft components A82-12697

CRITICAL FLOW

- Aerodynamic calculations and design of subcritical
aerofoils N82-10983

CRITICAL LOADING

- Impact-initiated damage thresholds in composites
A82-12028

CROSS FLOW

- A numerical three-dimensional turbulent simulation
of a subsonic VSTOL jet in a cross-flow using a
finite element algorithm N82-11055
[AD-A104514]
Amplified crossflow disturbances in the laminar
boundary layer on swept wings with suction
[NASA-TP-1902] N82-11391

CRYOGENIC WIND TUNNELS

- Design predictions for noise control in the
cryogenic National Transonic Facility A82-12025

CYCLIC LOADS

- Fatigue substantiation of non-linear structures
A82-11224

D**DAMAGE ASSESSMENT**

- Acoustic emission - An emerging technology for
assessing fatigue damage in aircraft structure
A82-11149

DAMPING

- New estimation method for flutter or divergence
boundary from random responses at subcritical
speeds N82-11034
[NAL-TR-667T]

DATA ACQUISITION

- A microprocessor-based data acquisition system for
stall/spin research A82-10126
[AIAA 81-2177]
FAA developing new collision avoidance, data
acquisition and transmission systems A82-10396

DATA TRANSMISSION

- FAA developing new collision avoidance, data
acquisition and transmission systems A82-10396
Electronic master monitor and advisory display
system, data transmission study N82-11064
[AD-A104243]

DC 9 AIRCRAFT

- Fuel conservation - DC-9 series 20/30/40
A82-12563

DECELERATION

- Limiting payload deceleration during ground impact
[AIAA PAPER 81-1918] A82-10404

DECISION MAKING

- Management of redundancy in flight control systems
using optimal decision theory N82-11084

DEICERS

- Rotorcraft icing: Status and prospects
[AGARD-AR-166] N82-11056
Ice protection system technology N82-11060

DEICING

- Icing tunnel test of a glycol-exuding porous
leading edge ice protection system on a general
aviation airfoil --- conducted in the Lewis
Research Center icing research tunnel N82-10021
[NASA-CR-165444]

DELTA WINGS

- Formation of triangular-element stiffness matrix
using sliding interpolation A82-11464
Increasing the lift:drag ratio of a flat delta wing
A82-11899

DESIGN ANALYSIS

- Development of new lifting parachute designs with
increased trim angle A82-10407
[AIAA PAPER 81-1921]
Optimization of the principal design parameters of
a passenger aircraft A82-10816
Design analysis of high temperature transparent
windshields for high-performance aircraft
[ASME PAPER 81-ENAS-5] A82-10893
Parachute technology under pressure A82-12804

DIESEL ENGINES

- Lightweight diesel engine designs for commuter
type aircraft N82-11068
[NASA-CR-165470]

DIFFUSION ELECTRODES

- Unsolved problems of nickel cadmium batteries
A82-11725

DIGITAL COMPUTERS

- Aircraft digital input controlled hydraulic
actuation and control system N82-11072
[AD-A104263]

DIGITAL RADAR SYSTEMS

- The evolution of airborne weather avoidance radar
toward a calibrated remote rain gauge using REACT
--- Rain Echo Attenuation Compensation Hardware
A82-10225

DIGITAL SIMULATION

- Real-time, on-line digital simulation of optimum
maneuvers of supersonic aircraft
[AIAA 81-2178] A82-10127

DIGITAL SYSTEMS

- Digital avionics - Promise and practice;
Proceedings of the Joint Symposium, London,
England, March 20, 1980 A82-11934
- The all digital military aircraft A82-11937
- The digital civil aircraft A82-11938
- The certification of digital systems A82-11940
- Digital avionics systems - The RAF experience A82-11941
- Digital avionics: Promise and practice - An
airlines experience in the field A82-11942
- Practical design and realization of a digital
adaptive flight control system N82-11079
- Control law design for transport aircraft flight
tasks N82-11080
- Application of nonlinear systems inverses to
automatic flight control design: System
concepts and flight evaluations N82-11083

DIGITAL TECHNIQUES

- Use of Space Shuttle technology in conventional
aircraft [AIAA 81-2176] A82-10125
- Air supply system bite for Boeing 767 airplane ---
Built-In-Test-Equipment [ASME PAPER 81-ENAS-7] A82-10895
- Design considerations for the direct digital
control of dry-tuned gyroscope A82-11933

DIRECT LIFT CONTROLS

- Theoretical investigation of the influence of
spoiler dynamics on the handling qualities of an
aircraft with direct lift control [ESA-TT-681] N82-10036
- Development and evaluation of automatic landing
control laws for light wing loading STOL aircraft
[NASA-CR-166160] N82-10043

DISCRETE ADDRESS BEACON SYSTEM

- Discrete address beacon, navigation and landing
system A82-10650

DISPERSIONS

- The dispersion of drop sizes in gas turbine fuel
nozzle sprays A82-12107

DISPLACEMENT MEASUREMENT

- Optical sensors for displacement measurement A82-11407

DISPLAY DEVICES

- Improving the MLS through enhanced cockpit displays A82-10649
- Electronic master monitor and advisory display
system, data transmission study [AD-A104243] N82-11064
- Electronic master monitor and advisory display
system, human engineering summary report [AD-A104244] N82-11065

DOPPLER RADAR

- Applications of conventional and Doppler radars
for aviation safety A82-10215
- An airport wind shear detection and warning system
using Doppler radar A82-10220
- Instrumented aircraft verification of clear-air
radar detection of low-level wind shear A82-10221
- Detection and display of wind shear and turbulence A82-10222
- Gust front structure observed by Doppler radar A82-10223
- Multiple Doppler radar observations of PBL structure A82-10292

DRAG REDUCTION

- Reductions in parachute drag due to forebody wake
effects [AIAA PAPER 81-1939] A82-10417
- The principles and methods for shaping the wing
root regions of a wing-body combination at
transonic and lower supersonic speeds N82-11016

DRONE AIRCRAFT

- Development of a nylon-Kevlar recovery system for
the CL-289 /AN/USD 502/ surveillance drone
[AIAA PAPER 81-1952] A82-10427

DROP SIZE

- The dispersion of drop sizes in gas turbine fuel
nozzle sprays A82-12107

DROP TESTS

- The constricted rigging line trials technique for
assessing the opening characteristics of
parachutes [AIAA PAPER 81-1932] A82-10413

DYNAMIC CONTROL

- The need for multivariable design and analysis
techniques N82-10049
- An introduction to stochastic optimal control theory N82-11076

DYNAMIC MODELS

- New molding method of three-dimensional hollow
photoelastic model and centrifugal stress
analysis of air cooled turbine blade model
[NAL-TR-427T] N82-11067

DYNAMIC RESPONSE

- Dynamic response of aircraft structure to gun
shock loads A82-11314

- A method for determination of the aeroelastic
behavior of aircraft with active control systems
[DFVLR-FB-81-05] N82-10047

- A preliminary experimental investigation of the
response of a turbojet engine to inlet pressure
distortion N82-11007

DYNAMIC STABILITY

- A contribution to the stabilization of flight
vehicle parachute systems --- mathematical models
[ESA-TT-679] N82-10046

DYNAMIC STRUCTURAL ANALYSIS

- Fatigue substantiation of non-linear structures A82-11224
- Emerging technologies in aerospace structures,
design, structural dynamics and materials;
Proceedings of the Aerospace Conference, San
Francisco, CA, August 13-15, 1980 A82-12026
- The Shock and Vibration Digest, volume 13, no. 9
[AD-A105062] N82-10421

E

EARLY WARNING SYSTEMS

- Airborne associative processor /ASPRO/ --- for
early warning radar surveillance, command, and
control applications [AIAA 81-2145] A82-10104

EARTH OBSERVATIONS (FROM SPACE)

- SARSAT applications A82-12698

EDGE LOADING

- Aeroacoustic theory for noncompact wing-gust
interaction [FDRL-81-7] N82-11071

EDUCATION

- Development of aircraft production engineering
discipline at IIT, Bombay A82-11317

EFFECTIVE PERCEIVED NOISE LEVELS

- SEL and EPNL noise duration coefficients for the
747 and T-38 aircraft [NASA-TN-83214] N82-11860

EIGENVALUES

- Multivariable design techniques based on singular
value generalizations of classical control N82-10051

EJECTION INJURIES

- Development and construction of pilot ejector
seats in Germany from 1938-1945 [DFVLR-FB-81-04] N82-10026

EJECTION SEATS

- Development and construction of pilot ejector
seats in Germany from 1938-1945 [DFVLR-FB-81-04] N82-10026

ELASTIC DEFORMATION

- On low-speed wind tunnels with deformable boundaries A82-11462

ELECTRIC CHARGE Electrical ground testing of aircraft antistatic protection A82-10822	Cost reduction in air transportation --- energy conservation [SNIAS-811-150-101] N82-10025
ELECTRIC CONTROL Control of electromechanical actuator elements for flight vehicles --- Russian book A82-12170	ENERGY CONSUMPTION Characteristics and trends of energy consumption in transport missions with aircraft and surface vehicles A82-10495
ELECTRIC EQUIPMENT TESTS High voltage surge and partial discharge test to evaluate aerospace equipment parts A82-11740	Towards minimum power for environmental control in transport aircraft [ASME PAPER 81-ENAS-4] A82-10892
ELECTRIC FIELDS Application of numerical methods to the calculation of electrostatic fields in aircraft fuel tanks [AD-A103270] N82-10033	ENERGY CONVERSION EFFICIENCY A hidden advantage of permanent magnet electrical generating systems A82-11720
ELECTRIC GENERATORS A hidden advantage of permanent magnet electrical generating systems A82-11720	ENGINE CONTROL Helicopter engine technology - With particular reference to the Rolls-Royce Gem engine A82-10304
ELECTRIC POWER SUPPLIES Applications of finite element method in aerospace power systems design A82-11717	The digital civil aircraft A82-11938
Advanced aircraft electric power system A82-11718	ENGINE COOLANTS Air-film cooling returns to ramjets [ASME PAPER 81-ENAS-8] A82-10896
Variable speed constant frequency /VSCF/ electrical system cuts cost of ownership A82-11719	End losses in turbine cascades with porous cooling A82-11434
High voltage surge and partial discharge test to evaluate aerospace equipment parts A82-11740	The enhancement of heat exchange in channels /2nd revised and enlarged edition/ --- Russian book A82-12222
ELECTRICAL RESISTIVITY Electrical ground testing of aircraft antistatic protection A82-10822	ENGINE DESIGN Helicopter engine technology - With particular reference to the Rolls-Royce Gem engine A82-10304
ELECTRO-OPTICS Design challenges of high performance aircraft POD EOCM cooling systems --- Electro-Optical/Countermeasure [ASME PAPER 81-ENAS-6] A82-10894	Design considerations for duty cycle, life and reliability of small limited life engines [AIAA PAPER 81-1402] A82-10465
Optical sensors for displacement measurement A82-11407	Basic problem of aircraft gasturbine engine analytic design. II A82-11463
ELECTROMAGNETIC FIELDS Antenna theory and design --- Book A82-12323	Thermal expansion accommodation in a jet engine frame A82-11999
ELECTROMAGNETIC NOISE Tangential sensitivity of EW receivers A82-11020	Propulsion study for Small Transport Aircraft Technology (STAT) [NASA-CR-165499] N82-10037
ELECTROMAGNETIC PULSES System safety program plan --- electromagnetic pulse testing of the A-7E aircraft [AD-A104557] N82-11354	Propulsion study for Small Transport Aircraft Technology (STAT), Appendix B [NASA-CR-165499-APP-B] N82-10038
ELECTROMECHANICAL DEVICES Control of electromechanical actuator elements for flight vehicles --- Russian book A82-12170	Lightweight diesel engine designs for commuter type aircraft [NASA-CR-165470] N82-11068
ELECTRONIC AIRCRAFT Design challenges of high performance aircraft POD EOCM cooling systems --- Electro-Optical/Countermeasure [ASME PAPER 81-ENAS-6] A82-10894	Development of multivariable controllers for aircraft turbine engines N82-11087
ELECTRONIC CONTROL Advanced aircraft electrical system control technology demonstrator. Phase 1: Requirements analysis and conceptual design [AD-A103922] N82-10326	Integrated analysis of engine [NASA-TM-82713] N82-11491
ELECTRONIC COUNTERMEASURES Design challenges of high performance aircraft POD EOCM cooling systems --- Electro-Optical/Countermeasure [ASME PAPER 81-ENAS-6] A82-10894	ENGINE INLETS A summary of V/STOL inlet analysis methods [NASA-TM-82725] N82-11043
ELECTRONIC TRANSDUCERS Outsider's look at flight instrumentation [DE81-025409] N82-11066	ENGINE MONITORING INSTRUMENTS Commercial EMS considerations for small gas turbine engines --- automated engine monitoring systems A82-12449
ELECTRONIC WARFARE Digital avionics systems - The RAF experience A82-11941	Further application and development of an engine usage/life monitoring system for military services A82-12450
ELECTROSTATICS Application of numerical methods to the calculation of electrostatic fields in aircraft fuel tanks [AD-A103270] N82-10033	ENGINE NOISE Rotor wake characteristics relevant to rotor-stator interaction noise generation [AIAA PAPER 81-2031] A82-10456
ENERGY CONSERVATION Fuel conservation - DC-9 series 20/30/40 A82-12563	ENGINE PARTS Superalloy powder engine components; controls employed to assure high quality hardware A82-12499
	Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure N82-11006
	ENGINE STARTERS 60 KVA ADP permanent magnet VSCF starter generator system - Generator system performance characteristics A82-11721
	ENGINE TESTS History of flight testing the L-1011 TriStar jet transport. II - Testing highlights since initial certification of the L-1011-1 A82-12049

- Propulsion study for Small Transport Aircraft
Technology (STAT), Appendix B
[NASA-CR-165499-APP-B] A82-10038
- Adaptation of a turbine test facility to
high-temperature research
[RAE-LIB-TRANS-2064] A82-11089
- ENVIRONMENTAL CONTROL**
- A new APU for medium place aircraft environmental
control systems
[ASME PAPER 81-ENAS-1] A82-10889
- Closed loop environmental control systems for
fighter aircraft
[ASME PAPER 81-ENAS-2] A82-10890
- Towards minimum power for environmental control in
transport aircraft
[ASME PAPER 81-ENAS-4] A82-10892
- Air-freon integrated environmental conditioning
system for trainer subsonic aircraft
[ASME PAPER 81-ENAS-33] A82-10920
- ENVIRONMENTAL TESTS**
- Quantification of the thermal environment for
externally carried aircraft stores and ordnance
A82-12100
- The Shock and Vibration Digest, volume 13, no. 9
[AD-A105062] A82-10421
- EPOXY MATRIX COMPOSITE MATERIALS**
- Kevlar composites; Proceedings of the Symposium,
El Segundo, CA, December 2, 1980
A82-12646
- EQUATIONS OF MOTION**
- Optimal flight paths for winged, supersonic flight
vehicles - Extension to the case where thrust
can be vectored
A82-10310
- On the question of trailing airplane motion
A82-11470
- EQUATIONS OF STATE**
- On computing Floquet transition matrices of
rotorcraft
A82-11225
- ESTIMATING**
- New estimation method for flutter or divergence
boundary from random responses at subcritical
speeds
[NAL-TR-667T] A82-11034
- EXHAUST EMISSION**
- Baseline data on utilization of low-grade fuels in
gas turbine applications. Volume 3: Emissions
evaluation
[DE81-903764] A82-10254
- EXHAUST GASES**
- Study of reingestion of exhaust gases with
different initial temperature in a reversed
turbojet engine
A82-11444
- EXPANSION**
- Design of airport pavements for expansive soils
[AD-A104660] A82-11313
- EXPERIENCE**
- Relationships between naval aviation safety and
pilot flight experience
A82-11031
- EXTERNAL STORES**
- Quantification of the thermal environment for
externally carried aircraft stores and ordnance
A82-12100
- EXTRUDING**
- Superalloy turbine components - Which is the
superior manufacturing process, as-HIP, HIP plus
Isoforge, or 'gatorizing' of extrusion
consolidated billet
A82-12497
- F**
- F-5 AIRCRAFT**
- F-5G Tigershark
A82-12775
- F-18 AIRCRAFT**
- Variable speed constant frequency /VSCF/
electrical system cuts cost of ownership
A82-11719
- FAILURE ANALYSIS**
- Synchronous fault-tolerant flight control systems
[AIAA 81-2109] A82-10083
- Unsolved problems of nickel cadmium batteries
A82-11725
- Extending the limits of reliability theory --- Book
A82-12318
- Fractographic determination of fatigue crack
growth rates in aircraft components
A82-12697
- FAN BLADES**
- Effects of vane/blade ratio and spacing on fan noise
[AIAA PAPER 81-2033] A82-10457
- FATIGUE (MATERIALS)**
- Sophisticated aircraft structure developments -
Combat aeroplanes
A82-10309
- Fractographic determination of fatigue crack
growth rates in aircraft components
A82-12697
- FATIGUE LIFE**
- Acoustic emission - An emerging technology for
assessing fatigue damage in aircraft structure
A82-11149
- Fatigue life of lugs under service loading - Test
results and predictions
A82-11685
- FATIGUE TESTS**
- Superclean superalloy powders by the rotating
electrode process
A82-12496
- Matrix analysis of wings
A82-10998
- FATTY ACIDS**
- A protective additive for jet fuels
A82-12022
- FAULT TOLERANCE**
- Synchronous fault-tolerant flight control systems
[AIAA 81-2109] A82-10083
- FEDERAL BUDGETS**
- Airport and Airway Improvement Act of 1981, part 1
[GPO-76-241-PT-1] A82-10062
- NASA Authorization, 1982: Index
[GPO-84-713] A82-10959
- FEEDBACK CONTROL**
- Closed loop environmental control systems for
fighter aircraft
[ASME PAPER 81-ENAS-2] A82-10890
- Comparative study of flare control laws
[NASA-CR-164903] A82-10032
- Multi-variable analysis and design techniques
[AGARD-LS-117] A82-10048
- The need for multivariable design and analysis
techniques
A82-10049
- Characteristic and principal gains and phases and
their use as multivariable control design tools
--- generalizing Nyquist and root-locus diagram
techniques
A82-10050
- Multivariable design techniques based on singular
value generalizations of classical control
A82-10051
- Limitations on achievable performance of
multivariable feedback systems
A82-10052
- LQG-based multivariable design: Frequency domain
interpretation
A82-10053
- LQG multivariable design tools
A82-10054
- Design of high integrity multivariable control
systems
A82-10055
- A geometric approach to multivariable control
system synthesis
A82-10056
- Multivariable design: The optimization of
approximate inverses
A82-10057
- Feedback and minimax sensitivity
A82-10058
- Design techniques for multivariable flight control
systems
A82-11078
- Practical design and realization of a digital
adaptive flight control system
A82-11079
- FIBER OPTICS**
- Optical sensors for displacement measurement
A82-11407
- Electronic master monitor and advisory display
system, data transmission study
[AD-A104243] A82-11064

- FIELD THEORY (PHYSICS)**
Antenna theory and design --- Book
A82-12323
- FIGHTER AIRCRAFT**
Analysis of augmented aircraft flying qualities through application of the Neal-Smith criterion [AIAA PAPER 81-1776] A82-10462
Closed loop environmental control systems for fighter aircraft [ASME PAPER 81-ENAS-2] A82-10890
Dynamic response of aircraft structure to gun shock loads A82-11314
The case for a defensive air-to-air fighter A82-12801
- FILM COOLING**
Air-film cooling returns to ramjets [ASME PAPER 81-ENAS-8] A82-10896
- FINITE DIFFERENCE THEORY**
Finite difference computation of the steady transonic potential flow around airplanes N82-10981
- FINITE ELEMENT METHOD**
Applications of finite element method in aerospace power systems design A82-11717
Application of numerical methods to the calculation of electrostatic fields in aircraft fuel tanks [AD-A103270] N82-10033
Calculation of natural modes of vibration for rotor blades by the finite element method [DFVLR-FB-81-07] N82-10452
Structural analysis of fuselages with cutouts by finite element method N82-10995
Structural analysis computer programs for rigid multicomponent pavement structures with discontinuities, WESLIQID and WESLAYER. Report 1: Program development and numerical presentations [AD-A104545] N82-11498
- FIRE PREVENTION**
Rheological behavior of progressively shear-thickening solutions --- aircraft fuel polymer additives for fire protection in survivable crashes A82-11177
- FLEXIBILITY**
The effects of flexibility on the steady-state performance of small ribbon parachute models [AIAA PAPER 81-1923] A82-10408
- FLEXIBLE SPACECRAFT**
Control design of flexible spacecraft N82-11081
- FLIGHT CHARACTERISTICS**
Analysis of augmented aircraft flying qualities through application of the Neal-Smith criterion [AIAA PAPER 81-1776] A82-10462
Wings in the sun - The evolution of Solar Challenger A82-12694
- FLIGHT CONTROL**
KC-135 Avionics Modernization Hot Bench [AIAA 81-2105] A82-10081
Synchronous fault-tolerant flight control systems [AIAA 81-2109] A82-10083
The Space Shuttle vehicle checkout involving flight avionics software [AIAA 81-2141] A82-10100
High-efficiency hydraulic power transfer units for multisystem aircraft A82-10853
Developments in boundary layer Thrust Vector Control A82-10855
Control of electromechanical actuator elements for flight vehicles --- Russian book A82-12170
The integrated inertial sensor assembly /IISA/ - A redundant strapdown system for advanced aircraft navigation and flight control functions A82-12642
Development and evaluation of automatic landing control laws for light wing loading STOL aircraft [NASA-CR-166160] N82-10043
Flight trajectory control investigation [AD-A104542] N82-11048
Electronic master monitor and advisory display system, human engineering summary report [AD-A104244] N82-11065
- Design considerations for optimal flight control systems N82-11077
Design techniques for multivariable flight control systems N82-11078
Practical design and realization of a digital adaptive flight control system N82-11079
Control law design for transport aircraft flight tasks N82-11080
Management of redundancy in flight control systems using optimal decision theory N82-11084
- FLIGHT CREWS**
The all digital military aircraft A82-11937
- FLIGHT HAZARDS**
Downbursts and microbursts - An aviation hazard --- downdrafts beneath thunderstorms A82-10214
Airborne weather radar and severe weather penetration A82-10219
- FLIGHT INSTRUMENTS**
In-situ calibration of flight heat transfer instrumentation [ASME PAPER 81-ENAS-13] A82-10901
- FLIGHT MECHANICS**
On the question of trailing airplane motion A82-11470
- FLIGHT OPTIMIZATION**
Real-time, on-line digital simulation of optimum maneuvers of supersonic aircraft [AIAA 81-2178] A82-10127
Helicopter icing spray system - Improvements and flight experience A82-12696
Optimum climb and descent trajectories for airline missions N82-11082
- FLIGHT PATHS**
Optimal flight paths for winged, supersonic flight vehicles - Extension to the case where thrust can be vectored A82-10310
- FLIGHT SAFETY**
Applications of conventional and Doppler radars for aviation safety A82-10215
Detection and display of wind shear and turbulence A82-10222
Test Pilots' Aviation Safety Workshop, U.S. Naval Postgraduate School, Monterey, CA, February 25-28, 1981, Proceedings A82-10500
Relationships between naval aviation safety and pilot flight experience A82-11031
A proposed flight safety program for the Korean Air Force [AD-A102373] N82-10023
- FLIGHT SIMULATION**
Real-time, on-line digital simulation of optimum maneuvers of supersonic aircraft [AIAA 81-2178] A82-10127
Comparison of simulation and experimental data for a gliding parachute in dynamic flight [AIAA PAPER 81-1924] A82-10409
Ideal and simulated performance of an aircraft in the terrain following mission A82-11302
Fatigue life of lugs under service loading - Test results and predictions A82-11685
- FLIGHT TEST INSTRUMENTS**
Outsider's look at flight instrumentation [DE81-025409] N82-11066
- FLIGHT TESTS**
HiMAT onboard flight computer system architecture and qualification [AIAA 81-2107] A82-10082
A microprocessor-based data acquisition system for stall/spin research [AIAA 81-2177] A82-10126

- The constricted rigging line trials technique for assessing the opening characteristics of parachutes
[AIAA PAPER 81-1932] A82-10413
- Inflatable system for fast deployment of parachutes at low altitudes from slow moving aircraft or stationary supports
[AIAA PAPER 81-1953] A82-10428
- Dynamic response of aircraft structure to gun shock loads A82-11314
- History of flight testing the L-1011 TriStar jet transport. II - Testing highlights since initial certification of the L-1011-1 A82-12049
- FAA acceptance tests on the NAVSTAR GPS Z-Set receiver A82-12639
- Ring Laser Gyro Navigator /RLGN/ flight test results A82-12644
- Flight test results of the model simulation controller for the HPB 320 for in-flight simulation of the A310 airbus
[ESA-TT-660] N82-10107
- FLIGHT TRAINING**
- Spin recovery training --- licensing requirement
[GPO-66-020] N82-10022
- FLOORS**
- Evaluation of the acoustic measurement capability of the NASA Langley V/STOL wind tunnel open test section with acoustically absorbent ceiling and floor treatments
[NASA-CR-165796] N82-10059
- FLOQUET THEOREM**
- On computing Floquet transition matrices of rotorcraft A82-11225
- Numerical treatment of helicopter rotor stability problems A82-12045
- FLOW DISTORTION**
- On evaluating the influence of local disruptions of flow over trailing edge and leading edge flaps from the data of wind tunnel tests of a rectangular wing segment A82-11465
- Amplified crossflow disturbances in the laminar boundary layer on swept wings with suction
[NASA-TP-1902] N82-11391
- FLOW DISTRIBUTION**
- On the prediction of swirling flowfields found in axisymmetric combustor geometries A82-12120
- Second order approximation theory of an arbitrary aerofoil in compressible potential flow N82-10982
- An aerodynamic design method for transonic axial flow compressor stage N82-10984
- A comparison of theoretical and experimental pressure distributions for two advanced fighter wings
[NASA-TM-81331] N82-11054
- FLOW EQUATIONS**
- Computation of high Reynolds number internal/external flows
[NASA-TM-84049] N82-11046
- FLOW GEOMETRY**
- Thermal and flow analysis of a convection, air-cooled ceramic coated porous metal concept for turbine vanes
[ASME PAPER 81-BT-48] A82-10952
- FLOW VISUALIZATION**
- Experimental study of subsonic and transonic flows past a wing A82-10363
- Effects of vortex flaps on the low-speed aerodynamic characteristics of an arrow wing
[NASA-TP-1914] N82-11013
- FLOWMETERS**
- Advanced fuel flowmeter for future naval aircraft
[AD-A104364] N82-11063
- FLUID DYNAMICS**
- V/STOL aircraft and fluid dynamics
[NASA-TM-81328] N82-10029
- FLUID POWER**
- Fluid power technology for the '80s --- Book A82-10851
- FLUIDIC CIRCUITS**
- Considerations and applications for the use of fluidics in aerospace controls A82-12087
- FLUTTER**
- New estimation method for flutter or divergence boundary from random responses at subcritical speeds
[NAL-TR-667T] N82-11034
- FLUTTER ANALYSIS**
- Experimental study of empennage snap-through vibrations A82-11471
- An influence coefficient method for the application of the modal technique to wing flutter suppression of the DAST ARW-1 wing
[NASA-CR-165772] N82-11070
- FLY BY WIRE CONTROL**
- Flight test results of the model simulation controller for the HPB 320 for in-flight simulation of the A310 airbus
[ESA-TT-660] N82-10107
- FLYING PLATFORMS**
- Parametric study of microwave-powered high-altitude airplane platforms designed for linear flight
[NASA-TP-1918] N82-11050
- FLYWHEELS**
- Low maintenance hydraulic accumulator
[AD-A103947] N82-10034
- FOREBODIES**
- Reductions in parachute drag due to forebody wake effects
[AIAA PAPER 81-1939] A82-10417
- FOREIGN BODIES**
- Coupled fluid/structure response predictions for soft body impact of airfoil configurations --- ice and bird impact on aircraft engines A82-12039
- FOSSIL FUELS**
- Baseline data on utilization of low-grade fuels in gas turbine applications. Volume 3: Emissions evaluation
[DE81-903764] N82-10254
- FOUNDATIONS**
- Design of airport pavements for expansive soils
[AD-A104660] N82-11313
- FRACTOGRAPHY**
- Fractographic determination of fatigue crack growth rates in aircraft components A82-12697
- FRACTURE STRENGTH**
- The application of improved aluminium alloys and steels in aircraft structures A82-10305
- FRAMES**
- Thermal expansion accommodation in a jet engine frame A82-11999
- FREE FLOW**
- Multiple-scale turbulence modeling of free turbulent flows
[ASME PAPER 81-FE-20] A82-10934
- FREON**
- Air-freon integrated environmental conditioning system for trainer subsonic aircraft
[ASME PAPER 81-ENAS-33] A82-10920
- FREQUENCY STABILITY**
- 60 KVA ADP permanent magnet VSCF starter generator system - Generator system performance characteristics A82-11721
- FRONTS (METEOROLOGY)**
- Gust front structure observed by Doppler radar A82-10223
- FUEL CONSUMPTION**
- Helicopter engine technology - With particular reference to the Rolls-Royce Gem engine A82-10304
- Characteristics and trends of energy consumption in transport missions with aircraft and surface vehicles A82-10495
- A hidden advantage of permanent magnet electrical generating systems A82-11720
- Fuel conservation - DC-9 series 20/30/40 A82-12563

FUEL CORROSION
 A protective additive for jet fuels
 A82-12022

FUEL GAGES
 Advanced fuel flowmeter for future naval aircraft
 [AD-A104364] N82-11063

FUEL PRODUCTION
 Fuel for future transport aircraft
 [ASME PAPER 81-HT-80] A82-10965

FUEL SPRAYS
 The dispersion of drop sizes in gas turbine fuel
 nozzle sprays
 A82-12107

FUEL TANKS
 Application of numerical methods to the
 calculation of electrostatic fields in aircraft
 fuel tanks
 [AD-A103270] N82-10033

FUSELAGES
 Experimental modal analysis of the fuselage panels
 of an Aero Commander aircraft
 [NASA-CR-165750] N82-10028
 Structural analysis of fuselages with cutouts by
 finite element method
 N82-10995

G

GAS COOLING
 A new method of cooling turbine vanes
 N82-11027

GAS FLOW
 Theoretical investigations and experimental
 researches for higher subsonic two-dimensional
 compressor cascade
 N82-11024

GAS TEMPERATURE
 Study of reingestion of exhaust gases with
 different initial temperature in a reversed
 turbojet engine
 A82-11444

GAS TURBINE ENGINES
 Design considerations for duty cycle, life and
 reliability of small limited life engines
 [AIAA PAPER 81-1402] A82-10465
 A new APU for medium place aircraft environmental
 control systems
 [ASME PAPER 81-ENAS-1] A82-10889
 End losses in turbine cascades with porous
 cooling
 A82-11434
 Basic problem of aircraft gasturbine engine
 analytic design. II
 A82-11463
 The CIVIC - A concept in vortex induced
 combustion. II
 [ASME PAPER 81-GT-12] A82-11997
 Thermal expansion accommodation in a jet engine
 frame
 A82-11999
 The dispersion of drop sizes in gas turbine fuel
 nozzle sprays
 A82-12107
 Application of numerical modeling to gas turbine
 combustor development problems
 A82-12118
 Validation studies of turbulence and combustion
 models for aircraft gas turbine combustors
 A82-12267
 Commercial EMS considerations for small gas
 turbine engines --- automated engine monitoring
 systems
 A82-12449
 Further application and development of an engine
 usage/life monitoring system for military services
 A82-12450
 Superclean superalloy powders by the rotating
 electrode process
 A82-12496
 Lineup of the IB-series aircraft-derivative gas
 turbines
 A82-12560
 Development of low modulus material for use in
 ceramic gas path seal applications
 [NASA-CR-165469] N82-10039
 Baseline data on utilization of low-grade fuels in
 gas turbine applications. Volume 3: Emissions
 evaluation
 [DE81-903764] N82-10254

A new method of cooling turbine vanes
 N82-11027

GAUSS EQUATION
 LQG-based multivariable design: Frequency domain
 interpretation
 N82-10053
 LQG multivariable design tools
 N82-10054

GENERAL AVIATION AIRCRAFT
 A new APU for medium place aircraft environmental
 control systems
 [ASME PAPER 81-ENAS-1] A82-10889
 Icing tunnel test of a glycol-exuding porous
 leading edge ice protection system on a general
 aviation airfoil --- conducted in the Lewis
 Research Center icing research tunnel
 [NASA-CR-165444] N82-10021
 General aviation aircraft antennas for the global
 positioning system
 [NASA-TM-83212] N82-11339

GEOMETRY
 A solution to the static geometry problem for
 JTIDS relative navigation
 A82-12634
 The statistical theory of radio direction finding
 [AD-A104156] N82-10027
 A geometric approach to multivariable control
 system synthesis
 N82-10056
 Aerodynamic calculations and design of subcritical
 aerofoils
 N82-10983

GLASS FIBER REINFORCED PLASTICS
 On the use of carbon composites in slat and
 stabilizer construction
 A82-11468

GLIDING
 Comparison of simulation and experimental data for
 a gliding parachute in dynamic flight
 [AIAA PAPER 81-1924] A82-10409

GLOBAL POSITIONING SYSTEM
 National Aerospace Meeting, Trevoise, PA, April
 8-10, 1981, Proceedings
 A82-12626
 Satellite geometry considerations for low cost GPS
 user equipment
 A82-12630
 FAA acceptance tests on the NAVSTAR GPS Z-Set
 receiver
 A82-12639
 A navigation systems planning model
 A82-12640
 Integrated satellite navigation and strapdown
 attitude and heading reference systems for civil
 air carriers
 A82-12643
 General aviation aircraft antennas for the global
 positioning system
 [NASA-TM-83212] N82-11339

GROUND BASED CONTROL
 HIMAT onboard flight computer system architecture
 and qualification
 [AIAA 81-2107] A82-10082

GROUND TESTS
 Electrical ground testing of aircraft antistatic
 protection
 A82-10822

GUATEMALA
 Radar mapping, archaeology, and ancient land use
 in the Maya lowlands
 [NASA-CR-164931] N82-11514

GUIDANCE SENSORS
 The integrated inertial sensor assembly /IISA/ - A
 redundant strapdown system for advanced aircraft
 navigation and flight control functions
 A82-12642

GUNFIRE
 Dynamic response of aircraft structure to gun
 shock loads
 A82-11314

GUST LOADS
 Crack growth evaluation of a method to convert
 real-time loads history to a simplified
 engineering spectra --- for aircraft structural
 analysis
 A82-12043
 Aeroacoustic theory for noncompact wing-gust
 interaction
 [PDEL-81-7] N82-11071

GUSTS

Gust front structure observed by Doppler radar
A82-10223

GYROCOMPASSES

Fast and accurate gyrocompass using strapdown
tuned rotor gyros as a solution to combat
helicopters navigation problems
A82-11927

GYROSCOPES

Problems relating to the classical rate-gyro
A82-10497
Design and development of a low cost servoed rate
gyro for unmanned aircraft
A82-11932

GYROSTABILIZERS

Synthesis of system for evaluating gyrostabilizer
state with unknown disturbances
A82-11469

H

HARDWARE

Controlling the software/hardware interface for
the validation of avionics systems --- in flight
control systems
[AIAA 81-2159]
A82-10116

HEAD-UP DISPLAYS

Study and development of an integrated head-up
display
[AD-A104337]
N82-11062

HEAT EXCHANGERS

The enhancement of heat exchange in channels /2nd
revised and enlarged edition/ --- Russian book
A82-12222
A new method of cooling turbine vanes
N82-11027

HEAT RESISTANT ALLOYS

Powder metallurgy superalloys - Aerospace
materials for the 1980's; Proceedings of the
Conference, Zurich, Switzerland, November 18-20,
1980. Volume 1
A82-12495
Superclean superalloy powders by the rotating
electrode process
A82-12496
Superalloy turbine components - Which is the
superior manufacturing process, as-HIP, HIP plus
Isoforge, or 'gatorizing' of extrusion
consolidated billet
A82-12497
Superalloy powder engine components; controls
employed to assure high quality hardware
A82-12499

HEAT TRANSFER

In-situ calibration of flight heat transfer
instrumentation
[ASME PAPER 81-ENAS-13]
A82-10901
Thermal and flow analysis of a convection,
air-cooled ceramic coated porous metal concept
for turbine vanes
[ASME PAPER 81-HT-48]
A82-10952
Results of experimental study of heat transfer to
turbine blades with porous cooling
A82-11446

HEAT TRANSMISSION

The enhancement of heat exchange in channels /2nd
revised and enlarged edition/ --- Russian book
A82-12222

HEATING EQUIPMENT

Ice protection system technology
N82-11060
Experimental study of fuel heating at low
temperatures in a wing tank model, volume 1
[NASA-CR-165391]
N82-11224

HELICOPTER CONTROL

Electronic master monitor and advisory display
system, data transmission study
[AD-A104243]
N82-11064
Electronic master monitor and advisory display
system, human engineering summary report
[AD-A104244]
N82-11065

HELICOPTER DESIGN

An investigation of a stoppable helicopter rotor
with circulation control --- anes 40 by 80 foot
wind tunnel
[NASA-TN-81218]
N82-10030

HELICOPTER ENGINES

Helicopter engine technology - With particular
reference to the Rolls-Royce Gen engine
A82-10304

HELICOPTER PERFORMANCE

Helicopter rotor trailing edge noise
[AIAA PAPER 81-2001]
A82-10455
Numerical treatment of helicopter rotor stability
problems
A82-12045
Helicopter icing spray system - Improvements and
flight experience
A82-12696

HELICOPTERS

Model helicopter rotor impulsive noise
A82-11300
A comprehensive bibliography of literature on
helicopter noise technology
[AD-A103331]
N82-10812
Rotorcraft icing: Status and prospects
[AGARD-AR-166]
N82-11056
Helicopter rotor trailing edge noise --- noise
prediction
[NASA-CR-3470]
N82-11859

HPB-320 AIRCRAFT

System identification of the longitudinal motion
of the DFVLR HPB 320 research aircraft with
particular consideration of control surface
effectiveness
[ESA-TT-666]
N82-10045
Flight test results of the model simulation
controller for the HPB 320 for in-flight
simulation of the A310 airbus
[ESA-TT-660]
N82-10107

HIGH ALTITUDE BALLOONS

A new thermal and trajectory model for high
altitude balloons
[AIAA PAPER 81-1926]
A82-10411

HIGH POLYMERS

Rheological behavior of progressively
shear-thickening solutions --- aircraft fuel
polymer additives for fire protection in
survivable crashes
A82-11177

HIGH STRENGTH STEELS

The application of improved aluminium alloys and
steels in aircraft structures
A82-10305

HIGH TEMPERATURE RESEARCH

Adaptation of a turbine test facility to
high-temperature research
[RAE-LIB-TRANS-2064]
N82-11089

HIGH VOLTAGES

High voltage surge and partial discharge test to
evaluate aerospace equipment parts
A82-11740

HONEYCOMB STRUCTURES

Light aircraft structural design in non-metallics
- Use of composite honeycomb for light aircraft
A82-10308

HORIZONTAL FLIGHT

Analysis of augmented aircraft flying qualities
through application of the Neal-Smith criterion
[AIAA PAPER 81-1776]
A82-10462
Parametric study of microwave-powered
high-altitude airplane platforms designed for
linear flight
[NASA-TP-1918]
N82-11050

HORIZONTAL TAIL SURFACES

A CFRP taileron for the Tornado: Construction and
production --- horizontal stabilizer
[NBB-PB-212/KFK/PUB/2]
N82-10035

HUBS

Development of the Triflex rotor head
A82-11222

HUMAN FACTORS ENGINEERING

Electronic master monitor and advisory display
system, human engineering summary report
[AD-A104244]
N82-11065

HUMAN PERFORMANCE

Relationships between naval aviation safety and
pilot flight experience
A82-11031

HUMAN REACTIONS

Effects of aircraft noise on the equilibrium of
airport residents: Testing and utilization of a
new methodology
[NASA-TN-76628]
N82-11636

HYDRAULIC CONTROL
High-efficiency hydraulic power transfer units for multisystem aircraft
A82-10853

HYDRAULIC EQUIPMENT
Fluid power technology for the '80s --- Book
A82-10851

Low maintenance hydraulic accumulator
[AD-A103947] N82-10034

Aircraft digital input controlled hydraulic actuation and control system
[AD-A104263] N82-11072

HYDROCARBON FUEL PRODUCTION
Jet fuel from carbon
A82-12021

Jet fuel locks to shale oil: The 1980 technology review
[AD-A104414] N82-11228

HYDROGEN FUELS
Fuel for future transport aircraft
[ASME PAPER 81-HT-80] A82-10965

HYDROGENATION
Jet fuel from carbon
A82-12021

ICE FORMATION
Helicopter icing spray system - Improvements and flight experience
A82-12696

Selected bibliography of NACA-NASA aircraft icing publications
[NASA-TM-81651] N82-11053

Rotorcraft icing: Status and prospects
[AGARD-AR-166] N82-11056

Operational environment, meteorological conditions and weather forecasting
N82-11057

Technology base for icing instrumentation and mathematical modelling
N82-11058

Facilities for development and clearance
N82-11059

Ice protection system technology
N82-11060

Proposed standard requirements and procedures for icing clearance
N82-11061

ICE PREVENTION
Icing tunnel test of a glycol-exuding porous leading edge ice protection system on a general aviation airfoil --- conducted in the Lewis Research Center icing research tunnel
[NASA-CR-165444] N82-10021

Icing tunnel tests of a composite porous leading edge for use with a liquid anti-ice system --- Lewis icing research tunnel
[NASA-CR-164966] N82-11052

Selected bibliography of NACA-NASA aircraft icing publications
[NASA-TM-81651] N82-11053

IMAGE ENHANCEMENT
Solution to the hidden-line problem
A82-12803

IMPACT ACCELERATION
Limiting payload deceleration during ground impact
[AIAA PAPER 81-1918] A82-10404

IMPACT DAMAGE
Impact-initiated damage thresholds in composites
A82-12028

IMPACT LOADS
Coupled fluid/structure response predictions for soft body impact of airfoil configurations --- ice and bird impact on aircraft engines
A82-12039

IMPACT RESISTANCE
Seven years experience with Kevlar-49 in the Lockheed L-1011 TriStar
A82-12647

IMPACT TESTS
Air bag impact attenuation system for the AQM-34V remote piloted vehicle
[AIAA PAPER 81-1917] A82-10403

IN-FLIGHT MONITORING
Performance analysis of enroute air traffic control computers in the National Airspace System
[AIAA 81-2203] A82-10140

Commercial EMS considerations for small gas turbine engines --- automated engine monitoring systems
A82-12449

Further application and development of an engine usage/life monitoring system for military services
A82-12450

Electronic master monitor and advisory display system, data transmission study
[AD-A104243] N82-11064

Electronic master monitor and advisory display system, human engineering summary report
[AD-A104244] N82-11065

INCOMPRESSIBLE FLOW
Theoretical analysis of parachute inflation including fluid kinetics
[AIAA PAPER 81-1925] A82-10410

Second order approximation theory of an arbitrary aerofoil in compressible potential flow
N82-10982

INCOMPRESSIBLE FLUIDS
Calculation of aerodynamic characteristics of jet flapped airplane
A82-11459

INDEXES (DOCUMENTATION)
NASA Authorization, 1982: Index
[GPO-84-713] N82-10959

INERTIAL NAVIGATION
Synthesis of system for evaluating gyrostabilizer state with unknown disturbances
A82-11469

Ring Laser Gyro Navigator /RLGN/ flight test results
A82-12644

INERTIAL REFERENCE SYSTEMS
Integrated satellite navigation and strapdown attitude and heading reference systems for civil air carriers
A82-12643

INFLATABLE STRUCTURES
Inflatable system for fast deployment of parachutes at low altitudes from slow moving aircraft or stationary supports
[AIAA PAPER 81-1953] A82-10428

INFLATING
Theoretical analysis of parachute inflation including fluid kinetics
[AIAA PAPER 81-1925] A82-10410

The constricted rigging line trials technique for assessing the opening characteristics of parachutes
[AIAA PAPER 81-1932] A82-10413

Stress measurements in a ribbon parachute canopy during inflation and at steady state
[AIAA PAPER 81-1944] A82-10420

INJECTORS
One reason for the onset of high-frequency self-excited oscillations --- in combustion chambers of aircraft engines
A82-11448

INLET FLOW
A theoretical analysis of the stream surface of revolution with supersonic inlet flow in a transonic axial compressor
N82-11025

A summary of V/STOL inlet analysis methods
[NASA-TM-82725] N82-11043

INLET PRESSURE
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006

A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion
N82-11007

INSPECTION
Mathematical model for the maintenance program of modern jet aircraft --- crack detection; inspection intervals
[DFVLR-PB-81-14] N82-10002

INSTRUMENT LANDING SYSTEMS
Discrete address beacon, navigation and landing system
A82-10650

INTAKE SYSTEMS
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006

INTEGRAL EQUATIONS

A study on numerical method for evaluating spanwise integral in subsonic lifting-surface theory
[NAL-TR-661T] N82-11035

INTELLIGENCE

Interoperability testing of decentralized command, control, communications and intelligence /C3I/ systems
[AIAA 81-2205] A82-10143

INTERPOLATION

Feedback and minimax sensitivity N82-10058

INVERSIONS

The net-skirt to a parachute canopy as a device to prevent inversion
[AIAA PAPER 81-1927] A82-10412

INVISCID FLOW

Theoretical analysis of parachute inflation including fluid kinetics
[AIAA PAPER 81-1925] A82-10410
The arbitrary quasi-orthogonal surface method for computing three-dimensional flow in turbine machinery. 2. Calculation of the three-dimensional flow with the S sub 1-surface twisted
N82-11015

J

JAGUAR AIRCRAFT

Digital avionics systems - The RAF experience A82-11941

JET AIRCRAFT

Calculation of aerodynamic characteristics of jet flapped airplane A82-11459
History of flight testing the L-1011 TriStar jet transport. II - Testing highlights since initial certification of the L-1011-1 A82-12049

JET AIRCRAFT NOISE

SEL and EPNL noise duration coefficients for the 747 and T-38 aircraft
[NASA-TM-83214] N82-11860

JET ENGINE FUELS

Fuel for future transport aircraft
[ASME PAPER 81-HT-80] A82-10965
Jet fuel from carbon A82-12021
A protective additive for jet fuels A82-12022

Experimental study of fuel heating at low temperatures in a wing tank model, volume 1
[NASA-CR-165391] N82-11224

Jet fuel locks to shale oil: The 1980 technology review
[AD-A104414] N82-11228

An assessment of the use of antimisting fuel in turbofan engines
[NASA-CR-165258] N82-11230

JET ENGINES

Thermal expansion accommodation in a jet engine frame A82-11999
Coupled fluid/structure response predictions for soft body impact of airfoil configurations --- ice and bird impact on aircraft engines A82-12039

JET FLAPS

Calculation of aerodynamic characteristics of jet flapped airplane A82-11459

JET IMPINGEMENT

Study of reingestion of exhaust gases with different initial temperature in a reversed turbojet engine A82-11444

JET VANES

Effects of vane/blade ratio and spacing on fan noise
[AIAA PAPER 81-2033] A82-10457

K

KERNEL FUNCTIONS

On the kernel function collocation method in steady subsonic flow for wing with control surfaces N82-12023

KEVLAR (TRADEMARK)

Kevlar composites; Proceedings of the Symposium, El Segundo, CA, December 2, 1980 A82-12646
Seven years experience with Kevlar-49 in the Lockheed L-1011 Tristar A82-12647

KINEMATICS

Analytical determination of undercarriage retraction kinematics A82-10364

KOREA

A proposed flight safety program for the Korean Air Force
[AD-A102373] N82-10023

L

L-1011 AIRCRAFT

History of flight testing the L-1011 TriStar jet transport. II - Testing highlights since initial certification of the L-1011-1 A82-12049
Seven years experience with Kevlar-49 in the Lockheed L-1011 Tristar A82-12647

LAMINAR BOUNDARY LAYER

Amplified crossflow disturbances in the laminar boundary layer on swept wings with suction
[NASA-TP-1902] N82-11391

LAMINAR FLOW

On low-speed wind tunnels with deformable boundaries A82-11462

LAMINATES

Impact-initiated damage thresholds in composites A82-12028

LAND USE

Radar mapping, archaeology, and ancient land use in the Maya lowlands
[NASA-CR-164931] N82-11514

LANDING AIDS

Comparative study of flare control laws
[NASA-CR-164903] N82-10032

LANDING GEAR

The possibility of using deformable rubber components in landing gear A82-10496

LASER GYROSCOPES

Ring Laser Gyro Navigator /RLGN/ flight test results A82-12644

LATERAL CONTROL

Procedures and analysis techniques for determining static air minimum control speeds A82-12564

LEAD ACID BATTERIES

Sealed lead-acid batteries for aircraft applications A82-11716

LEADING EDGE SLATS

On evaluating the influence of local disruptions of flow over trailing edge and leading edge flaps from the data of wind tunnel tests of a rectangular wing segment A82-11465
On the use of carbon composites in slat and stabilizer construction A82-11468

LEADING EDGES

Icing tunnel test of a glycol-exuding porous leading edge ice protection system on a general aviation airfoil --- conducted in the Lewis Research Center icing research tunnel
[NASA-CR-165444] N82-10021
Icing tunnel tests of a composite porous leading edge for use with a liquid anti-ice system --- Lewis icing research tunnel
[NASA-CR-164966] N82-11052

LICENSING

Spin recovery training --- licensing requirement
[GPO-66-020] N82-10022

LIFE CYCLE COSTS

Closed loop environmental control systems for fighter aircraft
[ASME PAPER 81-ENAS-2] A82-10890
Variable speed constant frequency /VSCF/ electrical system cuts cost of ownership A82-11719
A hidden advantage of permanent magnet electrical generating systems A82-11720

LIFE SUPPORT SYSTEMS

Air supply system bite for Boeing 767 airplane ---
Built-In-Test-Equipment
[ASME PAPER 81-ENAS-7] A82-10895

LIFT

A study on numerical method for evaluating
spanwise integral in subsonic lifting-surface
theory
[NAL-TR-661T] N82-11035

LIFT AUGMENTATION

An investigation of a stoppable helicopter rotor
with circulation control --- ames 40 by 80 foot
wind tunnel
[NASA-TM-81218] N82-10030

LIFT DRAG RATIO

A modular asymmetric parachute for wind tunnel
testing
[AIAA PAPER 81-1933] A82-10414
Increasing the lift:drag ratio of a flat delta wing
A82-11899

LIFTING BODIES

Development of new lifting parachute designs with
increased trim angle
[AIAA PAPER 81-1921] A82-10407

A modular asymmetric parachute for wind tunnel
testing
[AIAA PAPER 81-1933] A82-10414

LIGHT AIRCRAFT

Some possibilities for composite light aircraft
construction
A82-10307
Light aircraft structural design in non-metals
- Use of composite honeycomb for light aircraft
A82-10308
The possibility of using deformable rubber
components in landing gear
A82-10496

Experimental modal analysis of the fuselage panels
of an Aero Commander aircraft
[NASA-CR-165750] N82-10028

LIGHTNING

Lightning effects on aircraft and composites.
Literature study on lightning strikes and
protection --- advanced composite materials
[FOA-C-20388-F9] N82-10024

LINEAR EQUATIONS

LQG-based multivariable design: Frequency domain
interpretation
N82-10053
LQG multivariable design tools
N82-10054

LINEAR SYSTEMS

Limitations on achievable performance of
multivariable feedback systems
N82-10052
Design of high integrity multivariable control
systems
N82-10055
A geometric approach to multivariable control
system synthesis
N82-10056
Multivariable design: The optimization of
approximate inverses
N82-10057
Feedback and minimax sensitivity
N82-10058
Theory of stochastic optimal control some basic
notions
N82-11075

LIQUID HYDROGEN

Fuel for future transport aircraft
[ASME PAPER 81-HT-80] A82-10965

LOAD TESTS

Fatigue life of lugs under service loading - Test
results and predictions
A82-11685

LONGITUDINAL CONTROL

System identification of the longitudinal motion
of the DFVLR HF 320 research aircraft with
particular consideration of control surface
effectiveness
[ESA-TT-666] N82-10045

LONGITUDINAL STABILITY

Active control elements on the transonic wing of
the Airbus A-300 (ACTTA A). Airbus A-300 with
reduced longitudinal stability (ACTTA-C) ---
advanced control transonic transport aircraft
(ACTTA); design considerations
N82-10044

LOOPS

The need for multivariable design and analysis
techniques
N82-10049
Multivariable design techniques based on singular
value generalizations of classical control
N82-10051
Limitations on achievable performance of
multivariable feedback systems
N82-10052
LQG-based multivariable design: Frequency domain
interpretation
N82-10053
LQG multivariable design tools
N82-10054
Design of high integrity multivariable control
systems
N82-10055

LOW ALTITUDE

Inflatable system for fast deployment of
parachutes at low altitudes from slow moving
aircraft or stationary supports
[AIAA PAPER 81-1953] A82-10428

LOW SPEED STABILITY

Effects of vortex flaps on the low-speed
aerodynamic characteristics of an arrow wing
[NASA-TP-1914] N82-11013
Wind-tunnel results for a modified
17-percent-thick low-speed airfoil section
[NASA-TP-1919] N82-11033

LOW SPEED WIND TUNNELS

On low-speed wind tunnels with deformable boundaries
A82-11462
On evaluating the influence of local disruptions
of flow over trailing edge and leading edge
flaps from the data of wind tunnel tests of a
rectangular wing segment
A82-11465

LOW TEMPERATURE ENVIRONMENTS

Experimental study of fuel heating at low
temperatures in a wing tank model, volume 1
[NASA-CR-165391] N82-11224

LOGS

Fatigue life of lugs under service loading - Test
results and predictions
A82-11685

M**MAGNETS**

A hidden advantage of permanent magnet electrical
generating systems
A82-11720
60 KVA ADP permanent magnet VSCF starter generator
system - Generator system performance
characteristics
A82-11721

MAN MACHINE SYSTEMS

Improving the MLS through enhanced cockpit displays
A82-10649

MANUAL CONTROL

Improving the MLS through enhanced cockpit displays
A82-10649
Control law design for transport aircraft flight
tasks
N82-11080

MASS DISTRIBUTION

Experimental determination of parachute apparent
mass and its significance in predicting dynamic
stability
[AIAA PAPER 81-1920] A82-10406

MATCHING

Strong matching method for computing transonic
viscous flows including wakes and separations -
Lifting airfoils
A82-10821

MATERIALS TESTS

The possibility of using deformable rubber
components in landing gear
A82-10496

MATHEMATICAL MODELS

A mathematical model of an over-sea airborne UHF
radio link
A82-11406
Validation studies of turbulence and combustion
models for aircraft gas turbine combustors
A82-12267

- Mathematical model for the maintenance program of modern jet aircraft --- crack detection; inspection intervals
[DPVLR-FB-81-14] N82-10002
- A contribution to the stabilization of flight vehicle parachute systems --- mathematical models
[ESA-TT-679] N82-10046
- Technology base for icing instrumentation and mathematical modelling N82-11058
- Aeroacoustic theory for noncompact wing-gust interaction
[FDRL-81-7] N82-11071
- Integrated analysis of engine
[NASA-TM-82713] N82-11491
- Structural analysis computer programs for rigid multicomponent pavement structures with discontinuities, WESLIQID and WESLAYER. Report 1: Program development and numerical presentations
[AD-A104545] N82-11498
- MATRICES (MATHEMATICS)**
On computing Floquet transition matrices of rotorcraft N82-11225
- MATRIX METHODS**
The automatic matrix force method and techniques for handling more complex computations with given computer capacity N82-10994
- MAXWELL EQUATION**
Antenna theory and design --- Book N82-12323
- MEASURING INSTRUMENTS**
Technology base for icing instrumentation and mathematical modelling N82-11058
- MECHANICAL DEVICES**
A comprehensive bibliography of literature on helicopter noise technology
[AD-A103331] N82-10812
- MECHANICAL PROPERTIES**
Superalloy turbine components - Which is the superior manufacturing process, as-HIP, HIP plus Isoforge, or 'gatorizing' of extrusion consolidated billet N82-12497
- Superalloy powder engine components; controls employed to assure high quality hardware N82-12499
- METAL FATIGUE**
Fatigue substantiation of non-linear structures N82-11224
- A note on fatal aircraft accidents involving metal fatigue N82-11400
- METAL POWDER**
Superclean superalloy powders by the rotating electrode process N82-12496
- METALLIZING**
Electrical ground testing of aircraft antistatic protection N82-10822
- METEOROLOGICAL PARAMETERS**
Rotorcraft icing: Status and prospects
[AGARD-AR-166] N82-11056
- Operational environment, meteorological conditions and weather forecasting N82-11057
- METEOROLOGICAL RADAR**
Applications of conventional and Doppler radars for aviation safety N82-10215
- Description of the meteorological research radar system aboard NOAA/Research Facilities Center WP-3D aircraft N82-10217
- Airborne weather radar and severe weather penetration N82-10219
- An airport wind shear detection and warning system using Doppler radar N82-10220
- Instrumented aircraft verification of clear-air radar detection of low-level wind shear N82-10221
- The evolution of airborne weather avoidance radar toward a calibrated remote rain gauge using REACT --- Rain Echo Attenuation Compensation Hardware A82-10225
- METEOROLOGICAL RESEARCH AIRCRAFT**
Description of the meteorological research radar system aboard NOAA/Research Facilities Center WP-3D aircraft N82-10217
- MEXICO**
Radar mapping, archaeology, and ancient land use in the Maya lowlands
[NASA-CR-164931] N82-11514
- MICROMETEOROLOGY**
Downbursts and microbursts - An aviation hazard --- downdrafts beneath thunderstorms A82-10214
- MICROPROCESSORS**
A microprocessor-based data acquisition system for stall/spin research
[AIAA 81-2177] N82-10126
- Navigation task partitioning in distributed-processing avionics systems N82-10646
- MICROWAVE LANDING SYSTEMS**
Improving the MLS through enhanced cockpit displays N82-10649
- MICROWAVE TRANSMISSION**
Parametric study of microwave-powered high-altitude airplane platforms designed for linear flight
[NASA-TP-1918] N82-11050
- MILITARY AIRCRAFT**
Automated Paint and Process Line /APPL/ --- for aircraft production
[AIAA 81-2166] N82-10120
- Sophisticated aircraft structure developments - Combat aeroplanes N82-10309
- Sealed lead-acid batteries for aircraft applications N82-11716
- Advanced aircraft electric power system N82-11718
- The all digital military aircraft N82-11937
- ACMA - Fact or fantasy --- Advanced Civilian/Military Aircraft N82-12048
- Further application and development of an engine usage/life monitoring system for military services N82-12450
- MILITARY AVIATION**
Relationships between naval aviation safety and pilot flight experience N82-11031
- MILITARY HELICOPTERS**
Fast and accurate gyrocompass using strapdown tuned rotor gyros as a solution to combat helicopters navigation problems N82-11927
- MILITARY OPERATIONS**
The case for a defensive air-to-air fighter N82-12801
- MILITARY TECHNOLOGY**
Implementation of AVRADCOM MMET --- for military aircraft parts production engineering N82-10545
- The all digital military aircraft N82-11937
- Digital avionics systems - The RAF experience N82-11941
- Parachute technology under pressure N82-12804
- MINICOMPUTERS**
The use of the Weber method for minicomputer-assisted numerical analysis of airfoils N82-10362
- MINIMAX TECHNIQUE**
Feedback and minimax sensitivity N82-10058
- MISSILE BODIES**
Nonlinear prediction of subsonic aerodynamic loads on wings and bodies at high angles of attack N82-11359
- MISSILE DESIGN**
Design considerations for duty cycle, life and reliability of small limited life engines
[AIAA PAPER 81-1402] N82-10465

- Outsider's look at flight instrumentation
[DE81-025409] N82-11066
- MOLDS**
New molding method of three-dimensional hollow photoelastic model and centrifugal stress analysis of air cooled turbine blade model
[NAL-TR-427T] N82-11067
- MONOPLANES**
Analytical determination of undercarriage retraction kinematics
A82-10364
- MCCA AIRCRAFT**
A CFRP taileron for the Tornado: Construction and production --- horizontal stabilizer
[MBB-FE-212/KFK/PUB/2] N82-10035
- MULTIENGINE VEHICLES**
Procedures and analysis techniques for determining static air minimum control speeds
A82-12564
- MULTIPROCESSING (COMPUTERS)**
Airborne associative processor /ASPRO/ --- for early warning radar surveillance, command, and control applications
[AIAA 81-2145] A82-10104
Navigation task partitioning in distributed-processing avionics systems
A82-10646
- N**
- NACELLES**
Low speed testing of the inlets designed for a tandem-fan V/STOL nacelle --- conducted in the Lewis 10 by 10 foot wind tunnel
[NASA-TM-82728] N82-11042
- NASA PROGRAMS**
NASA Authorization, 1982: Index
[GPO-84-713] N82-10959
- NATIONAL AIRSPACE UTILIZATION SYSTEM**
Performance analysis of enroute air traffic control computers in the National Airspace System
[AIAA 81-2203] A82-10140
- NATIONAL AVIATION SYSTEM**
Airport and Airway Improvement Act of 1981, part 1
[GPO-76-241-PT-1] N82-10062
- NAVIER-STOKES EQUATION**
Computation of high Reynolds number internal/external flows
[NASA-TM-84049] N82-11046
- NAVIGATION**
Flight trajectory control investigation
[AD-A104542] N82-11048
An overview of optimal control in aerospace systems
N82-11074
- NAVIGATION AIDS**
Three navigation systems and their costs of acquiring remote sensing data
A82-10049
- NAVSTAR SATELLITES**
FAA acceptance tests on the NAVSTAR GPS Z-Set receiver
A82-12639
- NETS**
The net-skirt to a parachute canopy as a device to prevent inversion
[AIAA PAPER 81-1927] A82-10412
- NETWORK CONTROL**
A solution to the static geometry problem for JTIDS relative navigation
A82-12634
- NICKEL CADMIUM BATTERIES**
Unsolved problems of nickel cadmium batteries
A82-11725
- NOISE GENERATORS**
Rotor wake characteristics relevant to rotor-stator interaction noise generation
[AIAA PAPER 81-2031] A82-10456
A comprehensive bibliography of literature on helicopter noise technology
[AD-A103331] N82-10812
- NOISE MEASUREMENT**
Model helicopter rotor impulsive noise
A82-11300
SEL and EPNL noise duration coefficients for the 747 and T-38 aircraft
[NASA-TM-83214] N82-11860
- NOISE POLLUTION**
A comprehensive bibliography of literature on helicopter noise technology
[AD-A103331] N82-10812
Effects of aircraft noise on the equilibrium of airport residents: Testing and utilization of a new methodology
[NASA-TM-76628] N82-11636
- NOISE PREDICTION (AIRCRAFT)**
Helicopter rotor trailing edge noise
[AIAA PAPER 81-2001] A82-10455
Rotor wake characteristics relevant to rotor-stator interaction noise generation
[AIAA PAPER 81-2031] A82-10456
Effects of vane/blade ratio and spacing on fan noise
[AIAA PAPER 81-2033] A82-10457
Helicopter rotor trailing edge noise --- noise prediction
[NASA-CR-3470] N82-11859
- NOISE REDUCTION**
'Quiet please' --- aircraft hydraulic systems noise reduction
A82-10854
Design predictions for noise control in the cryogenic National Transonic Facility
A82-12025
Experimental modal analysis of the fuselage panels of an Aero Commander aircraft
[NASA-CR-165750] N82-10028
Comparative study of flare control laws
[NASA-CR-164903] N82-10032
A comprehensive bibliography of literature on helicopter noise technology
[AD-A103331] N82-10812
- NOISE SPECTRA**
SEL and EPNL noise duration coefficients for the 747 and T-38 aircraft
[NASA-TM-83214] N82-11860
- NONLINEAR SYSTEMS**
Fatigue substantiation of non-linear structures
A82-11224
A geometric approach to multivariable control system synthesis
N82-10056
Theory of stochastic optimal control some basic notions
N82-11075
Application of nonlinear systems inverses to automatic flight control design: System concepts and flight evaluations
N82-11083
- NOZZLE DESIGN**
Developments in boundary layer Thrust Vector Control
A82-10855
- NUMERICAL ANALYSIS**
The use of the Weber method for minicomputer-assisted numerical analysis of airfoils
A82-10362
Numerical treatment of helicopter rotor stability problems
A82-12045
Procedures and analysis techniques for determining static air minimum control speeds
A82-12564
The need for multivariable design and analysis techniques
N82-10049
- NUMERICAL FLOW VISUALIZATION**
A numerical three-dimensional turbulent simulation of a subsonic VSTOL jet in a cross-flow using a finite element algorithm
[AD-A104514] N82-11055
- NYQUIST DIAGRAM**
Characteristic and principal gains and phases and their use as multivariable control design tools --- generalizing Nyquist and root-locus diagram techniques
N82-10050
- O**
- OH-58 HELICOPTER**
Composite main rotor tubular braided
A82-10547
- OMEGA NAVIGATION SYSTEM**
Omega station 10.2 kHz signal selection made easy
A82-12638

ONBOARD DATA PROCESSING

Description of the meteorological research radar system aboard NOAA/Research Facilities Center WP-3D aircraft
A82-10217

Navigation task partitioning in distributed-processing avionics systems
A82-10646

OPENINGS
Structural analysis of fuselages with cutouts by finite element method
N82-10995

OPTICAL MEASURING INSTRUMENTS
Optical sensors for displacement measurement
A82-11407

OPTIMAL CONTROL
Design of high integrity multivariable control systems
N82-10055

Multivariables design: The optimization of approximate inverses
N82-10057

Flight trajectory control investigation [AD-A104542]
N82-11048

Theory and applications of optimal control in aerospace systems [AGARD-AG-251]
N82-11073

An overview of optimal control in aerospace systems
N82-11074

Theory of stochastic optimal control some basic notions
N82-11075

An introduction to stochastic optimal control theory
N82-11076

Design considerations for optimal flight control systems
N82-11077

Design techniques for multivariable flight control systems
N82-11078

Control law design for transport aircraft flight tasks
N82-11080

Control design of flexible spacecraft
N82-11081

Optimum climb and descent trajectories for airline missions
N82-11082

Management of redundancy in flight control systems using optimal decision theory
N82-11084

OPTIMIZATION
Optimization of the principal design parameters of a passenger aircraft
A82-10816

ORGANIC LIQUIDS
Rheological behavior of progressively shear-thickening solutions --- aircraft fuel polymer additives for fire protection in survivable crashes
A82-11177

ORTHOGONALITY
The arbitrary quasi-orthogonal surface method for computing three-dimensional flow in turbine machinery. 2. Calculation of the three-dimensional flow with the S sub 1-surface twisted
N82-11015

P

PAINTS
Automated Paint and Process Line /APPL/ --- for aircraft production [AIAA 81-2166]
A82-10120

PANELS
Response of nonlinear aircraft structural panels to high intensity noise
A82-12041

PARACHUTE DESCENT
Aerodynamics and performance of cruciform parachute canopies [AIAA PAPER 81-1919]
A82-10405

Experimental determination of parachute apparent mass and its significance in predicting dynamic stability [AIAA PAPER 81-1920]
A82-10406

Comparison of simulation and experimental data for a gliding parachute in dynamic flight [AIAA PAPER 81-1924]
A82-10409

Theoretical analysis of parachute inflation including fluid kinetics [AIAA PAPER 81-1925]
A82-10410

The constricted rigging line trials technique for assessing the opening characteristics of parachutes [AIAA PAPER 81-1932]
A82-10413

Reductions in parachute drag due to forebody wake effects [AIAA PAPER 81-1939]
A82-10417

Aeroballistic characteristics of sonobuoy parachute decelerators limited to a length of three feet [AIAA PAPER 81-1950]
A82-10425

Inflatable system for fast deployment of parachutes at low altitudes from slow moving aircraft or stationary supports [AIAA PAPER 81-1953]
A82-10428

A contribution to the stabilization of flight vehicle parachute systems --- mathematical models [ESA-TT-679]
N82-10046

PARACHUTE FABRICS
Stress measurements in bias constructed parachute canopies during inflation and at steady-state [AIAA PAPER 81-1945]
A82-10421

Development of a nylon-Kevlar recovery system for the CL-289 /AN/USD 502/ surveillance drone [AIAA PAPER 81-1952]
A82-10427

PARACHUTES
Experimental determination of parachute apparent mass and its significance in predicting dynamic stability [AIAA PAPER 81-1920]
A82-10406

Development of new lifting parachute designs with increased trim angle [AIAA PAPER 81-1921]
A82-10407

The net-skirt to a parachute canopy as a device to prevent inversion [AIAA PAPER 81-1927]
A82-10412

A modular asymmetric parachute for wind tunnel testing [AIAA PAPER 81-1933]
A82-10414

Parachute technology under pressure
A82-12804

PARAMETER IDENTIFICATION
Parametric study of microwave-powered high-altitude airplane platforms designed for linear flight [NASA-TP-1918]
N82-11050

PARAMETERIZATION
Estimation of airplane stability and control derivatives from large amplitude longitudinal maneuvers [NASA-TN-83185]
N82-10042

PARTICLE SIZE DISTRIBUTION
Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity
A82-12149

PASSENGER AIRCRAFT
How large should a commuter transport be [AIAA PAPER 81-1732]
A82-10463

Optimization of the principal design parameters of a passenger aircraft
A82-10816

Lightweight diesel engine designs for commuter type aircraft [NASA-CR-165470]
N82-11068

PAVEMENTS
Design of airport pavements for expansive soils [AD-A104660]
N82-11313

Structural analysis computer programs for rigid multicomponent pavement structures with discontinuities, WESLIQID and WESLAYER. Report 1: Program development and numerical presentations [AD-A104545]
N82-11498

PAYLOADS
Limiting payload deceleration during ground impact [AIAA PAPER 81-1918]
A82-10404

PERFORMANCE PREDICTION
Ideal and simulated performance of an aircraft in the terrain following mission
A82-11302

- On the prediction of swirling flowfields found in axisymmetric combustor geometries A82-12120
- Parametric study of microwave-powered high-altitude airplane platforms designed for linear flight [NASA-TP-1918] N82-11050
- PERFORMANCE TESTS**
- Interoperability testing of decentralized command, control, communications and intelligence /C3I/ systems [AIAA 81-2205] A82-10143
- Air bag impact attenuation system for the AQM-34V remote piloted vehicle [AIAA PAPER 81-1917] A82-10403
- Aerodynamics and performance of cruciform parachute canopies [AIAA PAPER 81-1919] A82-10405
- The constricted rigging line trials technique for assessing the opening characteristics of parachutes [AIAA PAPER 81-1932] A82-10413
- High-efficiency hydraulic power transfer units for multisystem aircraft A82-10853
- The certification of digital systems A82-11940
- FAA acceptance tests on the NAVSTAR GPS Z-Set receiver A82-12639
- PERTURBATION THEORY**
- Synthesis of system for evaluating gyrostabilizer state with unknown disturbances A82-11469
- PHOTOELASTICITY**
- New molding method of three-dimensional hollow photoelastic model and centrifugal stress analysis of air cooled turbine blade model [NAL-TR-427T] N82-11067
- PILOT TRAINING**
- Spin recovery training --- licensing requirement [GPO-66-020] N82-10022
- PILOTS (PERSONNEL)**
- Development and construction of pilot ejector seats in Germany from 1938-1945 [DFVLR-PB-81-04] N82-10026
- PISTON ENGINES**
- The CIVIC - A concept in vortex induced combustion. II [ASME PAPER 81-GT-12] A82-11997
- PLANETARY BOUNDARY LAYER**
- Multiple Doppler radar observations of PBL structure A82-10292
- PLANNING**
- A navigation systems planning model A82-12640
- PLASMA SPRAYING**
- Thermal-barrier-coated turbine blade study [NASA-CR-165351] N82-10040
- PLASTIC AIRCRAFT STRUCTURES**
- On the use of carbon composites in slat and stabilizer construction A82-11468
- Seven years experience with Kevlar-49 in the Lockheed L-1011 Tristar A82-12647
- PLOTTING**
- Multivariable design techniques based on singular value generalizations of classical control N82-10051
- PNEUMATIC EQUIPMENT**
- A new APU for medium place aircraft environmental control systems [ASME PAPER 81-ENAS-1] A82-10889
- Towards minimum power for environmental control in transport aircraft [ASME PAPER 81-ENAS-4] A82-10892
- Air supply system bite for Boeing 767 airplane --- Built-In-Test-Equipment [ASME PAPER 81-ENAS-7] A82-10895
- POLLUTION CONTROL**
- Baseline data on utilization of low-grade fuels in gas turbine applications. Volume 3: Emissions evaluation [DE81-903764] N82-10254
- POLYETHER RESINS**
- Polyurethane foams for aircraft shock mounts. 3: Vibration damping by polyether foams [AD-A104496] N82-11212
- POLYURETHANE FOAM**
- Polyurethane foams for aircraft shock mounts. 3: Vibration damping by polyether foams [AD-A104496] N82-11212
- POROUS MATERIALS**
- Development of low modulus material for use in ceramic gas path seal applications [NASA-CR-165469] N82-10039
- Icing tunnel tests of a composite porous leading edge for use with a liquid anti-ice system --- Lewis icing research tunnel [NASA-CR-164966] N82-11052
- POROUS WALLS**
- Thermal and flow analysis of a convection, air-cooled ceramic coated porous metal concept for turbine vanes [ASME PAPER 81-HT-48] A82-10952
- End losses in turbine cascades with porous cooling A82-11434
- Results of experimental study of heat transfer to turbine blades with porous cooling A82-11446
- POSITION (LOCATION)**
- A solution to the static geometry problem for JTIDS relative navigation A82-12634
- The statistical theory of radio direction finding [AD-A104156] N82-10027
- POTENTIAL FLOW**
- Finite difference computation of the steady transonic potential flow around airplanes N82-10981
- Second order approximation theory of an arbitrary aerofoil in compressible potential flow N82-10982
- Aerodynamic calculations and design of subcritical aerofoils N82-10983
- POWDER METALLURGY**
- Powder metallurgy superalloys - Aerospace materials for the 1980's; Proceedings of the Conference, Zurich, Switzerland, November 18-20, 1980. Volume 1 A82-12495
- Superclean superalloy powders by the rotating electrode process A82-12496
- Superalloy turbine components - Which is the superior manufacturing process, as-HIP, HIP plus Isoforge, or 'gatorizing' of extrusion consolidated billet. A82-12497
- Superalloy powder engine components; controls employed to assure high quality hardware A82-12499
- POWER EFFICIENCY**
- Helicopter engine technology - With particular reference to the Rolls-Royce Gem engine A82-10304
- 60 KVA ADP permanent magnet VSCF starter generator system - Generator system performance characteristics A82-11721
- PRECIPITATION (METEOROLOGY)**
- The evolution of airborne weather avoidance radar toward a calibrated remote rain gauge using REACT --- Rain Echo Attenuation Compensation Hardware A82-10225
- PREDICTION ANALYSIS TECHNIQUES**
- A new thermal and trajectory model for high altitude balloons [AIAA PAPER 81-1926] A82-10411
- PRESSURE DISTRIBUTION**
- The use of the Weber method for microcomputer-assisted numerical analysis of airfoils A82-10362
- Aerodynamic calculations and design of subcritical aerofoils N82-10983
- Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure N82-11006
- A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion N82-11007

A comparison of theoretical and experimental pressure distributions for two advanced fighter wings
[NASA-TM-81331] N82-11054

PRESSURE OSCILLATIONS
One reason for the onset of high-frequency self-excited oscillations --- in combustion chambers of aircraft engines
A82-11448

PRESSURE REDUCTION
Thermal and flow analysis of a convection, air-cooled ceramic coated porous metal concept for turbine vanes
[ASME PAPER 81-HT-48] A82-10952

PRESSURIZED CABINS
Air supply system bite for Boeing 767 airplane --- Built-In-Test-Equipment
[ASME PAPER 81-ENAS-7] A82-10895

PROBABILITY THEORY
Extending the limits of reliability theory --- Book
A82-12318

PROCEDURES
Proposed standard requirements and procedures for icing clearance
A82-11061

PRODUCT DEVELOPMENT
Study and development of an integrated head-up display
[AD-A104337] N82-11062

Integrated analysis of engine
[NASA-TM-82713] N82-11491

PRODUCTION ENGINEERING
Automated Paint and Process Line /APPL/ --- for aircraft production
[AIAA 81-2166] A82-10120

Development of aircraft production engineering discipline at IIT, Bombay
A82-11317

A CFRP taileron for the Tornado: Construction and production --- horizontal stabilizer
[MBB-FE-212/KPK/PUB/2] N82-10035

PROGRAM VERIFICATION (COMPUTERS)
The Space Shuttle vehicle checkout involving flight avionics software
[AIAA 81-2141] A82-10100

PROJECT MANAGEMENT
Implementation of AVRADCOM MM&T --- for military aircraft parts production engineering
A82-10545

PROPELLER FANS
Propfan installation aerodynamics of a supercritical swept wing transport configuration
[AIAA PAPER 81-1563] A82-10466

PROPULSIVE EFFICIENCY
Quiet short-haul research aircraft familiarization document, revision 1
[NASA-TM-81298] N82-10031

Propulsion study for Small Transport Aircraft Technology (STAT), Appendix B
[NASA-CR-165499-APP-B] N82-10038

PROTECTIVE COATINGS
Thermal-barrier-coated turbine blade study
[NASA-CR-165351] N82-10040

PROTUBERANCES
Aircraft excrescence drag
[AGARD-AG-264] N82-10020

PUMPS
High-efficiency hydraulic power transfer units for multisystem aircraft
A82-10853

Q

QUADRATIC EQUATIONS
LQG-based multivariable design: Frequency domain interpretation
N82-10053

LQG multivariable design tools
N82-10054

QUIET ENGINE PROGRAM
Quiet short-haul research aircraft familiarization document, revision 1
[NASA-TM-81298] N82-10031

R

RADAR ATTENUATION
The evolution of airborne weather avoidance radar toward a calibrated remote rain gauge using REACT --- Rain Echo Attenuation Compensation Hardware
A82-10225

RADAR DATA
Description of the meteorological research radar system aboard NOAA/Research Facilities Center WP-3D aircraft
A82-10217

RADAR DETECTION
Instrumented aircraft verification of clear-air radar detection of low-level wind shear
A82-10221

RADAR MAPS
Radar mapping, archaeology, and ancient land use in the Maya lowlands
[NASA-CR-164931] N82-11514

RADAR MEASUREMENT
Multiple Doppler radar observations of PBL structure
A82-10292

RADAR TARGETS
Synthetic aperture radar target simulator
[NASA-CASE-NPO-15024-1] N82-10286

RADAR TRACKING
Hard limited approaches to correlation velocity sensing
A82-12636

RADIANT FLUX DENSITY
Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity
A82-12149

RADIO DIRECTION FINDERS
The statistical theory of radio direction finding
[AD-A104156] N82-10027

RADIO NAVIGATION
Omega station 10.2 kHz signal selection made easy
A82-12638

FAA acceptance tests on the NAVSTAR GPS Z-Set receiver
A82-12639

RADIO RECEIVERS
Tangential sensitivity of EW receivers
A82-11020

FAA acceptance tests on the NAVSTAR GPS Z-Set receiver
A82-12639

RADIO RELAY SYSTEMS
A mathematical model of an over-sea airborne UHF radio link
A82-11406

RADIO TRACKING
The statistical theory of radio direction finding
[AD-A104156] N82-10027

RAIN
Airborne weather radar and severe weather penetration
A82-10219

RAIN GAGES
The evolution of airborne weather avoidance radar toward a calibrated remote rain gauge using REACT --- Rain Echo Attenuation Compensation Hardware
A82-10225

RAMJET ENGINES
Air-film cooling returns to ramjets
[ASME PAPER 81-ENAS-8] A82-10896

An investigation of the combustion process in solid fuel ramjets
[AD-A104603] N82-11232

REAL TIME OPERATION
Real-time, on-line digital simulation of optimum maneuvers of supersonic aircraft
[AIAA 81-2178] A82-10127

RECIRCULATIVE FLUID FLOW
On the prediction of swirling flowfields found in axisymmetric combustor geometries
A82-12120

RECOVERY PARACHUTES
Development of a nylon-Kevlar recovery system for the CL-289 /AN/USD 502/ surveillance drone
[AIAA PAPER 81-1952] A82-10427

- RECTANGULAR PLATES**
Response of nonlinear aircraft structural panels to high intensity noise
A82-12041
- RECTANGULAR WINGS**
On evaluating the influence of local disruptions of flow over trailing edge and leading edge flaps from the data of wind tunnel tests of a rectangular wing segment
A82-11465
Experimental investigations of the separated flow around a rectangular wing --- in a wind tunnel [DFVLR-FB-81-12]
N82-10017
- REDUNDANCY**
Management of redundancy in flight control systems using optimal decision theory
N82-11084
- REGISTERS**
Air-breathing engine test facilities register. [AGARD-AG-269]
N82-10063
- REGRESSION ANALYSIS**
Determination of airplane model structure from flight data by using modified stepwise regression [NASA-TP-1916]
N82-10041
Estimation of airplane stability and control derivatives from large amplitude longitudinal maneuvers [NASA-TM-83185]
N82-10042
- RELIABILITY ANALYSIS**
Extending the limits of reliability theory --- Book
A82-12318
- REMOTE SENSING**
Three navigation systems and their costs of acquiring remote sensing data
A82-10049
- REMOTELY PILOTED VEHICLES**
HiMAT onboard flight computer system architecture and qualification [AIAA 81-2107]
A82-10082
Air bag impact attenuation system for the AQ8-34V remote piloted vehicle [AIAA PAPER 81-1917]
A82-10403
Design and development of a low cost servoed rate gyro for unmanned aircraft
A82-11932
Parametric study of microwave-powered high-altitude airplane platforms designed for linear flight [NASA-TP-1918]
N82-11050
- RENE 95**
Superalloy powder engine components; controls employed to assure high quality hardware
A82-12499
- RESCUE OPERATIONS**
SARSAT applications
A82-12698
- RESEARCH AND DEVELOPMENT**
Development and construction of pilot ejector seats in Germany from 1938-1945 [DFVLR-FB-81-04]
N82-10026
- RESEARCH FACILITIES**
Description of the meteorological research radar system aboard NOAA/Research Facilities Center WP-3D aircraft
A82-10217
- RESIDENTIAL AREAS**
Effects of aircraft noise on the equilibrium of airport residents: Testing and utilization of a new methodology [NASA-TM-76628]
N82-11636
- RESOLUTION**
Study and development of an integrated head-up display [AD-A104337]
N82-11062
- RESONANT FREQUENCIES**
Calculation of natural modes of vibration for rotor blades by the finite element method [DFVLR-FB-81-07]
N82-10452
- RETRACTABLE EQUIPMENT**
Analytical determination of undercarriage retraction kinematics
A82-10364
- REYNOLDS NUMBER**
Computation of high Reynolds number internal/external flows [NASA-TM-84049]
N82-11046
- RHEOLOGY**
Rheological behavior of progressively shear-thickening solutions --- aircraft fuel polymer additives for fire protection in survivable crashes
A82-11177
- RIBBON PARACHUTES**
The effects of flexibility on the steady-state performance of small ribbon parachute models [AIAA PAPER 81-1923]
A82-10408
Stress measurements in a ribbon parachute canopy during inflation and at steady state [AIAA PAPER 81-1944]
A82-10420
- RIGID ROTORS**
Development of the Triflex rotor head
A82-11222
- RING LASERS**
Ring Laser Gyro Navigator /BLGN/ flight test results
A82-12644
- ROBUSTNESS (MATHEMATICS)**
Limitations on achievable performance of multivariable feedback systems
N82-10052
- ROCKET ENGINES**
The enhancement of heat exchange in channels /2nd revised and enlarged edition/ --- Russian book
A82-12222
- ROCKET NOZZLES**
Developments in boundary layer Thrust Vector Control
A82-10855
- ROCKET-BORNE INSTRUMENTS**
Limiting payload deceleration during ground impact [AIAA PAPER 81-1918]
A82-10404
- ROTARY GYROSCOPES**
Fast and accurate gyrocompass using strapdown tuned rotor gyros as a solution to combat helicopters navigation problems
A82-11927
Design considerations for the direct digital control of dry-tuned gyroscope
A82-11933
- ROTARY WING AIRCRAFT**
On computing Floquet transition matrices of rotorcraft
A82-11225
- ROTARY WINGS**
Helicopter rotor trailing edge noise [AIAA PAPER 81-2001]
A82-10455
Composite main rotor tubular braided
A82-10547
Model helicopter rotor impulsive noise
A82-11300
Numerical treatment of helicopter rotor stability problems
A82-12045
Standard tests of a research model rotor in a wind tunnel, including model similarity --- calculations compared with measurements [BNVG-FBWT-79-16]
N82-10016
Rotorcraft icing: Status and prospects [AGARD-AR-166]
N82-11056
Operational environment, meteorological conditions and weather forecasting
N82-11057
Technology base for icing instrumentation and mathematical modelling
N82-11058
Facilities for development and clearance
N82-11059
Ice protection system technology
N82-11060
Proposed standard requirements and procedures for icing clearance
N82-11061
Aeroacoustic theory for noncompact wing-gust interaction [FDRL-81-7]
N82-11071
Helicopter rotor trailing edge noise --- noise prediction [NASA-CR-3470]
N82-11859
- ROTATING BODIES**
The Shock and Vibration Digest, volume 13, no. 9 [AD-A105062]
N82-10421
- ROTATING FLUIDS**
A theoretical analysis of the stream surface of revolution with supersonic inlet flow in a transonic axial compressor
N82-11025

ROTOR AERODYNAMICS

Rotor wake characteristics relevant to rotor-stator interaction noise generation [AIAA PAPER 81-2031] A82-10456
 Wind tunnel tests on airfoils in tandem cascade A82-10987
 Numerical treatment of helicopter rotor stability problems A82-12045

ROTOR BLADES (TURBOMACHINERY)
 Effects of vane/blade ratio and spacing on fan noise [AIAA PAPER 81-2033] A82-10457

ROTOR SPEED
 60 KVA ADP permanent magnet VSCF starter generator system - Generator system performance characteristics A82-11721

RUBBER
 The possibility of using deformable rubber components in landing gear A82-10496

RUNWAYS
 Design of airport pavements for expansive soils [AD-A104660] N82-11313

S

SAFETY MANAGEMENT

A proposed flight safety program for the Korean Air Force [AD-A102373] N82-10023
 System safety program plan --- electromagnetic pulse testing of the A-7E aircraft [AD-A104557] N82-11354

SANDWICH STRUCTURES

Impact-initiated damage thresholds in composites A82-12028

SARSAT

SARSAT applications A82-12698

SATELLITE NAVIGATION SYSTEMS

National Aerospace Meeting, Trevese, PA, April 8-10, 1981, Proceedings A82-12626
 Satellite geometry considerations for low cost GPS user equipment A82-12630
 A navigation systems planning model A82-12640
 Integrated satellite navigation and strapdown attitude and heading reference systems for civil air carriers A82-12643

SATELLITE NETWORKS

Satellite geometry considerations for low cost GPS user equipment A82-12630

SCALE MODELS

Standard tests of a research model rotor in a wind tunnel, including model similarity --- calculations compared with measurements [BMVG-PBWT-79-16] N82-10016

SEALS (STOPPEES)

Development of low modulus material for use in ceramic gas path seal applications [NASA-CR-165469] N82-10039

SEARCH RADAR

Threat Alert and Collision Avoidance System (TCAS) Symposium [AD-A104563] N82-11047

SELF OSCILLATION

One reason for the onset of high-frequency self-excited oscillations --- in combustion chambers of aircraft engines A82-11448

SENSITIVITY

Feedback and minimax sensitivity N82-10058

SEPARATED FLOW

Strong matching method for computing transonic viscous flows including wakes and separations - Lifting airfoils A82-10821
 Nonlinear prediction of subsonic aerodynamic loads on wings and bodies at high angles of attack A82-11359
 Experimental investigations of the separated flow around a rectangular wing --- in a wind tunnel [DPVLR-PB-81-12] N82-10017

SEPARATORS

New separators for battery systems A82-11715

SERVICE LIFE

Design considerations for duty cycle, life and reliability of small limited life engines [AIAA PAPER 81-1402] A82-10465
 Unsolved problems of nickel cadmium batteries A82-11725

SERVOCONTROL

A method for determination of the aeroelastic behavior of aircraft with active control systems [DPVLR-PB-81-05] N82-10047

SHALE OIL

Jet fuel locks to shale oil: The 1980 technology review [AD-A104414] N82-11228

SHEAR STRESS

Crack growth evaluation of a method to convert real-time loads history to a simplified engineering spectra --- for aircraft structural analysis A82-12043

SHIP TERMINALS

A mathematical model of an over-sea airborne UHF radio link A82-11406

SHOCK ABSORBERS

Polyurethane foams for aircraft shock mounts. 3: Vibration damping by polyether foams [AD-A104496] N82-11212

SHOCK LOADS

Dynamic response of aircraft structure to gun shock loads A82-11314
 The Shock and Vibration Digest, volume 13, no. 9 [AD-A105062] N82-10421

SHOCK WAVE PROPAGATION

Acta mechanica sinica [AD-A105184] N82-11014

SHORT HAUL AIRCRAFT

Quiet short-haul research aircraft familiarization document, revision 1 [NASA-TM-81298] N82-10031
 Propulsion study for Small Transport Aircraft Technology (STAT) [NASA-CR-165499] N82-10037

SHORT TAKEOFF AIRCRAFT

Quiet short-haul research aircraft familiarization document, revision 1 [NASA-TM-81298] N82-10031
 Development and evaluation of automatic landing control laws for light wing loading STOL aircraft [NASA-CR-166160] N82-10043

SIGNAL PROCESSING

Omega station 10.2 kHz signal selection made easy A82-12638

SIGNAL TO NOISE RATIOS

Tangential sensitivity of EW receivers A82-11020

SIMILARITY THEOREM

Standard tests of a research model rotor in a wind tunnel, including model similarity --- calculations compared with measurements [BMVG-PBWT-79-16] N82-10016

SIZE DISTRIBUTION

The dispersion of drop sizes in gas turbine fuel nozzle sprays A82-12107

SKIRTS

The net-skirt to a parachute canopy as a device to prevent inversion [AIAA PAPER 81-1927] A82-10412

SLABS

Structural analysis computer programs for rigid multicomponent pavement structures with discontinuities, WESLIQID and WESLAYER. Report 1: Program development and numerical presentations [AD-A104545] N82-11498

SNAP

Experimental study of empennage snap-through vibrations A82-11471

SOIL MECHANICS

Design of airport pavements for expansive soils [AD-A104660] N82-11313

SOILS

Design of airport pavements for expansive soils [AD-A104660] N82-11313

- SOLAR POWERED AIRCRAFT**
Wings in the sun - The evolution of Solar Challenger
A82-12694
- SOLID ELECTRODES**
Unsolved problems of nickel cadmium batteries
A82-11725
- SOLID PROPELLANT COMBUSTION**
An investigation of the combustion process in
solid fuel ramjets
[AD-A104603] N82-11232
- SOLID PROPELLANTS**
An investigation of the combustion process in
solid fuel ramjets
[AD-A104603] N82-11232
- SONOBOUOYS**
Aeroballistic characteristics of sonobuoy
parachute decelerators limited to a length of
three feet
[AIAA PAPER 81-1950] A82-10425
- SOUND PRESSURE**
Evaluation of the acoustic measurement capability
of the NASA Langley V/STOL wind tunnel open test
section with acoustically absorbent ceiling and
floor treatments
[NASA-CR-165796] N82-10059
- SOUND TRANSMISSION**
Experimental modal analysis of the fuselage panels
of an Aero Commander aircraft
[NASA-CR-165750] N82-10028
- SPACE NAVIGATION**
National Aerospace Meeting, Trevese, PA, April
8-10, 1981, Proceedings
A82-12626
Memory requirements for future navigation systems
A82-12637
- SPACE SHUTTLES**
The Space Shuttle vehicle checkout involving
flight avionics software
[AIAA 81-2141] A82-10100
Use of Space Shuttle technology in conventional
aircraft
[AIAA 81-2176] A82-10125
- SPACE VEHICLE CHECKOUT PROGRAM**
The Space Shuttle vehicle checkout involving
flight avionics software
[AIAA 81-2141] A82-10100
- SPACECRAFT CONSTRUCTION MATERIALS**
Powder metallurgy superalloys - Aerospace
materials for the 1980's; Proceedings of the
Conference, Zurich, Switzerland, November 18-20,
1980. Volume 1
A82-12495
- SPACECRAFT CONTROL**
Synthesis of system for evaluating gyrostabilizer
state with unknown disturbances
A82-11469
- SPACECRAFT DESIGN**
Control design of flexible spacecraft
N82-11081
- SPACECRAFT ELECTRONIC EQUIPMENT**
Bridging the gap from aircraft to space computers
[AIAA 81-2142] A82-10101
- SPANWISE BLOWING**
A study on numerical method for evaluating
spanwise integral in subsonic lifting-surface
theory
[NAL-TR-661T] N82-11035
- SPEED CONTROL**
Procedures and analysis techniques for determining
static air minimum control speeds
A82-12564
- SPIN DYNAMICS**
A microprocessor-based data acquisition system for
stall/spin research
[AIAA 81-2177] A82-10126
- SPOILERS**
Theoretical investigation of the influence of
spoiler dynamics on the handling qualities of an
aircraft with direct lift control
[ESA-TT-681] N82-10036
Development and evaluation of automatic landing
control laws for light wing loading STOL aircraft
[NASA-CR-166160] N82-10043
System identification of the longitudinal motion
of the DFVLR HPB 320 research aircraft with
particular consideration of control surface
effectiveness
[ESA-TT-666] N82-10045
- SPRAY NOZZLES**
The dispersion of drop sizes in gas turbine fuel
nozzle sprays
A82-12107
Helicopter icing spray system - Improvements and
flight experience
A82-12696
- STABILIZERS (AGENTS)**
On the use of carbon composites in slat and
stabilizer construction
A82-11468
- STANDARDS**
Rotorcraft icing: Status and prospects
[AGARD-AR-166] N82-11056
Proposed standard requirements and procedures for
icing clearance
N82-11061
- STATE VECTORS**
Synthesis of system for evaluating gyrostabilizer
state with unknown disturbances
A82-11469
- STEADY FLOW**
Finite difference computation of the steady
transonic potential flow around airplanes
N82-10981
- STEADY STATE**
The effects of flexibility on the steady-state
performance of small ribbon parachute models
[AIAA PAPER 81-1923] A82-10408
- STIFFNESS MATRIX**
Formation of triangular-element stiffness matrix
using sliding interpolation
A82-11464
An influence coefficient method for the
application of the modal technique to wing
flutter suppression of the DAST ARW-1 wing
[NASA-CR-165772] N82-11070
- STOCHASTIC PROCESSES**
Synthesis of system for evaluating gyrostabilizer
stat. with unknown disturbances
A82-11469
Theory of stochastic optimal control some basic
notions
N82-11075
An introduction to stochastic optimal control theory
N82-11076
- STORAGE BATTERIES**
New separators for battery systems
A82-11715
- STORMS (METEOROLOGY)**
Applications of conventional and Doppler radars
for aviation safety
A82-10215
- STRAPDOWN INERTIAL GUIDANCE**
Fast and accurate gyrocompass using strapdown
tuned rotor gyros as a solution to combat
helicopters navigation problems
A82-11927
Design considerations for the direct digital
control of dry-tuned gyroscope
A82-11933
Simulation study of a hybrid strapdown attitude
and heading reference system
A82-12641
The integrated inertial sensor assembly /IISA/ - A
redundant strapdown system for advanced aircraft
navigation and flight control functions
A82-12642
Integrated satellite navigation and strapdown
attitude and heading reference systems for civil
air carriers
A82-12643
- STREAM FUNCTIONS (FLUIDS)**
An aerodynamic design method for transonic axial
flow compressor stage
N82-10984
- STRESS ANALYSIS**
Lineup of the IM-series aircraft-derivative gas
turbines
A82-12560
New molding method of three-dimensional hollow
photoelastic model and centrifugal stress
analysis of air cooled turbine blade model
[NAL-TR-427T] N82-11067
- STRESS CORROSION CRACKING**
The application of improved aluminium alloys and
steels in aircraft structures
A82-10305

STRESS MEASUREMENT

- Stress measurements in a ribbon parachute canopy during inflation and at steady state [AIAA PAPER 81-1944] A82-10420
- Stress measurements in bias constructed parachute canopies during inflation and at steady-state [AIAA PAPER 81-1945] A82-10421
- STRUCTURAL ANALYSIS**
- Formation of triangular-element stiffness matrix using sliding interpolation A82-11464
- Crack growth evaluation of a method to convert real-time loads history to a simplified engineering spectra --- for aircraft structural analysis A82-12043
- Mathematical model for the maintenance program of modern jet aircraft --- crack detection; inspection intervals [DFVLR-FB-81-14] N82-10002
- Structural analysis of fuselages with cutouts by finite element method N82-10995
- Matrix analysis of wings N82-10998
- Integrated analysis of engine [NASA-TM-82713] N82-11491
- Structural analysis computer programs for rigid multicomponent pavement structures with discontinuities, WESLIQID and WESLAYER. Report 1: Program development and numerical presentations [AD-A104545] N82-11498
- STRUCTURAL DESIGN**
- Light aircraft structural design in non-metallics - Use of composite honeycomb for light aircraft A82-10308
- Emerging technologies in aerospace structures, design, structural dynamics and materials; Proceedings of the Aerospace Conference, San Francisco, CA, August 13-15, 1980 A82-12026
- Determination of airplane model structure from flight data by using modified stepwise regression [NASA-TP-1916] N82-10041
- Control design of flexible spacecraft N82-11081
- Design of airport pavements for expansive soils [AD-A104660] N82-11313
- STRUCTURAL FAILURE**
- A note on fatal aircraft accidents involving metal fatigue A82-11400
- STRUCTURAL INFLUENCE COEFFICIENTS**
- An influence coefficient method for the application of the modal technique to wing flutter suppression of the DAST ARW-1 wing [NASA-CR-165772] N82-11070
- STRUCTURAL RELIABILITY**
- Lineup of the IM-series aircraft-derivative gas turbines A82-12560
- STRUCTURAL STABILITY**
- An influence coefficient method for the application of the modal technique to wing flutter suppression of the DAST ARW-1 wing [NASA-CR-165772] N82-11070
- STRUCTURAL STRAIN**
- Optical sensors for displacement measurement A82-11407
- STRUCTURAL VIBRATION**
- Helicopter engine technology - With particular reference to the Rolls-Royce Gem engine A82-10304
- Lineup of the IM-series aircraft-derivative gas turbines A82-12560
- New estimation method for flutter or divergence boundary from random responses at subcritical speeds [NAL-TR-667T] N82-11034
- SUBSONIC AIRCRAFT**
- Air-freon integrated environmental conditioning system for trainer subsonic aircraft [ASME PAPER 81-ENAS-33] A82-10920
- SUBSONIC FLOW**
- The use of the Weber method for minicomputer-assisted numerical analysis of airfoils A82-10362
- Experimental study of subsonic and transonic flows past a wing A82-10363
- Nonlinear prediction of subsonic aerodynamic loads on wings and bodies at high angles of attack A82-11359
- Theoretical investigations and experimental researches for higher subsonic two-dimensional compressor cascade N82-11024
- Aeroacoustic theory for noncompact wing-gust interaction [FDRL-81-7] N82-11071
- On the kernel function collocation method in steady subsonic flow for wing with control surfaces N82-12023
- SUBSONIC WIND TUNNELS**
- Subsonic cascade wind tunnel tests using a compressor configuration of DCA blades [AD-A104597] N82-11069
- SUCTION**
- Amplified crossflow disturbances in the laminar boundary layer on swept wings with suction [NASA-TP-1902] N82-11391
- SUPERCRITICAL WINGS**
- Propfan installation aerodynamics of a supercritical swept wing transport configuration [AIAA PAPER 81-1563] A82-10466
- A comparison of the theoretical and experimental pressure distributions for two advanced fighter wings [NASA-TM-81331] N82-11054
- SUPERSONIC AIRCRAFT**
- Real-time, on-line digital simulation of optimum maneuvers of supersonic aircraft [AIAA 81-2178] A82-10127
- SUPERSONIC COMBUSTION RAMJET ENGINES**
- Multiple-scale turbulence modeling of free turbulent flows [ASME PAPER 81-PE-20] A82-10934
- SUPERSONIC FLIGHT**
- Optimal flight paths for winged, supersonic flight vehicles - Extension to the case where thrust can be vectored A82-10310
- SUPERSONIC INLETS**
- A theoretical analysis of the stream surface of revolution with supersonic inlet flow in a transonic axial compressor N82-11025
- SUPERSONIC JET FLOW**
- Multiple-scale turbulence modeling of free turbulent flows [ASME PAPER 81-PE-20] A82-10934
- SUPERSONIC SPEEDS**
- The principles and methods for shaping the wing root regions of a wing-body combination at transonic and lower supersonic speeds N82-11016
- SURFACE LAYERS**
- Results of experimental study of heat transfer to turbine blades with porous cooling A82-11446
- SURFACE PROPERTIES**
- Design of airport pavements for expansive soils [AD-A104660] N82-11313
- SURFACE VEHICLES**
- Characteristics and trends of energy consumption in transport missions with aircraft and surface vehicles A82-10495
- SURFACES**
- A study on numerical method for evaluating spanwise integral in subsonic lifting-surface theory [NAL-TR-661T] N82-11035
- SURGES**
- High voltage surge and partial discharge test to evaluate aerospace equipment parts A82-11740
- SURVEILLANCE RADAR**
- Airborne associative processor /ASPRO/ --- for early warning radar surveillance, command, and control applications [AIAA 81-2145] A82-10104

SWEAT COOLING

Results of experimental study of heat transfer to turbine blades with porous cooling A82-11446

SWEEP WINGS

Propfan installation aerodynamics of a supercritical swept wing transport configuration [AIAA PAPER 81-1563] A82-10466
Amplified crossflow disturbances in the laminar boundary layer on swept wings with suction [NASA-TP-1902] N82-11391

SWITCHING CIRCUITS

Advanced aircraft electrical system control technology demonstrator. Phase 1: Requirements analysis and conceptual design [AD-A103922] N82-10326

SYNTHETIC APERTURE RADAR

Synthetic aperture radar target simulator [NASA-CASE-NPO-15024-1] N82-10286

SYSTEM FAILURES

Extending the limits of reliability theory --- Book A82-12318

SYSTEMS ANALYSIS

Multi-variable analysis and design techniques [AGARD-LS-117] N82-10048
Multivariable design techniques based on singular value generalizations of classical control N82-10051

SYSTEMS ENGINEERING

Acoustic emission - An emerging technology for assessing fatigue damage in aircraft structure A82-11149

The certification of digital systems A82-11940

Digital avionics: Promise and practice - An airlines experience in the field A82-11942

Multi-variable analysis and design techniques [AGARD-LS-117] N82-10048

The need for multivariable design and analysis techniques N82-10049

Design of high integrity multivariable control systems N82-10055

A geometric approach to multivariable control system synthesis N82-10056

Multivariable design: The optimization of approximate inverses N82-10057

Design considerations for optimal flight control systems N82-11077

Design techniques for multivariable flight control systems N82-11078

Application of nonlinear systems inverses to automatic flight control design: System concepts and flight evaluations N82-11083

SYSTEMS INTEGRATION

KC-135 Avionics Modernization Hot Bench [AIAA 81-2105] A82-10081

Discrete address beacon, navigation and landing system A82-10650

The integrated inertial sensor assembly /IISA/ - A redundant strapdown system for advanced aircraft navigation and flight control functions A82-12642

Integrated satellite navigation and strapdown attitude and heading reference systems for civil air carriers A82-12643

SYSTEMS SIMULATION

Interoperability testing of decentralized command, control, communications and intelligence /C3I/ systems [AIAA 81-2205] A82-10143

Simulation study of a hybrid strapdown attitude and heading reference system A82-12641

T

T-38 AIRCRAFT

SEL and EPNL noise duration coefficients for the 747 and T-38 aircraft [NASA-TM-83214] N82-11860

TACAN

Interoperability testing of decentralized command, control, communications and intelligence /C3I/ systems [AIAA 81-2205] A82-10143

TAIL ASSEMBLIES

Experimental study of empennage snap-through vibrations A82-11471

TARGET SIMULATORS

Synthetic aperture radar target simulator [NASA-CASE-NPO-15024-1] N82-10286

TECHNOLOGICAL FORECASTING

Propulsion study for Small Transport Aircraft Technology (STAT) [NASA-CR-165499] N82-10037

TECHNOLOGY ASSESSMENT

Fluid power technology for the '80s --- Book A82-10851

Jet fuel locks to shale oil: The 1980 technology review [AD-A104414] N82-11228

TECHNOLOGY TRANSFER

Bridging the gap from aircraft to space computers [AIAA 81-2142] A82-10101

TECHNOLOGY UTILIZATION

Use of Space Shuttle technology in conventional aircraft [AIAA 81-2176] A82-10125

The balloon and the airship technological heritage [AIAA PAPER 81-1912] A82-10401

SARSAT applications A82-12698

TELEMETRY

Outsider's look at flight instrumentation [DE81-025409] N82-11066

TEMPERATURE MEASUREMENT

In-situ calibration of flight heat transfer instrumentation [ASME PAPER 81-ENAS-13] A82-10901

Adaptation of a turbine test facility to high-temperature research [BAE-LIB-TRANS-2064] N82-11089

TERRAIN FOLLOWING AIRCRAFT

Ideal and simulated performance of an aircraft in the terrain following mission A82-11302

TEST FACILITIES

Air-breathing engine test facilities register [AGARD-AG-269] N82-10063

Rotorcraft icing: Status and prospects [AGARD-AR-166] N82-11056

Facilities for development and clearance N82-11059

Adaptation of a turbine test facility to high-temperature research [BAE-LIB-TRANS-2064] N82-11089

System safety program plan --- electromagnetic pulse testing of the A-7E aircraft [AD-A104557] N82-11354

TEST PILOTS

Test Pilots' Aviation Safety Workshop, U.S. Naval Postgraduate School, Monterey, CA, February 25-28, 1981, Proceedings A82-10500

THERMAL ENVIRONMENTS

Closed loop environmental control systems for fighter aircraft [ASME PAPER 81-ENAS-2] A82-10890

Quantification of the thermal environment for externally carried aircraft stores and ordnance A82-12100

THERMAL EXPANSION

Thermal expansion accommodation in a jet engine frame A82-11999

THERMAL FATIGUE

Thermal expansion accommodation in a jet engine frame A82-11999

THERMAL PROTECTION

The Shock and Vibration Digest, volume 13, no. 9
[AD-A105062] N82-10421

THERMAL RESISTANCE
Design analysis of high temperature transparent
windshields for high performance aircraft
[ASME PAPER 81-ENAS-5] A82-10893
Thermal-barrier-coated turbine blade study
[NASA-CR-165351] N82-10040

THERMAL SIMULATION
A new thermal and trajectory model for high
altitude balloons
[AIAA PAPER 81-1926] A82-10411

THERMOCOUPLES
In-situ calibration of flight heat transfer
instrumentation
[ASME PAPER 81-ENAS-13] A82-10901

THERMODYNAMIC PROPERTIES
Basic problem of aircraft gasturbine engine
analytic design. II
A82-11463

THREE DIMENSIONAL FLOW
Acta mechanica sinica
[AD-A105184] N82-11014
The arbitrary quasi-orthogonal surface method for
computing three-dimensional flow in turbine
machinery. 2. Calculation of the
three-dimensional flow with the S sub 1-surface
twisted
N82-11015
A theoretical analysis of the stream surface of
revolution with supersonic inlet flow in a
transonic axial compressor
N82-11025
A numerical three-dimensional turbulent simulation
of a subsonic VSTOL jet in a cross-flow using a
finite element algorithm
[AD-A104514] N82-11055
Aeroacoustic theory for noncompact wing-gust
interaction
[PDRL-81-7] N82-11071

THREE DIMENSIONAL MOTION
On the question of trailing airplane motion
A82-11470

THRUST CONTROL
V/STOL aircraft and fluid dynamics
[NASA-TM-81328] N82-10029

THRUST REVERSAL
Study of reingestion of exhaust gases with
different initial temperature in a reversed
turbojet engine
A82-11444

THRUST VECTOR CONTROL
Optimal flight paths for winged, supersonic flight
vehicles - Extension to the case where thrust
can be vectored
A82-10310
Developments in boundary layer Thrust Vector Control
A82-10855

TIME
SEL and EPNL noise duration coefficients for the
747 and T-38 aircraft
[NASA-TM-83214] N82-11860

TIME LAG
Hard limited approaches to correlation velocity
sensing
A82-12636

TIME OPTIMAL CONTROL
LQG-based multivariable design: Frequency domain
interpretation
N82-10053

TITANIUM ALLOYS
Sophisticated aircraft structure developments -
Combat aeroplanes
A82-10309

TOUCHDOWN
Comparative study of flare control laws
[NASA-CR-164903] N82-10032

TRACKING RADAR
Synthetic aperture radar target simulator
[NASA-CASE-NPO-15024-1] N82-10286

TRADEOFFS
Active control elements on the transonic wing of
the Airbus A-300 (ACTTA A). Airbus A-300 with
reduced longitudinal stability (ACTTA-C) ---
advanced control transonic transport aircraft
(ACCTA); design considerations
N82-10044

TRAILING EDGES

Helicopter rotor trailing edge noise
[AIAA PAPER 81-2001] A82-10455
Aircraft wing trailing-edge noise
[NASA-CR-164952] N82-11039
Helicopter rotor trailing edge noise --- noise
prediction
[NASA-CR-3470] N82-11859

TRAILING-EDGE FLAPS
On evaluating the influence of local disruptions
of flow over trailing edge and leading edge
flaps from the data of wind tunnel tests of a
rectangular wing segment
A82-11465
System identification of the longitudinal motion
of the DFVLR HPB 320 research aircraft with
particular consideration of control surface
effectiveness
[ESA-TT-666] N82-10045

TRAINING AIRCRAFT
Air-freon integrated environmental conditioning
system for trainer subsonic aircraft
[ASME PAPER 81-ENAS-33] A82-10920

TRAJECTORY ANALYSIS
A new thermal and trajectory model for high
altitude balloons
[AIAA PAPER 81-1926] A82-10411

TRAJECTORY CONTROL
Flight trajectory control investigation
[AD-A104542] N82-11048
Optimum climb and descent trajectories for airline
missions
N82-11082

TRAJECTORY OPTIMIZATION
Optimal flight paths for winged, supersonic flight
vehicles - Extension to the case where thrust
can be vectored
A82-10310

TRANSFER FUNCTIONS
Limitations on achievable performance of
multivariable feedback systems
N82-10052

TRANSONIC COMPRESSORS
A theoretical analysis of the stream surface of
revolution with supersonic inlet flow in a
transonic axial compressor
N82-11025

TRANSONIC FLOW
Experimental study of subsonic and transonic flows
past a wing
A82-10363
Strong matching method for computing transonic
viscous flows including wakes and separations -
lifting airfoils
A82-10821
Finite difference computation of the steady
transonic potential flow around airplanes
N82-10981
A comparison of theoretical and experimental
pressure distributions for two advanced fighter
wings
[NASA-TM-81331] N82-11054

TRANSONIC SPEED
The principles and methods for shaping the wing
root regions of a wing-body combination at
transonic and lower supersonic speeds
N82-11016

TRANSONIC WIND TUNNELS
Design predictions for noise control in the
cryogenic National Transonic Facility
A82-12025

TRANSPONDERS
Threat Alert and Collision Avoidance System (TCAS)
Symposium
[AD-A104563] N82-11047

TRANSPORT AIRCRAFT
Propfan installation aerodynamics of a
supercritical swept wing transport configuration
[AIAA PAPER 81-1563] A82-10466
Characteristics and trends of energy consumption
in transport missions with aircraft and surface
vehicles
A82-10495
Towards minimum power for environmental control in
transport aircraft
[ASME PAPER 81-ENAS-4] A82-10892
Fuel for future transport aircraft
[ASME PAPER 81-BT-80] A82-10965

- History of flight testing the L-1011 TriStar jet transport. II - Testing highlights since initial certification of the L-1011-1
A82-12049
- Theoretical investigation of the influence of spoiler dynamics on the handling qualities of an aircraft with direct lift control
[ESA-TT-681] N82-10036
- Propulsion study for Small Transport Aircraft Technology (STAT)
[NASA-CR-165499] N82-10037
- Propulsion study for Small Transport Aircraft Technology (STAT), Appendix B
[NASA-CR-165499-APP-B] N82-10038
- Control law design for transport aircraft flight tasks
N82-11080
- TRAPEZOIDAL WINGS**
Experimental study of subsonic and transonic flows past a wing
A82-10363
- TUBE HEAT EXCHANGERS**
The enhancement of heat exchange in channels /2nd revised and enlarged edition/ --- Russian book
A82-12222
- TURBINE BLADES**
Thermal and flow analysis of a convection, air-cooled ceramic coated porous metal concept for turbine vanes
[ASME PAPER 81-HT-48] A82-10952
- End losses in turbine cascades with porous cooling
A82-11434
- Results of experimental study of heat transfer to turbine blades with porous cooling
A82-11446
- Thermal-barrier-coated turbine blade study
[NASA-CR-165351] N82-10040
- A new method of cooling turbine vanes
N82-11027
- New molding method of three-dimensional hollow photoelastic model and centrifugal stress analysis of air cooled turbine blade model
[NAL-TR-427T] N82-11067
- TURBINE ENGINES**
Superalloy turbine components - Which is the superior manufacturing process, as-HIP, HIP plus Isoforge, or 'gatorizing' of extrusion consolidated billet
A82-12497
- Superalloy powder engine components; controls employed to assure high quality hardware
A82-12499
- Development of multivariable controllers for aircraft turbine engines
N82-11087
- TURBOCOMPRESSORS**
Wind tunnel tests on airfoils in tandem cascade
A82-10987
- An aerodynamic design method for transonic axial flow compressor stage
N82-10984
- Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006
- An experimental investigation of the rotating stall, surge and wake behind the rotor for a single stage axial compressor
N82-11008
- A theoretical analysis of the stream surface of revolution with supersonic inlet flow in a transonic axial compressor
N82-11025
- TURBOFAN ENGINES**
Rotor wake characteristics relevant to rotor-stator interaction noise generation
[AIAA PAPER 81-2031] A82-10456
- Application of numerical modeling to gas turbine combustor development problems
A82-12118
- An assessment of the use of antimisting fuel in turbofan engines
[NASA-CR-165258] N82-11230
- TURBOJET ENGINES**
Study of reingestion of exhaust gases with different initial temperature in a reversed turbojet engine
A82-11444
- Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006
- A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion
N82-11007
- TURBOMACHINE BLADES**
Calculation of natural modes of vibration for rotor blades by the finite element method
[DFVLR-FB-81-07] N82-10452
- TURBOMACHINERY**
Acta mechanica sinica
[AD-A105184] N82-11014
- The arbitrary quasi-orthogonal surface method for computing three-dimensional flow in turbine machinery. 2. Calculation of the three-dimensional flow with the S sub 1-surface twisted
N82-11015
- TURBOPROP ENGINES**
Propulsion study for Small Transport Aircraft Technology (STAT)
[NASA-CR-165499] N82-10037
- TURBULENT BOUNDARY LAYER**
Theoretical investigations and experimental researches for higher subsonic two-dimensional compressor cascade
N82-11024
- TURBULENT FLOW**
Multiple-scale turbulence modeling of free turbulent flows
[ASME PAPER 81-FE-20] A82-10934
- On the prediction of swirling flowfields found in axisymmetric combustor geometries
A82-12120
- Validation studies of turbulence and combustion models for aircraft gas turbine combustors
A82-12267
- A new method of cooling turbine vanes
N82-11027
- Wind-tunnel results for a modified 17-percent-thick low-speed airfoil section
[NASA-TP-1919] N82-11033
- A numerical three-dimensional turbulent simulation of a subsonic VSTOL jet in a cross-flow using a finite element algorithm
[AD-A104514] N82-11055
- TURBULENT WAKES**
Reductions in parachute drag due to forebody wake effects
[AIAA PAPER 81-1939] A82-10417
- Rotor wake characteristics relevant to rotor-stator interaction noise generation
[AIAA PAPER 81-2031] A82-10456
- TWO DIMENSIONAL FLOW**
Control laws for adaptive wind tunnels
A82-10985
- An aerodynamic design method for transonic axial flow compressor stage
N82-10984
- Theoretical investigations and experimental researches for higher subsonic two-dimensional compressor cascade
N82-11024

U

- UH-1 HELICOPTER**
Helicopter icing spray system - Improvements and flight experience
A82-12696
- ULTRAHIGH FREQUENCIES**
A mathematical model of an over-sea airborne UHF radio link
A82-11406
- UNDERCARRIAGES**
Analytical determination of undercarriage retraction kinematics
A82-10364
- UNSTEADY FLOW**
An experimental investigation of the rotating stall, surge and wake behind the rotor for a single stage axial compressor
N82-11008

UPPER SURFACE BLOWING

Quiet short-haul research aircraft familiarization document, revision 1
[NASA-TM-81298] N82-10031

V

V/STOL AIRCRAFT

V/STOL aircraft and fluid dynamics
[NASA-TM-81328] N82-10029
Low speed testing of the inlets designed for a tandem-fan V/STOL nacelle --- conducted in the Lewis 10 by 10 foot wind tunnel
[NASA-TM-82728] N82-11042
A summary of V/STOL inlet analysis methods
[NASA-TM-82725] N82-11043
A numerical three-dimensional turbulent simulation of a subsonic VSTOL jet in a cross-flow using a finite element algorithm
[AD-A104514] N82-11055

VARIABILITY

Characteristic and principal gains and phases and their use as multivariable control design tools --- generalizing Nyquist and root-locus diagram techniques
N82-10050
Multivariable design techniques based on singular value generalizations of classical control
N82-10051

VELOCITY DISTRIBUTION

Aerodynamic calculations and design of subcritical aerofoils
N82-10983

VELOCITY MEASUREMENT

Hard limited approaches to correlation velocity sensing
A82-12636

VERTICAL AIR CURRENTS

Downbursts and microbursts - An aviation hazard --- downdrafts beneath thunderstorms
A82-10214

VERTICAL DISTRIBUTION

Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity
A82-12149

VERY LOW FREQUENCIES

Omega station 10.2 kHz signal selection made easy
A82-12638

VIBRATION DAMPING

'Quiet please' --- aircraft hydraulic systems noise reduction
A82-10854
Polyurethane foams for aircraft shock mounts. 3: Vibration damping by polyether foams
[AD-A104496] N82-11212

VIBRATION EFFECTS

The Shock and Vibration Digest, volume 13, no. 9
[AD-A105062] N82-10421

VIBRATION ISOLATORS

The possibility of using deformable rubber components in landing gear
A82-10496
Polyurethane foams for aircraft shock mounts. 3: Vibration damping by polyether foams
[AD-A104496] N82-11212

VIBRATION MODE

Applications of finite element method in aerospace power systems design
A82-11717
Calculation of natural modes of vibration for rotor blades by the finite element method
[DFVLR-FB-81-07] N82-10452

VIBRATION TESTS

The Shock and Vibration Digest, volume 13, no. 9
[AD-A105062] N82-10421

VIBRATORY LOADS

Lineup of the IN-series aircraft-derivative gas turbines
A82-12560

VIDEO EQUIPMENT

Tangential sensitivity of EW receivers
A82-11020

VISCIOUS FLOW

Strong matching method for computing transonic viscous flows including wakes and separations - Lifting airfoils
A82-10821

VORTEX FLAPS

Effects of vortex flaps on the low-speed aerodynamic characteristics of an arrow wing
[NASA-TP-1914] N82-11013

VORTICES

Increasing the lift:drag ratio of a flat delta wing
A82-11899

The CIVIC - A concept in vortex induced combustion. II
[ASME PAPER 81-GT-12] A82-11997

W

WALL FLOW

Control laws for adaptive wind tunnels
A82-10985

WARNING SYSTEMS

An airport wind shear detection and warning system using Doppler radar
A82-10220

Threat Alert and Collision Avoidance System (TCAS)

Symposium
[AD-A104563] N82-11047

WAVE DIFFRACTION

Acta mechanica sinica
[AD-A105184] N82-11014

WAVE REFLECTION

Acta mechanica sinica
[AD-A105184] N82-11014

WEAPON SYSTEMS

Quantification of the thermal environment for externally carried aircraft stores and ordnance
A82-12100

WEATHER FORECASTING

Operational environment, meteorological conditions and weather forecasting
N82-11057

WIND DIRECTION

Gust front structure observed by Doppler radar
A82-10223

WIND MEASUREMENT

Detection and display of wind shear and turbulence
A82-10222

WIND SHEAR

An airport wind shear detection and warning system using Doppler radar
A82-10220

Instrumented aircraft verification of clear-air radar detection of low-level wind shear
A82-10221

Detection and display of wind shear and turbulence
A82-10222

Comparative study of flare control laws
[NASA-CR-164903] N82-10032

WIND TUNNEL DRIVES

Design predictions for noise control in the cryogenic National Transonic Facility
A82-12025

WIND TUNNEL TESTS

A modular asymmetric parachute for wind tunnel testing
[AIAA PAPER 81-1933] A82-10414

Stress measurements in a ribbon parachute canopy during inflation and at steady state
[AIAA PAPER 81-1944] A82-10420

Wind tunnel tests on airfoils in tandem cascade
A82-10987

Standard tests of a research model rotor in a wind tunnel, including model similarity --- calculations compared with measurements
[BNVG-FBWT-79-16] N82-10016

Experimental investigations of the separated flow around a rectangular wing --- in a wind tunnel
[DFVLR-FB-81-12] N82-10017

Effects of vortex flaps on the low-speed aerodynamic characteristics of an arrow wing
[NASA-TP-1914] N82-11013

Wind-tunnel results for a modified 17-percent-thick low-speed airfoil section
[NASA-TP-1919] N82-11033

Icing tunnel tests of a composite porous leading edge for use with a liquid anti-ice system --- Lewis icing research tunnel
[NASA-CR-164966] N82-11052

Subsonic cascade wind tunnel tests using a compressor configuration of DCA blades
[AD-A104597] N82-11069

SUBJECT INDEX

X WING ROTORS

Helicopter rotor trailing edge noise --- noise
prediction
[NASA-CR-3470] N82-11859

WIND TUNNEL WALLS
Control laws for adaptive wind tunnels A82-10985
On low-speed wind tunnels with deformable boundaries A82-11462

WIND TUNNELS
Evaluation of the acoustic measurement capability
of the NASA Langley V/STOL wind tunnel open test
section with acoustically absorbent ceiling and
floor treatments
[NASA-CR-165796] N82-10059

WIND VELOCITY
Gust front structure observed by Doppler radar A82-10223

WINDSHIELDS
Design analysis of high temperature transparent
windshields for high performance aircraft
[ASME PAPER 81-ENAS-5] A82-10893

WING FLAPS
Increasing the lift:drag ratio of a flat delta wing A82-11899

WING FLOW METHOD TESTS
Experimental study of subsonic and transonic flows
past a wing A82-10363

WING LOADING
Nonlinear prediction of subsonic aerodynamic loads
on wings and bodies at high angles of attack A82-11359
On the question of trailing airplane motion A82-11470
A study on numerical method for evaluating
spanwise integral in subsonic lifting-surface
theory
[NAL-TR-661T] N82-11035
Aeroacoustic theory for noncompact wing-gust
interaction
[PDBL-81-7] N82-11071

WING OSCILLATIONS
Experimental study of empennage snap-through
vibrations A82-11471

WING PANELS
Formation of triangular-element stiffness matrix
using sliding interpolation A82-11464

WING PROFILES
An influence coefficient method for the
application of the modal technique to wing
flutter suppression of the DAST ARW-1 wing
[NASA-CR-165772] N82-11070

WING ROOTS
Acta mechanica sinica
[AD-A105184] N82-11014
The principles and methods for shaping the wing
root regions of a wing-body combination at
transonic and lower supersonic speeds N82-11016

WING TANKS
Experimental study of fuel heating at low
temperatures in a wing tank model, volume 1
[NASA-CR-165391] N82-11224

WINGS
Aircraft wing trailing-edge noise
[NASA-CR-164952] N82-11039
On the kernel function collocation method in
steady subsonic flow for wing with control
surfaces N82-12023

X

X WING ROTORS

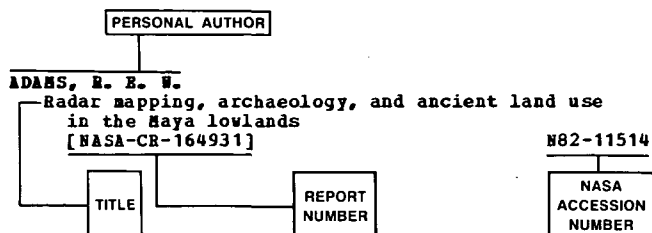
An investigation of a stoppable helicopter rotor
with circulation control --- ames 40 by 80 foot
wind tunnel
[NASA-TM-81218] N82-10030

PERSONAL AUTHOR INDEX

AERONAUTICAL ENGINEERING/A Continuing Bibliography (Suppl. 145)

FEBRUARY 1982

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 cited (e.g., NASA report, translation, NASA contractor report). The accession number is located beneath and to the right of the title, e.g., N82-11514. Under any one author's name the accession numbers are arranged in sequence with the /AA accession numbers appearing first.

A

- ADAM, V.**
Control law design for transport aircraft flight tasks
N82-11080
- ADAMS, R. E. W.**
Radar mapping, archaeology, and ancient land use in the Maya lowlands
[NASA-CR-164931] N82-11514
- AGLIULLIN, I. N.**
Basic problem of aircraft gasturbine engine analytic design. II
A82-11463
- AKHENTEV, V. G.**
Calculation of aerodynamic characteristics of jet flapped airplane
A82-11459
- AKHTER, M. M.**
Development of multivariable controllers for aircraft turbine engines
N82-11087
- AKHTIAHOV, Z. V.**
Study of reingestion of exhaust gases with different initial temperature in a reversed turbojet engine
A82-11444
- ALBRIGHT, A. E.**
Icing tunnel test of a glycol-exuding porous leading edge ice protection system on a general aviation airfoil
[NASA-CR-165444] N82-10021
- ALLRAMSEDER, E.**
Standard tests of a research model rotor in a wind tunnel, including model similarity
[BMVG-PBWT-79-16] N82-10016
- ALM, A.**
Lightning effects on aircraft and composites. Literature study on lightning strikes and protection
[POA-C-20388-F9] N82-10024
- AMIER, R. K.**
Helicopter rotor trailing edge noise
[NASA-CR-3470] N82-11859
- AMIEY, R. K.**
Helicopter rotor trailing edge noise
[AIAA PAPER 81-2001] A82-10455
- ANDERSON, S. B.**
V/STOL aircraft and fluid dynamics
[NASA-TM-81328] N82-10029

- ANDO, Y.**
New estimation method for flutter or divergence boundary from random responses at subcritical speeds
[NAL-TR-667T] N82-11034
- ANDRIANO, M.**
Air-freon integrated environmental conditioning system for trainer subsonic aircraft
[ASME PAPER 81-ENAS-33] A82-10920
- ARCHBACON, J. L.**
KC-135 Avionics Modernization Hot Bench
[AIAA 81-2105] A82-10081
- ARIPULIN, A. C.**
Jet fuel from carbon
A82-12021
- ASHER, P.**
A solution to the static geometry problem for JTIDS relative navigation
A82-12634
- ATKINSON, G. P.**
Air supply system bite for Boeing 767 airplane
[ASME PAPER 81-ENAS-7] A82-10895

B

- BABISH, C. A., III**
Design analysis of high temperature transparent windshields for high performance aircraft
[ASME PAPER 81-ENAS-5] A82-10893
- BACHMAN, K. L.**
Ring Laser Gyro Navigator /RLGN/ flight test results
A82-12644
- BAILEY, C. D.**
Acoustic emission - An emerging technology for assessing fatigue damage in aircraft structure
A82-11149
- BAILEY, R. E.**
Analysis of augmented aircraft flying qualities through application of the Neal-Smith criterion
[AIAA PAPER 81-1776] A82-10462
- BAKER, A. J.**
A numerical three-dimensional turbulent simulation of a subsonic VSTOL jet in a cross-flow using a finite element algorithm
[AD-A104514] N82-11055
- BALASUBRAMANIAN, T. S.**
Numerical treatment of helicopter rotor stability problems
A82-12045
- BALBUKH, V. V.**
Control of electromechanical actuator elements for flight vehicles
A82-12170
- BALLARD, J. D.**
An investigation of a stoppable helicopter rotor with circulation control
[NASA-TM-81218] N82-10030
- BALONBIN, J. R.**
Rotor wake characteristics relevant to rotor-stator interaction noise generation
[AIAA PAPER 81-2031] A82-10456
- BARBE, I.**
Quantification of the thermal environment for externally carried aircraft stores and ordnance
A82-12100
- BATTERSON, J. G.**
Determination of airplane model structure from flight data by using modified stepwise regression
[NASA-TP-1916] N82-10041
- Estimation of airplane stability and control derivatives from large amplitude longitudinal maneuvers
[NASA-TM-83185] N82-10042

- BEASLEY, W. D.
Wind-tunnel results for a modified
17-percent-thick low-speed airfoil section
[NASA-TP-1919] N82-11033
- BELTE, D.
Helicopter icing spray system - Improvements and
flight experience A82-12696
- BERKOVITS, A.
Fatigue life of lugs under service loading - Test
results and predictions A82-11685
- BICKLER, T. C.
Synthetic aperture radar target simulator
[NASA-CASE-NPO-15024-1] N82-10286
- BIPPES, H.
Experimental investigations of the separated flow
around a rectangular wing
[DFVLR-FB-81-12] N82-10017
- BIRCH, S. A.
The constricted rigging line trials technique for
assessing the opening characteristics of
parachutes
[AIAA PAPER 81-1932] A82-10413
- BIRD, M.
Flight trajectory control investigation
[AD-A104542] N82-11048
- BJERGAAS, C. L.
Gust front structure observed by Doppler radar
A82-10223
- BJORKLUND, R. C.
Interoperability testing of decentralized command,
control, communications and intelligence /C3I/
systems
[AIAA 81-2205] A82-10143
- BLICK, E. F.
An airport wind shear detection and warning system
using Doppler radar A82-10220
- BOCKSTAHLER, A. J.
Design analysis of high temperature transparent
windshields for high performance aircraft
[ASME PAPER 81-ENAS-5] A82-10893
- BOENNINGER, W. E.
High-efficiency hydraulic power transfer units for
multisystem aircraft A82-10853
- BOLTON, W. R.
Development of new lifting parachute designs with
increased trim angle
[AIAA PAPER 81-1921] A82-10407
- BONHAM, A. J.
System safety program plan
[AD-A104557] N82-11354
- BORELLO, L.
Problems relating to the classical rate-gyro
A82-10497
- BOROVIK, V. O.
Basic problem of aircraft gasturbine engine
analytic design. II A82-11463
- BOROWSKY, M. S.
Relationships between naval aviation safety and
pilot flight experience A82-11031
- BRADFIELD, E. M.
Procedures and analysis techniques for determining
static air minimum control speeds A82-12564
- BRADSHAW, J. E.
Advanced fuel flowmeter for future naval aircraft
[AD-A104364] N82-11063
- BREWER, G. D.
Fuel for future transport aircraft
[ASME PAPER 81-HT-80] A82-10965
- BROUWERS, A. P.
Lightweight diesel engine designs for commuter
type aircraft
[NASA-CR-165470] N82-11068
- BROWN, W. E., JR.
Radar mapping, archaeology, and ancient land use
in the Maya lowlands
[NASA-CR-164931] N82-11514
- BRUERN, A.
Electrical ground testing of aircraft antistatic
protection A82-10822
- BRYSON, A. E., JR.
An overview of optimal control in aerospace systems
N82-11074
- BUCH, A.
Fatigue life of lugs under service loading - Test
results and predictions A82-11685
- BUCKER, H. O.
Inflatable system for fast deployment of
parachutes at low altitudes from slow moving
aircraft or stationary supports
[AIAA PAPER 81-1953] A82-10428
- BUCKINGHAM, R. D.
Design challenges of high performance aircraft POD
EOCM cooling systems
[ASME PAPER 81-ENAS-6] A82-10894
- C**
- CALIANNO, C. T.
Aeroballistic characteristics of sonobuoy
parachute decelerators limited to a length of
three feet
[AIAA PAPER 81-1950] A82-10425
- CALLIZO, L. A.
HiMAT onboard flight computer system architecture
and qualification
[AIAA 81-2107] A82-10082
- CAMP, D. W.
An airport wind shear detection and warning system
using Doppler radar A82-10220
- CAMPBELL, G. S.
A note on fatal aircraft accidents involving metal
fatigue A82-11400
- CAN, S.
Structural analysis of fuselages with cutouts by
finite element method N82-10995
- CAPRILE, C.
The possibility of using deformable rubber
components in landing gear A82-10496
- CARBONE, R.
Detection and display of wind shear and turbulence
A82-10222
- CARLSON, L. A.
A new thermal and trajectory model for high
altitude balloons
[AIAA PAPER 81-1926] A82-10411
- CARTER, A. H., JR.
A comprehensive bibliography of literature on
helicopter noise technology
[AD-A103331] N82-10812
- CASSIER, A.
Development of the Triflex rotor head
A82-11222
- CENTER, J. L.
Navigation task partitioning in
distributed-processing avionics systems A82-10646
- CHANIS, C. C.
Integrated analysis of engine
[NASA-TM-82713] N82-11491
- CHANGSHENG, Z.
An experimental investigation of the rotating
stall, surge and wake behind the rotor for a
single stage axial compressor N82-11008
- CHAOQIANG, L.
Second order approximation theory of an arbitrary
aerofoil in compressible potential flow N82-10982
- Aerodynamic calculations and design of subcritical
aerofoils N82-10983
- CHAPMAN, R. E.
Hard limited approaches to correlation velocity
sensing A82-12636
- CHATTERJEE, J. S.
General aviation aircraft antennas for the global
positioning system
[NASA-TM-83212] N82-11339

- CHEM, C.**
Superalloy turbine components - Which is the superior manufacturing process, as-HIP, HIP plus Isoforge, or 'gatorizing' of extrusion consolidated billet
A82-12497
- CHIA, F. I.**
The principles and methods for shaping the wing root regions of a wing-body combination at transonic and lower supersonic speeds
N82-11016
- CHOU, Y. T.**
Structural analysis computer programs for rigid multicomponent pavement structures with discontinuities, WESLIQID and WESLAYER. Report 1: Program development and numerical presentations [AD-A104545]
N82-11498
- CICOLANI, L.**
Application of nonlinear systems inverses to automatic flight control design: System concepts and flight evaluations
N82-11083
- CINA, F. S.**
Subsonic cascade wind tunnel tests using a compressor configuration of DCA blades [AD-A104597]
N82-11069
- CLARK, J. P.**
The evolution of airborne weather avoidance radar toward a calibrated remote rain gauge using REACT
A82-10225
- CLINE, H. C.**
Computation of high Reynolds number internal/external flows [NASA-TM-84049]
N82-11046
- COCKRELL, D. J.**
Aerodynamics and performance of cruciform parachute canopies [AIAA PAPER 81-1919]
A82-10405
Experimental determination of parachute apparent mass and its significance in predicting dynamic stability [AIAA PAPER 81-1920]
A82-10406
- COOTS, W. H.**
Superalloy turbine components - Which is the superior manufacturing process, as-HIP, HIP plus Isoforge, or 'gatorizing' of extrusion consolidated billet
A82-12497
- CONLEY, M.**
Wings in the sun - The evolution of Solar Challenger
A82-12694
- COX, S. K.**
Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity
A82-12149
- COYNE, J.**
Superalloy turbine components - Which is the superior manufacturing process, as-HIP, HIP plus Isoforge, or 'gatorizing' of extrusion consolidated billet
A82-12497
- COYNE, J. E.**
Superalloy powder engine components; controls employed to assure high quality hardware
A82-12499
- CROLL, R. H.**
A modular asymmetric parachute for wind tunnel testing [AIAA PAPER 81-1933]
A82-10414
- CROW, R. P.**
Discrete address beacon, navigation and landing system
A82-10650
- CULBERT, T. P.**
Radar mapping, archaeology, and ancient land use in the Maya lowlands [NASA-CR-164931]
N82-11514
- CZYZEWSKI, K.**
The use of the Weber method for minicomputer-assisted numerical analysis of airfoils
A82-10362
- D**
- DAGENHART, J. R.**
Amplified crossflow disturbances in the laminar boundary layer on swept wings with suction [NASA-TP-1902]
N82-11391
- DAGOSTINO, V.**
New separators for battery systems
A82-11715
- DAINTY, R. V.**
Fractographic determination of fatigue crack growth rates in aircraft components
A82-12697
- DEGANI, O.**
Development and evaluation of automatic landing control laws for light wing loading STOL aircraft [NASA-CR-166160]
N82-10043
- DEGUEST, P.**
Adaptation of a turbine test facility to high-temperature research [RAE-LIB-TRANS-2064]
N82-11089
- DEHOPF, R. L.**
Development of multivariable controllers for aircraft turbine engines
N82-11087
- DESARO, R.**
An assessment of the use of antimisting fuel in turbofan engines [NASA-CR-165258]
N82-11230
- DEZIDEREY, S. G.**
Results of experimental study of heat transfer to turbine blades with porous cooling
A82-11446
- DI-YI, T.**
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006
A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion
N82-11007
- DIEQIAN, W.**
Finite difference computation of the steady transonic potential flow around airplanes
N82-10981
- DIGIACINTO, T.**
Airborne associative processor /ASPRO/ [AIAA 81-2145]
A82-10104
- DIPASQUO, M. S.**
The integrated inertial sensor assembly /IISA/ - A redundant strapdown system for advanced aircraft navigation and flight control functions
A82-12642
- DONALDSON, R. J., JR.**
Gust front structure observed by Doppler radar
A82-10223
- DOVIK, R. J.**
An airport wind shear detection and warning system using Doppler radar
A82-10220
Instrumented aircraft verification of clear-air radar detection of low-level wind shear
A82-10221
- DOWELL, E. H.**
Control laws for adaptive wind tunnels
A82-10985
- DOYLE, J. C.**
Multivariable design techniques based on singular value generalizations of classical control
N82-10051
Limitations on achievable performance of multivariable feedback systems
N82-10052
- DREITZER, G. A.**
The enhancement of heat exchange in channels /2nd revised and enlarged edition/
A82-12222
- DUFFY, J. V.**
Polyurethane foams for aircraft shock mounts. 3: Vibration damping by polyether foams [AD-A104496]
N82-11212
- DUGRANBUT, J. D.**
Description of the meteorological research radar system aboard NOAA/Research Facilities Center WP-3D aircraft
A82-10217

DUNBAR, W. G.
High voltage surge and partial discharge test to evaluate aerospace equipment parts
A82-11740

DUNN, G. L.
Advanced aircraft electrical system control technology demonstrator. Phase 1: Requirements analysis and conceptual design [AD-A103922]
N82-10326

E

EARLE, R. V.
Propulsion study for Small Transport Aircraft Technology (STAT) [NASA-CR-165499]
N82-10037

EARLS, M. E.
HiMAT onboard flight computer system architecture and qualification [AIAA 81-2107]
A82-10082

EATON, H. E.
Development of low modulus material for use in ceramic gas path seal applications [NASA-CR-165469]
N82-10039

EISWIRTH, E. A.
In-situ calibration of flight heat transfer instrumentation [ASME PAPER 81-ENAS-13]
A82-10901

ELMORE, K. L.
An airport wind shear detection and warning system using Doppler radar
A82-10220

Instrumented aircraft verification of clear-air radar detection of low-level wind shear
A82-10221

ENGBLOM, J. J.
Coupled fluid/structure response predictions for soft body impact of airfoil configurations
A82-12039

EPIFANOV, V. M.
End losses in turbine cascades with porous cooling
A82-11434

EPPEL, J. C.
Quiet short-haul research aircraft familiarization document, revision 1 [NASA-TM-81298]
N82-10031

ERNSTOFF, E. H.
Study and development of an integrated head-up display [AD-A104337]
N82-11062

ERZBERGER, H.
Optimum climb and descent trajectories for airline missions
N82-11082

ESPOSITO, R. J.
FAA acceptance tests on the NAVSTAR GPS Z-Set receiver
A82-12639

EVERETT, W. H.
Superalloy powder engine components; controls employed to assure high quality hardware
A82-12499

F

FABRIS, G.
Multiple-scale turbulence modeling of free turbulent flows [ASME PAPER 81-FE-20]
A82-10934

FANGYUAN, Z.
An aerodynamic design method for transonic axial flow compressor stage
N82-10984

FEDORAK, R.
Memory requirements for future navigation systems
A82-12637

FEIDA, F.
An aerodynamic design method for transonic axial flow compressor stage
N82-10984

FEINREICH, B.
Development and evaluation of automatic landing control laws for light wing loading STOL aircraft [NASA-CR-166160]
N82-10043

FERKO, E. J.
Crack growth evaluation of a method to convert real-time loads history to a simplified engineering spectra
A82-12043

FIORENTINO, A.
An assessment of the use of antimisting fuel in turbofan engines [NASA-CR-165258]
N82-11230

FITZGERALD, R. E.
Developments in boundary layer Thrust Vector Control
A82-10855

FITZSIMMONS, R. D.
How large should a commuter transport be [AIAA PAPER 81-1732]
A82-10463

FORSYTH, T. J.
An investigation of a stoppable helicopter rotor with circulation control [NASA-TM-81218]
N82-10030

FRANCIS, B. A.
Feedback and minimax sensitivity
N82-10058

FRANCOIS, J.
Adaptation of a turbine test facility to high-temperature research [RAE-LIB-TRANS-2064]
N82-11089

Effects of aircraft noise on the equilibrium of airport residents: Testing and utilization of a new methodology [NASA-TM-76628]
N82-11636

FRANZ, T.
An assessment of the use of antimisting fuel in turbofan engines [NASA-CR-165258]
N82-11230

FREYMAN, R.
A method for determination of the aeroelastic behavior of aircraft with active control systems [DPVLR-FB-81-05]
N82-10047

FROST, W.
An airport wind shear detection and warning system using Doppler radar
A82-10220

FU-QUN, C.
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006

A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion
N82-11007

FUJITA, T. T.
Downbursts and microbursts - An aviation hazard
A82-10214

G

GABRIELLI, G.
Characteristics and trends of energy consumption in transport missions with aircraft and surface vehicles
A82-10495

GALDA, K. H.
Mathematical model for the maintenance program of modern jet aircraft [DPVLR-FB-81-14]
N82-10002

GAONKAR, G. H.
On computing Floquet transition matrices of rotorcraft
A82-11225

GARRARD, W. L.
The effects of flexibility on the steady-state performance of small ribbon parachute models [AIAA PAPER 81-1923]
A82-10408

Stress measurements in a ribbon parachute canopy during inflation and at steady state [AIAA PAPER 81-1944]
A82-10420

Stress measurements in bias constructed parachute canopies during inflation and at steady-state [AIAA PAPER 81-1945]
A82-10421

GARRETT, W. A.
ACMA - Fact or fantasy
A82-12048

GATINEAU, R. J.
History of flight testing the L-1011 TriStar jet transport. II - Testing highlights since initial certification of the L-1011-1
A82-12049

GRISLER, D.
Experimental modal analysis of the fuselage panels of an Aero Commander aircraft [NASA-CR-165750]
N82-10028

- GERSHTEIN, M. I.**
 Experimental study of empennage snap-through vibrations
 82-11471
- GEVAERT, G.**
 Development and evaluation of automatic landing control laws for light wing loading STOL aircraft [NASA-CR-166160]
 82-10043
- GILIAZOV, H. SH.**
 Study of reingestion of exhaust gases with different initial temperature in a reversed turbojet engine
 82-11444
- GILL, F. R.**
 Design considerations for optimal flight control systems
 82-11077
- GILL, J. C.**
 Propulsion study for Small Transport Aircraft Technology (STAT) [NASA-CR-165499]
 82-10037
- GILREATH, H. C.**
 General aviation aircraft antennas for the global positioning system [NASA-TM-83212]
 82-11339
- GIRARD, L. A., JR.**
 Air bag impact attenuation system for the AQM-34V remote piloted vehicle [AIAA PAPER 81-1917]
 82-10403
- GLIEBE, P. H.**
 Effects of vane/blade ratio and spacing on fan noise [AIAA PAPER 81-2033]
 82-10457
- GOETTING, H. C.**
 Mathematical model for the maintenance program of modern jet aircraft [DFVLR-FB-81-14]
 82-10002
- GOLDBERG, H.**
 Extending the limits of reliability theory
 82-12318
- GOLDSTEIN, R. H.**
 Synthetic aperture radar target simulator [NASA-CASE-NPO-15024-1]
 82-10286
- GOODMAN, A. W.**
 Sealed lead-acid batteries for aircraft applications
 82-11716
- GOODRICK, T. F.**
 Comparison of simulation and experimental data for a gliding parachute in dynamic flight [AIAA PAPER 81-1924]
 82-10409
- GOODWIN, W. V.**
 An investigation of the combustion process in solid fuel ramjets [AD-A104603]
 82-11232
- GORLINE, G. A.**
 Implementation of AVRADCOM MM&T
 82-10545
- GRIES, D. A.**
 Design considerations for duty cycle, life and reliability of small limited life engines [AIAA PAPER 81-1402]
 82-10465
- GROSS, S.**
 Unsolved problems of nickel cadmium batteries
 82-11725
- GRUZDEV, A. A.**
 On low-speed wind tunnels with deformable boundaries
 82-11462
- GUENTHER, R.**
 A CFRP taileron for the Tornado: Construction and production [MBB-FE-212/KFK/PUB/2]
 82-10035
- GULIAEV, V. V.**
 Calculation of aerodynamic characteristics of jet flapped airplane
 82-11459
- GUPTA, R. R.**
 Omega station 10.2 kHz signal selection made easy
 82-12638
- GURIANOV, A. IA.**
 Experimental study of empennage snap-through vibrations
 82-11471
- GUSEVA, R. I.**
 On the use of carbon composites in slat and stabilizer construction
 82-11468
- GUSKOV, V. I.**
 End losses in turbine cascades with porous cooling
 82-11434
- H**
- HALLIDAY, R.**
 Commercial EMS considerations for small gas turbine engines
 82-12449
- HANEY, H. P.**
 A comparison of theoretical and experimental pressure distributions for two advanced fighter wings [NASA-TM-81331]
 82-11054
- HARRIS, W. L.**
 Model helicopter rotor impulsive noise
 82-11300
- HARSHA, P. T.**
 Multiple-scale turbulence modeling of free turbulent flows [ASME PAPER 81-FE-20]
 82-10934
- HARTMANN, U.**
 Practical design and realization of a digital adaptive flight control system
 82-11079
- HARTMANN, W.**
 A CFRP taileron for the Tornado: Construction and production [MBB-FE-212/KFK/PUB/2]
 82-10035
- HASHIMOTO, R.**
 New molding method of three-dimensional hollow photoelastic model and centrifugal stress analysis of air cooled turbine blade model [NAL-TR-427T]
 82-11067
- HAWKES, D. J.**
 The certification of digital systems
 82-11940
- HAWLEY, D. L.**
 Three navigation systems and their costs of acquiring remote sensing data
 82-10049
- HEDGLEY, D. R.**
 Solution to the hidden-line problem
 82-12803
- HELD, D. H.**
 Synthetic aperture radar target simulator [NASA-CASE-NPO-15024-1]
 82-10286
- HICKS, R. H.**
 A comparison of theoretical and experimental pressure distributions for two advanced fighter wings [NASA-TM-81331]
 82-11054
- HILDEBRAND, P. H.**
 Multiple Doppler radar observations of PBL structure
 82-10292
- HILDEBRANT, R. V.**
 Variable speed constant frequency /VSCP/ electrical system cuts cost of ownership
 82-11719
- HILL, W., JR.**
 The case for a defensive air-to-air fighter
 82-12801
- HILLIG, W. B.**
 Thermal-barrier-coated turbine blade study [NASA-CR-165351]
 82-10040
- HODGSON, T. H.**
 Aircraft wing trailing-edge noise [NASA-CR-164952]
 82-11039
- HOLL, R.**
 Further application and development of an engine usage/life monitoring system for military services
 82-12450
- HOLLAND, R. L.**
 The statistical theory of radio direction finding [AD-A104156]
 82-10027
- HOLT, I. T.**
 Development of new lifting parachute designs with increased trim angle [AIAA PAPER 81-1921]
 82-10407
- HONG-KUN, X.**
 A new method of cooling turbine vanes
 82-11027
- HONG, Q.**
 Finite difference computation of the steady transonic potential flow around airplanes
 82-10981
- HOPKINS, J. J.**
 Integrated satellite navigation and strapdown attitude and heading reference systems for civil air carriers
 82-12643

- HORN, W. J.
A new thermal and trajectory model for high altitude balloons
[AIAA PAPER 81-1926] A82-10411
- HUBBARD, J. E., JR.
Model helicopter rotor impulsive noise A82-11300
- HUELSTER, D. S.
Propulsion study for Small Transport Aircraft Technology (STAT)
[NASA-CR-165499] N82-10037
- HUNTER, B. J.
Digital avionics systems - The RAF experience A82-11941
- HWANG, D. P.
A summary of V/STOL inlet analysis methods
[NASA-TM-82725] N82-11043
- I
- IARKHO, S. A.
The enhancement of heat exchange in channels /2nd revised and enlarged edition/
A82-12222
- ICHIKAWA, T.
A study on numerical method for evaluating spanwise integral in subsonic lifting-surface theory
[NAL-TR-661T] N82-11035
- ISAEV, V. V.
On evaluating the influence of local disruptions of flow over trailing edge and leading edge flaps from the data of wind tunnel tests of a rectangular wing segment A82-11465
- IULIN, M. K.
Jet fuel from carbon A82-12021
- IUN, G. H.
Optimization of the principal design parameters of a passenger aircraft A82-10816
- IVANOV, V. S.
Basic problem of aircraft gasturbine engine analytic design. II A82-11463
- J
- JACOB, K.
Experimental investigations of the separated flow around a rectangular wing
[DFVLR-FB-81-12] N82-10017
- JAIN, S. C.
Superalloy powder engine components; controls employed to assure high quality hardware A82-12499
- JENSEN, B. S.
Improving the MLS through enhanced cockpit displays A82-10649
- JIANPENG, L.
An experimental investigation of the rotating stall, surge and wake behind the rotor for a single stage axial compressor N82-11008
- JIAN-ZHONG, X.
A theoretical analysis of the stream surface of revolution with supersonic inlet flow in a transonic axial compressor N82-11025
- JIN-DI, Y.
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure N82-11006
A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion N82-11007
- JIN-LIANG, J.
The arbitrary quasi-orthogonal surface method for computing three-dimensional flow in turbine machinery. 2. Calculation of the three-dimensional flow with the S sub 1-surface twisted A82-11015
- JIN-SHENG, Y.
A theoretical analysis of the stream surface of revolution with supersonic inlet flow in a transonic axial compressor N82-11025
- JINQIANG, J.
Matrix analysis of wings N82-10998
- JOHANSSON, B. S.
Advanced fuel flowmeter for future naval aircraft
[AD-A104364] N82-11063
- JOHNSON, D. W.
Reductions in parachute drag due to forebody wake effects
[AIAA PAPER 81-1939] A82-10417
- JONES, J. L.
Aircraft excrescence drag
[AGARD-AG-264] N82-10020
- JORGENSEN, D. S.
Aerodynamics and performance of cruciform parachute canopies
[AIAA PAPER 81-1919] A82-10405
- JUE-LIANG, Z.
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure N82-11006
A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion N82-11007
- K
- KALININ, E. K.
The enhancement of heat exchange in channels /2nd revised and enlarged edition/
A82-12222
- KAMPE, R. F.
Developments in boundary layer Thrust Vector Control A82-10855
- KANIA, W.
Experimental study of subsonic and transonic flows past a wing A82-10363
- KANT, P.
Theory and applications of optimal control in aerospace systems
[AGARD-AG-251] N82-11073
- KANTOLA, E. A.
Effects of vane/blade ratio and spacing on fan noise
[AIAA PAPER 81-2033] A82-10457
- KARIMOVA, A. G.
Results of experimental study of heat transfer to turbine blades with porous cooling A82-11446
- KARMARKER, J.
Flight trajectory control investigation
[AD-A104542] N82-11048
- KHAKHULLIN, P. SH.
Experimental study of empennage snap-through vibrations A82-11471
- KISSLING, F.
Calculation of natural modes of vibration for rotor blades by the finite element method
[DFVLR-FB-81-07] N82-10452
- KIPP, H. W.
In-situ calibration of flight heat transfer instrumentation
[ASME PAPER 81-ENAS-13] A82-10901
- KLEIN, V.
Determination of airplane model structure from flight data by using modified stepwise regression
[NASA-TP-1916] N82-10041
- KLINAS, P. C.
A modular asymmetric parachute for wind tunnel testing
[AIAA PAPER 81-1933] A82-10414
- KLUG, H. G.
Active control elements on the transonic wing of the Airbus A-300 (ACTTA A). Airbus A-300 with reduced longitudinal stability (ACTTA-C) N82-10044
- KOHLMAN, D. L.
Icing tunnel test of a glycol-exuding porous leading edge ice protection system on a general aviation airfoil
[NASA-CR-165444] N82-10021

- Icing tunnel tests of a composite porous leading edge for use with a liquid anti-ice system [NASA-CR-164966] N82-11052
- KONDRATEV, K. IA.
Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity A82-12149
- KOBICKI, T. A.
Stress measurements in a ribbon parachute canopy during inflation and at steady state [AIAA PAPER 81-1944] A82-10420
Stress measurements in bias constructed parachute canopies during inflation and at steady-state [AIAA PAPER 81-1945] A82-10421
- KORNEV, B. M.
On the use of carbon composites in slat and stabilizer construction A82-11468
- KOZHEVNIKOV, IU. V.
Basic problem of aircraft gasturbine engine analytic design. II A82-11463
- KREBS, V.
Practical design and realization of a digital adaptive flight control system N82-11079
- KRENGEL, J. H.
Air-breathing engine test facilities register [AGARD-AG-269] N82-10063
- KRETH, J.
Mathematical model for the maintenance program of modern jet aircraft [DFVLR-FB-81-14] N82-10002
- KRICHKO, A. A.
Jet fuel from carbon A82-12021
- KRZYSIK, A.
Experimental study of subsonic and transonic flows past a wing A82-10363
- KSENOFONTOVA, E. M.
On evaluating the influence of local disruptions of flow over trailing edge and leading edge flaps from the data of wind tunnel tests of a rectangular wing segment A82-11465
- KUZHENKO, V. M.
Optimization of the principal design parameters of a passenger aircraft A82-10816
- KUZNETSOV, A. B.
On evaluating the influence of local disruptions of flow over trailing edge and leading edge flaps from the data of wind tunnel tests of a rectangular wing segment A82-11465
- L**
- LAGARDE, X.
Fast and accurate gyrocompass using strapdown tuned rotor gyros as a solution to combat helicopters navigation problems A82-11927
- LAHN, T. G.
Controlling the software/hardware interface for the validation of avionics systems [AIAA 81-2159] A82-10116
- LANDEL, R. P.
Rheological behavior of progressively shear-thickening solutions A82-11177
- LANDER, H. R.
Jet fuel locks to shale oil: The 1980 technology review [AD-A104414] N82-11228
- LARGE, H. H.
Flight test results of the model simulation controller for the HPB 320 for in-flight simulation of the A310 airbus [ESA-TT-660] N82-10107
- LAPIN, V. P.
A protective additive for jet fuels A82-12022
- LARGE, E.
Optimal flight paths for winged, supersonic flight vehicles - Extension to the case where thrust can be vectored A82-10310
- LASSITER, W. S.
Design predictions for noise control in the cryogenic National Transonic Facility A82-12025
- LAVOPIERRE, G.
Fast and accurate gyrocompass using strapdown tuned rotor gyros as a solution to combat helicopters navigation problems A82-11927
- LE BALLEUR, J. C.
Strong matching method for computing transonic viscous flows including wakes and separations - Lifting airfoils A82-10821
- LEBOT, Y.
Adaptation of a turbine test facility to high-temperature research [RAE-LIB-TRANS-2064] N82-11089
- LEBOUC, P.
Cost reduction in air transportation [SMIAS-811-150-101] N82-10025
- LEE, C. K.
A proposed flight safety program for the Korean Air Force [AD-A102373] N82-10023
- LEE, J.
New separators for battery systems A82-11715
- LEE, J. T.
Applications of conventional and Doppler radars for aviation safety A82-10215
- LEES, P.
Application of numerical methods to the calculation of electrostatic fields in aircraft fuel tanks [AD-A103270] N82-10033
- LEMMER, L.
A CFRP taileron for the Tornado: Construction and production [MBB-PE-212/KFK/PUB/2] N82-10035
- LEONG, P. J.
Advanced aircraft electrical system control technology demonstrator. Phase 1: Requirements analysis and conceptual design [AD-A103922] N82-10326
- LEPORSKIL, A. A.
Synthesis of system for evaluating gyrostabilizer state with unknown disturbances A82-11469
- LEVASHOV, P. D.
Formation of triangular-element stiffness matrix using sliding interpolation A82-11464
- LEVIN, A. D.
Propfan installation aerodynamics of a supercritical swept wing transport configuration [AIAA PAPER 81-1563] A82-10466
- LEWIS, D.
Helicopter engine technology - With particular reference to the Rolls-Royce Gem engine A82-10304
- LEYENDECKER, H.
Control law design for transport aircraft flight tasks N82-11080
- LIANG, D. P.
Simulation study of a hybrid strapdown attitude and heading reference system A82-12641
- LILLEY, D. G.
On the prediction of swirling flowfields found in axisymmetric combustor geometries A82-12120
- LIN, C.-P.
Real-time, on-line digital simulation of optimum maneuvers of supersonic aircraft [AIAA 81-2178] A82-10127
- LLORET, P.
Fast and accurate gyrocompass using strapdown tuned rotor gyros as a solution to combat helicopters navigation problems A82-11927

- LOEWENSTEIN, P.
Superclean superalloy powders by the rotating electrode process
A82-12496
- LOKAI, V. I.
Results of experimental study of heat transfer to turbine blades with porous cooling
A82-11446
- LUDWIG, D.
Calculation of natural modes of vibration for rotor blades by the finite element method [DFVLR-FB-81-07]
N82-10452
- LUKASZEWICZ, M.
The use of the Weber method for minicomputer-assisted numerical analysis of airfoils
A82-10362
- LUND, T. J.
Hard limited approaches to correlation velocity sensing
A82-12636
- LUNDY, A. S.
Outsider's look at flight instrumentation [DE81-025409]
N82-11066
- LUO, S.
Nonlinear prediction of subsonic aerodynamic loads on wings and bodies at high angles of attack
A82-11359
- LYKOV, O. P.
A protective additive for jet fuels
A82-12022
- LYNNWORTH, L. C.
Advanced fuel flowmeter for future naval aircraft [AD-A104364]
N82-11063
- M**
- MACFARLANE, A. G. J.
Characteristic and principal gains and phases and their use as multivariable control design tools
N82-10050
- MANHARDT, P. D.
A numerical three-dimensional turbulent simulation of a subsonic VSTOL jet in a cross-flow using a finite element algorithm [AD-A104514]
N82-11055
- MANION, W. E.
Automated Paint and Process Line /APPL/ [AIAA 81-2166]
A82-10120
- MANIINI, A.
Air-freon integrated environmental conditioning system for trainer subsonic aircraft [ASME PAPER 81-ENAS-33]
A82-10920
- MARCHIS, V.
Air-freon integrated environmental conditioning system for trainer subsonic aircraft [ASME PAPER 81-ENAS-33]
A82-10920
- MARKHAM, D. L.
The dispersion of drop sizes in gas turbine fuel nozzle sprays
A82-12107
- MARTINEZ, R.
Aeroacoustic theory for noncompact wing-gust interaction [PDRL-81-7]
N82-11071
- MATIAZH, A. I.
On evaluating the influence of local disruptions of flow over trailing edge and leading edge flaps from the data of wind tunnel tests of a rectangular wing segment
A82-11465
- MATSON, J. E.
Advanced fuel flowmeter for future naval aircraft [AD-A104364]
N82-11063
- MATSUUE, K.
New molding method of three-dimensional hollow photoelastic model and centrifugal stress analysis of air cooled turbine blade model [NAL-TR-427T]
N82-11067
- MATSUZAKI, Y.
New estimation method for flutter or divergence boundary from random responses at subcritical speeds [NAL-TR-667T]
N82-11034
- MATTICK, A. A.
Increasing the lift:drag ratio of a flat delta wing
A82-11899
- MAYER, J. T. B.
The Space Shuttle vehicle checkout involving flight avionics software [AIAA 81-2141]
A82-10100
- MAYER, N. J.
The balloon and the airship technological heritage [AIAA PAPER 81-1912]
A82-10401
- MCALLISTER, D.
Application of numerical methods to the calculation of electrostatic fields in aircraft fuel tanks [AD-A103270]
N82-10033
- MCCARTHY, J.
An airport wind shear detection and warning system using Doppler radar
A82-10220
- Instrumented aircraft verification of clear-air radar detection of low-level wind shear
A82-10221
- MCCLOUD, J. L., III
An investigation of a stoppable helicopter rotor with circulation control [NASA-TM-81218]
N82-10030
- MCDARMAID, D. S.
The application of improved aluminium alloys and steels in aircraft structures
A82-10305
- MCGHEE, R. J.
Wind-tunnel results for a modified 17-percent-thick low-speed airfoil section [NASA-TP-1919]
N82-11033
- MCGLADE, S. M.
Optical sensors for displacement measurement
A82-11407
- MCKEEN, R. G.
Design of airport pavements for expansive soils [AD-A104660]
N82-11313
- MCKENZIE, D. R.
Design and development of a low cost servoed rate gyro for unmanned aircraft
A82-11932
- MCLAUGHLIN, D. K.
On the prediction of swirling flowfields found in axisymmetric combustor geometries
A82-12120
- MCPHERSON, W. R.
SARSAT applications
A82-12698
- MCMILLIAN, B. N.
Simulation study of a hybrid strapdown attitude and heading reference system
A82-12641
- MEHDI, I. S.
Advanced aircraft electrical system control technology demonstrator. Phase 1: Requirements analysis and conceptual design [AD-A103922]
N82-10326
- MEI, C.
Response of nonlinear aircraft structural panels to high intensity noise
A82-12041
- MELUZOY, IU. V.
Basic problem of aircraft gasturbine engine analytic design. II
A82-11463
- METCALF, J. I.
Airborne weather radar and severe weather penetration
A82-10219
- MEYER, G.
Application of nonlinear systems inverses to automatic flight control design: System concepts and flight evaluations
N82-11083
- RICHARD, J.
Adaptation of a turbine test facility to high-temperature research [RAE-LIB-TRANS-2064]
N82-11089
- MIKALEVICH, V. S.
Optimization of the principal design parameters of a passenger aircraft
A82-10816
- MIKOLOWSKY, W. T.
ACMA - Fact or fantasy
A82-12048
- MIKULLA, V.
Standard tests of a research model rotor in a wind tunnel, including model similarity [BNVG-PBWT-79-16]
N82-10016

- HILLS, J. E.**
Digital avionics: Promise and practice - An airlines experience in the field
A82-11942
- HIROHER, A.**
Limiting payload deceleration during ground impact [AIAA PAPER 81-1918]
A82-10404
- HITCHELL, P.**
Bridging the gap from aircraft to space computers [AIAA 81-2142]
A82-10101
- MOORE, J. F.**
The digital civil aircraft
A82-11938
- MORRIS, C. E. K., JR.**
Parametric study of microwave-powered high-altitude airplane platforms designed for linear flight [NASA-TP-1918]
N82-11050
- MOSHNA, L. I.**
A protective additive for jet fuels
A82-12022
- MUENSCHEE, D.**
A contribution to the stabilization of flight vehicle parachute systems [ESA-TT-679]
N82-10046
- MURDOCK, G. A.**
Hard limited approaches to correlation velocity sensing
A82-12636
- MURPHY, P. C.**
Determination of airplane model structure from flight data by using modified stepwise regression [NASA-TP-1916]
N82-10041
- MURRI, D. G.**
Effects of vortex flaps on the low-speed aerodynamic characteristics of an arrow wing [NASA-TP-1914]
N82-11013
- MYERS, A. F.**
HiMAT onboard flight computer system architecture and qualification [AIAA 81-2107]
A82-10082
- N**
- NADKARNI, A. A.**
Comparative study of flare control laws [NASA-CR-164903]
N82-10032
- NAGLE-ESHELMAN, J.**
The Shock and Vibration Digest, volume 13, no. 9 [AD-A105062]
N82-10421
- NAIK, B. K.**
Development of aircraft production engineering discipline at IIT, Bombay
A82-11317
- NELSON, S. C.**
How large should a commuter transport be [AIAA PAPER 81-1732]
A82-10463
- NGUYEN, T. H.**
Advanced fuel flowmeter for future naval aircraft [AD-A104364]
N82-11063
- NIKIFOROVA, T. C.**
Jet fuel from carbon
A82-12021
- NOVAD, A. A.**
On the question of trailing airplane motion
A82-11470
- NOVAK, R. C.**
Development of low modulus material for use in ceramic gas path seal applications [NASA-CR-165469]
N82-10039
- O**
- ONEILL, J. J.**
A hidden advantage of permanent magnet electrical generating systems
A82-11720
- ORZECZOWSKI, J. A.**
A numerical three-dimensional turbulent simulation of a subsonic VSTOL jet in a cross-flow using a finite element algorithm [AD-A104514]
N82-11055
- P**
- PALM, L.**
Development of a nylon-kevlar recovery system for the CL-289 /AN/USD 502/ surveillance drone [AIAA PAPER 81-1952]
A82-10427
- PAPPE, N. P.**
Control of electromechanical actuator elements for flight vehicles
A82-12170
- PAPPE, V. P.**
Control of electromechanical actuator elements for flight vehicles
A82-12170
- PATERSON, J. E.**
Aircraft excrescence drag [AGARD-AG-264]
N82-10020
- PATRICK, J. P.**
Air supply system bite for Boeing 767 airplane [ASME PAPER 81-ENAS-7]
A82-10895
- PAVLOV, V. A.**
Experimental study of empennage snap-through vibrations
A82-11471
- PAVLOVSKII, V. P.**
One reason for the onset of high-frequency self-excited oscillations
A82-11448
- PEDERSEN, N. E.**
Advanced fuel flowmeter for future naval aircraft [AD-A104364]
N82-11063
- PEEL, C. J.**
The application of improved aluminium alloys and steels in aircraft structures
A82-10305
- PENG, S. T. J.**
Rheological behavior of progressively shear-thickening solutions
A82-11177
- PETERSON, C. W.**
Reductions in parachute drag due to forebody wake effects [AIAA PAPER 81-1939]
A82-10417
- PETROV, B. I.**
Control of electromechanical actuator elements for flight vehicles
A82-12170
- PIERREPONT, D.**
Towards minimum power for environmental control in transport aircraft [ASME PAPER 81-ENAS-4]
A82-10892
- PINES, S.**
An influence coefficient method for the application of the modal technique to wing flutter suppression of the DAST ARW-1 wing [NASA-CR-165772]
N82-11070
- PLESS, W. B.**
Acoustic emission - An emerging technology for assessing fatigue damage in aircraft structure
A82-11149
- POPE, R. E.**
The need for multivariable design and analysis techniques
N82-10049
- PRASAD, D. S. S.**
On computing Floquet transition matrices of rotorcraft
A82-11225
- PRASAD, U. R.**
Ideal and simulated performance of an aircraft in the terrain following mission
A82-11302
- PRATT, S.**
LQG multivariable design tools
N82-10054
- PRESS, J.**
Performance analysis of enroute air traffic control computers in the National Airspace System [AIAA 81-2203]
A82-10140
- PRINZ, R.**
Mathematical model for the maintenance program of modern jet aircraft [DFVLR-FB-81-14]
N82-10002
- PUCHKOV, V. A.**
Jet fuel from carbon
A82-12021
- PURI, S. H.**
Design considerations for the direct digital control of dry-tuned gyroscope
A82-11933
- PURVIS, J. W.**
Theoretical analysis of parachute inflation including fluid kinetics [AIAA PAPER 81-1925]
A82-10410

Q

QI-XUN, L.
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006
A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion
N82-11007
QINGXIANG, Y.
The automatic matrix force method and techniques for handling more complex computations with given computer capacity
N82-10994

R

RAGHUNATHAN, S.
Wind tunnel tests on airfoils in tandem cascade
A82-10987
RAGSDALE, W. A.
Use of Space Shuttle technology in conventional aircraft
[AIAA 81-2176]
A82-10125
RAJPAUL, V. K.
Closed loop environmental control systems for fighter aircraft
[ASME PAPER 81-ENAS-2]
A82-10890
RAJU, P. B.
Dynamic response of aircraft structure to gun shock loads
A82-11314
RANG, E. B.
Controlling the software/hardware interface for the validation of avionics systems
[AIAA 81-2159]
A82-10116
RANGAIAN, V. P.
Dynamic response of aircraft structure to gun shock loads
A82-11314
RAYMOND, E. T.
Aircraft digital input controlled hydraulic actuation and control system
[AD-A104263]
N82-11072
REED, E. A.
Parachute technology under pressure
A82-12804
REID, D. B.
Simulation study of a hybrid strapdown attitude and heading reference system
A82-12641
REID, J. A. I.
Design aspects of non rigid airship envelopes
A82-10306
REINHANN, J. J.
Selected bibliography of NACA-NASA aircraft icing publications
[NASA-TM-81651]
N82-11053
RHODE, D. L.
On the prediction of swirling flowfields found in axisymmetric combustor geometries
A82-12120
RICCI, R. J.
Integration of computer graphics design with analytical models
[AIAA 81-2134]
A82-10096
RICHARDSON, D.
F-5G Tigershark
A82-12775
RIES, E. G.
Interoperability testing of decentralized command, control, communications and intelligence /C3I/ systems
[AIAA 81-2205]
A82-10143
RIX, O.
System identification of the longitudinal motion of the DFVLR HPB 320 research aircraft with particular consideration of control surface effectiveness
[ESA-TT-666]
N82-10045
ROBERTS, L.
V/STOL aircraft and fluid dynamics
[NASA-TM-81328]
N82-10029
ROBERTS, W. E.
Air-film cooling returns to ramjets
[ASME PAPER 81-ENAS-8]
A82-10896

ROBINSON, C. W.
Aircraft digital input controlled hydraulic actuation and control system
[AD-A104263]
N82-11072
ROCK, S. M.
Development of multivariable controllers for aircraft turbine engines
N82-11087
RODGERS, C.
A new APU for medium place aircraft environmental control systems
[ASME PAPER 81-ENAS-1]
A82-10889
ROEHM, R. P.
Superalloy turbine components - Which is the superior manufacturing process, as-HIP, HIP plus Isoforge, or 'gatorizing' of extrusion consolidated billet
A82-12497
ROSENTHAL, Y.
Satellite geometry considerations for low cost GPS user equipment
A82-12630
BOUGHTON, D.
The all digital military aircraft
A82-11937
RU-QUN, Y.
Theoretical investigations and experimental researches for higher subsonic two-dimensional compressor cascade
N82-11024
RUPP, S.
Development and construction of pilot ejector seats in Germany from 1938-1945
[DFVLR-PB-81-04]
N82-10026
RUNZIAN, Z.
Matrix analysis of wings
N82-10998

S

SALIARIS, C.
A contribution to the stabilization of flight vehicle parachute systems
[ESA-TT-679]
N82-10046
SALVIOMI, L.
The possibility of using deformable rubber components in landing gear
A82-10496
SASHEVSKII, V. V.
A protective additive for jet fuels
A82-12022
SASTRY, D.
On computing Floquet transition matrices of rotorcraft
A82-11225
SCHAFER, H.
Quantification of the thermal environment for externally carried aircraft stores and ordnance
A82-12100
SCHAFRANEK, D.
Theoretical investigation of the influence of spoiler dynamics on the handling qualities of an aircraft with direct lift control
[ESA-TT-681]
N82-10036
SCHLINKER, R. H.
Helicopter rotor trailing edge noise
[AIAA PAPER 81-2001]
A82-10455
Helicopter rotor trailing edge noise
[NASA-CR-3470]
N82-11859
SCHNEIDER, M. H.
Thermal expansion accommodation in a jet engine frame
A82-11999
SCHWARTZ, A. C.
FAA developing new collision avoidance, data acquisition and transmission systems
A82-10396
SCHWEICKART, D.
High voltage surge and partial discharge test to evaluate aerospace equipment parts
A82-11740
SCHWEIKHARD, W. G.
Icing tunnel test of a glycol-exuding porous leading edge ice protection system on a general aviation airfoil
[NASA-CR-165444]
N82-10021
SEGREST, J. D.
Advanced aircraft electric power system
A82-11718

SEIF, J.
How large should a commuter transport be
[AIAA PAPER 81-1732] A82-10463

SELLARS, R. J.
Sophisticated aircraft structure developments -
Combat aeroplanes A82-10309

SENDERAK, K. L.
Sealed lead-acid batteries for aircraft applications
A82-11716

SEPULVEDA, D.
Application of numerical modeling to gas turbine
combustor development problems A82-12118

SERAFIN, R.
Detection and display of wind shear and turbulence
A82-10222

SERDIUK, V. A.
Control of electromechanical actuator elements for
flight vehicles A82-12170

SHAPIRO, A. A.
On evaluating the influence of local disruptions
of flow over trailing edge and leading edge
flaps from the data of wind tunnel tests of a
rectangular wing segment A82-11465

SHARMA, A. V.
Impact-initiated damage thresholds in composites
A82-12028

SHAW, L. H.
Rotor wake characteristics relevant to
rotor-stator interaction noise generation
[AIAA PAPER 81-2031] A82-10456

SHEKLETON, J. R.
The CIVIC - A concept in vortex induced
combustion. II
[ASME PAPER 81-GT-12] A82-11997

SHEHG, Y. T.
The principles and methods for shaping the wing
root regions of a wing-body combination at
transonic and lower supersonic speeds N82-11016

SHI-CAN, Z.
The arbitrary quasi-orthogonal surface method for
computing three-dimensional flow in turbine
machinery. 2. Calculation of the
three-dimensional flow with the S sub 1-surface
twisted N82-11015

SHIJUN, L.
Finite difference computation of the steady
transonic potential flow around airplanes N82-10981

SHOR, G. I.
A protective additive for jet fuels A82-12022

SHOU, W.
Nonlinear prediction of subsonic aerodynamic loads
on wings and bodies at high angles of attack
A82-11359

SHOULIAN, G.
Structural analysis of fuselages with cutouts by
finite element method N82-10995

SI-HONG, L.
Initial experimental research into the response of
turbojet engine compressors to distortion of
intake pressure N82-11006

A preliminary experimental investigation of the
response of a turbojet engine to inlet pressure
distortion N82-11007

SIDDIQUI, E. U. A.
Applications of finite element method in aerospace
power systems design A82-11717

SIEMERS, P. A.
Thermal-barrier-coated turbine blade study
[NASA-CR-165351] N82-10040

SKAISTIS, S. J.
'Quiet please' A82-10854

SKELTON, R. E.
Control design of flexible spacecraft N82-11081

SLATOR, T.
A mathematical model of an over-sea airborne UHF
radio link A82-11406

SMITH, J. R.
Application of numerical methods to the
calculation of electrostatic fields in aircraft
fuel tanks
[AD-A103270] N82-10033

SMITH, R. C.
Propfan installation aerodynamics of a
supercritical swept wing transport configuration
[AIAA PAPER 81-1563] A82-10466

SMITH, R. E.
Analysis of augmented aircraft flying qualities
through application of the Neal-Smith criterion
[AIAA PAPER 81-1776] A82-10462

SMITH, T. B.
Synchronous fault-tolerant flight control systems
[AIAA 81-2109] A82-10083

SOLOMON, H. L.
A navigation systems planning model A82-12640

SONG, C. J.
On the kernel function collocation method in
steady subsonic flow for wing with control
surfaces N82-12023

SONGLING, L.
An aerodynamic design method for transonic axial
flow compressor stage N82-10984

SONNICHSEN, T.
Baseline data on utilization of low-grade fuels in
gas turbine applications. Volume 3: Emissions
evaluation
[DE81-903764] N82-10254

SRI-JAYANTHA, M.
A microprocessor-based data acquisition system for
stall/spin research
[AIAA 81-2177] A82-10126

STANCZAK, R.
Analytical determination of undercarriage
retraction kinematics A82-10364

STATON, D. V.
Propulsion study for Small Transport Aircraft
Technology (STAT)
[NASA-CR-165499] N82-10037

STEBLETSOV, V. G.
Control of electromechanical actuator elements for
flight vehicles A82-12170

STEIN, G.
LQG-based multivariable design: Frequency domain
interpretation N82-10053

LQG multivariable design tools N82-10054

STENGEL, R. P.
A microprocessor-based data acquisition system for
stall/spin research
[AIAA 81-2177] A82-10126

STEPHENSON, A. R.
A navigation systems planning model A82-12640

STEPKA, P. S.
Thermal and flow analysis of a convection,
air-cooled ceramic coated porous metal concept
for turbine vanes
[ASME PAPER 81-HT-48] A82-10952

STERLIN, V. A.
On evaluating the influence of local disruptions
of flow over trailing edge and leading edge
flaps from the data of wind tunnel tests of a
rectangular wing segment A82-11465

STEVENS, G. W. H.
The net-skirt to a parachute canopy as a device to
prevent inversion
[AIAA PAPER 81-1927] A82-10412

STOCKMEIER, F. J.
Experimental study of fuel heating at low
temperatures in a wing tank model, volume 1
[NASA-CR-165391] N82-11224

STOCKER, B. P. W.
Fatigue substantiation of non-linear structures
A82-11224

- STOLLERY, J. L.
Increasing the lift:drag ratio of a flat delta wing
A82-11899
- STOLP, P. C.
Propulsion study for Small Transport Aircraft
Technology (STAT)
[NASA-CR-165499] N82-10037
- STONE, R. H.
Seven years experience with Kevlar-49 in the
Lockheed L-1011 Tristar
A82-12647
- STRICKER, R.
Standard tests of a research model rotor in a wind
tunnel, including model similarity
[BMVG-FBWT-79-16] N82-10016
- STURGES, G. J.
Application of numerical modeling to gas turbine
combustor development problems
A82-12118
Validation studies of turbulence and combustion
models for aircraft gas turbine combustors
A82-12267
- STUTZMAN, W. L.
Antenna theory and design
A82-12323
- SUBRAHMANYAM, B. S.
Ideal and simulated performance of an aircraft in
the terrain following mission
A82-11302
- SUNG, C. C.
The principles and methods for shaping the wing
root regions of a wing-body combination at
transonic and lower supersonic speeds
N82-11016
- SUTTON, T. G.
Considerations and applications for the use of
fluidics in aerospace controls
A82-12087
- SYED, S. A.
Application of numerical modeling to gas turbine
combustor development problems
A82-12118
Validation studies of turbulence and combustion
models for aircraft gas turbine combustors
A82-12267
- T**
- TAKAHARA, K.
New molding method of three-dimensional hollow
photoelastic model and centrifugal stress
analysis of air cooled turbine blade model
[NAL-TR-427T] N82-11067
- TALYZIN, V. A.
Basic problem of aircraft gasturbine engine
analytic design. II
A82-11463
- TAN, C. P.
Wind tunnel tests on airfoils in tandem cascade
A82-10987
- TERKEL, B.
An airport wind shear detection and warning system
using Doppler radar
A82-10220
- FERRY, G.
Sophisticated aircraft structure developments -
Combat aeroplanes
A82-10309
- THEOBALD, M. A.
Evaluation of the acoustic measurement capability
of the NASA Langley V/STOL wind tunnel open test
section with acoustically absorbent ceiling and
floor treatments
[NASA-CR-165796] N82-10059
- THIELE, G. A.
Antenna theory and design
A82-12323
- TIANGI, Y.
Structural analysis of fuselages with cutouts by
finite element method
N82-10995
- TIKHOMIROV, V. A.
On the use of carbon composites in slat and
stabilizer construction
A82-11468
- TSUI, J.
Tangential sensitivity of EW receivers
A82-11020
- TSUJIKAWA, G. S.
Closed loop environmental control systems for
fighter aircraft
[ASME PAPER 81-ENAS-2] A82-10890
- Tsun, T. C.
The principles and methods for shaping the wing
root regions of a wing-body combination at
transonic and lower supersonic speeds
N82-11016
- TUOHELA, C.
Test Pilots' Aviation Safety Workshop, U.S. Naval
Postgraduate School, Monterey, CA, February
25-28, 1981, Proceedings
A82-10500
- TURK, H.
Experimental investigations of the separated flow
around a rectangular wing
[DFVLR-FB-81-12] N82-10017
- TURNER, C. T.
Air bag impact attenuation system for the AQM-34V
remote piloted vehicle
[AIAA PAPER 81-1917] A82-10403
- U**
- UNDERWOOD, R. L.
Aircraft wing trailing-edge noise
[NASA-CR-164952] N82-11039
- URQUHART, R.
Limiting payload deceleration during ground impact
[AIAA PAPER 81-1918] A82-10404
- V**
- VANNOCKEE, R. C.
Variable speed constant frequency /VSCF/
electrical system cuts cost of ownership
A82-11719
- VEPA, R.
Numerical treatment of helicopter rotor stability
problems
A82-12045
- VINSON, J. R.
Emerging technologies in aerospace structures,
design, structural dynamics and materials;
Proceedings of the Aerospace Conference, San
Francisco, CA, August 13-15, 1980
A82-12026
- VLCEK, C.
Bridging the gap from aircraft to space computers
[AIAA 81-2142] A82-10101
- W**
- WAGNER, E. C.
Low maintenance hydraulic accumulator
[AD-A103947] N82-10034
- WALTERS, R.
Limiting payload deceleration during ground impact
[AIAA PAPER 81-1918] A82-10404
- WARREN, R. S.
Omega Station 10.2 kHz signal selection made easy
A82-12638
- WASSERBERG, S.
Air-film cooling returns to ramjets
[ASME PAPER 81-ENAS-8] A82-10896
- WEBB, D. B.
Development of a nylon-Kevlar recovery system for
the CL-289 /AN/USD 502/ surveillance drone
[AIAA PAPER 81-1952] A82-10427
- WEBB, J. H.
Some possibilities for composite light aircraft
construction
A82-10307
- WEBB, R. C.
60 KVA ADP permanent magnet VSCF starter generator
system - Generator system performance
characteristics
A82-11721
- WEBER, T.
The effects of flexibility on the steady-state
performance of small ribbon parachute models
[AIAA PAPER 81-1923] A82-10408
- WEI-ZAO, G.
A new method of cooling turbine vanes
N82-11027

WEIDE, Z.
An experimental investigation of the rotating stall, surge and wake behind the rotor for a single stage axial compressor
N82-11008

WEISS, R.
A solution to the static geometry problem for JTIDS relative navigation
A82-12634

WELCH, R. M.
Determination of vertical profiles of aerosol size spectra from aircraft radiative flux measurements. II - The effect of particle nonsphericity
A82-12149

WELLS, N. A. J.
Wind tunnel tests on airfoils in tandem cascade
A82-10987

WEN-LAN, I.
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006
A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion
N82-11007

WHITE, M.
Composite main rotor tubular braided
A82-10547

WIDDOWS, H. E.
A modular asymmetric parachute for wind tunnel testing
[AIAA PAPER 81-1933]
A82-10414

WIDMALL, S. E.
Aeroacoustic theory for noncompact wing-gust interaction
[FDRL-81-7]
N82-11071

WIEBE, W.
Fractographic determination of fatigue crack growth rates in aircraft components
A82-12697

WILENT, C. E.
KC-135 Avionics Modernization Hot Bench
[AIAA 81-2105]
A82-10081

WILK, K. E.
Applications of conventional and Doppler radars for aviation safety
A82-10215

WILLARD, W. E.
Low maintenance hydraulic accumulator
[AD-A103947]
N82-10034

WILLIAMS, J. C.
Design of high integrity multivariable control systems
N82-10055

WILLIAMS, R. C.
Low speed testing of the inlets designed for a tandem-fan V/STOL nacelle
[NASA-TM-82728]
N82-11042

WILLSHIRE, W. L., JR.
SEL and EPNL noise duration coefficients for the 747 and T-38 aircraft
[NASA-TM-83214]
N82-11860

WILMOTH, R. G.
Computation of high Reynolds number internal/external flows
[NASA-TM-84049]
N82-11046

WILSON, J.
Detection and display of wind shear and turbulence
A82-10222

WILSON, V. E.
Design analysis of high temperature transparent windshields for high performance aircraft
[ASME PAPER 81-ENAS-5]
A82-10893

WOHMAN, W. M.
A geometric approach to multivariable control system synthesis
N82-10056

WOODLEY, G. E.
Light aircraft structural design in non-metallics - Use of composite honeycomb for light aircraft
A82-10308

X

XIAO-KANG, X.
The arbitrary quasi-orthogonal surface method for computing three-dimensional flow in turbine machinery. 2. Calculation of the three-dimensional flow with the S sub 1-surface twisted
N82-11015

XIN-YUAN, W.
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006
A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion
N82-11007

XINHAI, Z.
An aerodynamic design method for transonic axial flow compressor stage
N82-10984

XUENCHUN, T.
Structural analysis of fuselages with cutouts by finite element method
N82-10995

Y

YAVUZ, T.
Experimental determination of parachute apparent mass and its significance in predicting dynamic stability
[AIAA PAPER 81-1920]
A82-10406

YBARRA, A. H.
Low speed testing of the inlets designed for a tandem-fan V/STOL nacelle
[NASA-TM-82728]
N82-11042

YING, Z.
A theoretical analysis of the stream surface of revolution with supersonic inlet flow in a transonic axial compressor
N82-11025

YIP, L. P.
Effects of vortex flaps on the low-speed aerodynamic characteristics of an arrow wing
[NASA-TP-1914]
N82-11013

YIULIU, C.
Matrix analysis of wings
N82-10998

YOSHIDA, T.
New molding method of three-dimensional hollow photoelastic model and centrifugal stress analysis of air cooled turbine blade model
[NAL-TR-427T]
N82-11067

YOUNG, A. D.
Aircraft excrescence drag
[AGARD-AG-264]
N82-10020

YU-MING, Z.
A new method of cooling turbine vanes
N82-11027

YUAN, X.
Matrix analysis of wings
N82-10998

YUNEN, Z.
Finite difference computation of the steady transonic potential flow around airplanes
N82-10981

Z

ZANES, G.
Multivariable design: The optimization of approximate inverses
N82-10057
Feedback and minimax sensitivity
N82-10058

ZEBKER, H. A.
Synthetic aperture radar target simulator
[NASA-CASE-NPO-15024-1]
N82-10286

ZEMPOLICH, B. A.
Memory requirements for future navigation systems
A82-12637

ZHAO-YAN, Q.
Theoretical investigations and experimental researches for higher subsonic two-dimensional compressor cascade
N82-11024

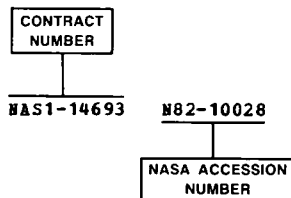
- ZHIVEI, L.
An experimental investigation of the rotating stall, surge and wake behind the rotor for a single stage axial compressor
N82-11008
- ZHU, P.
Nonlinear prediction of subsonic aerodynamic loads on wings and bodies at high angles of attack
A82-11359
- ZHUAN-SHE, D.
A theoretical analysis of the stream surface of revolution with supersonic inlet flow in a transonic axial compressor
N82-11025
- ZI-LONG, H.
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006
A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion
N82-11007
- ZOLEZZI, B. A.
Propulsion study for Small Transport Aircraft Technology (STAT)
[NASA-CR-165499]
N82-10037
- ZONG-YUAN, W.
Initial experimental research into the response of turbojet engine compressors to distortion of intake pressure
N82-11006
A preliminary experimental investigation of the response of a turbojet engine to inlet pressure distortion
N82-11007
- ZRNIC, D. S.
Instrumented aircraft verification of clear-air radar detection of low-level wind shear
A82-10221
- ZUO-BEN, J.
A theoretical analysis of the stream surface of revolution with supersonic inlet flow in a transonic axial compressor
N82-11025

CONTRACT NUMBER INDEX

AERONAUTICAL ENGINEERING / *A Continuing Bibliography (Suppl. 145)*

FEBRUARY 1982

Typical Contract Number Index Listing



530-01-13-02 N82-11050
532-02-11 N82-10031
534-01-13-14 N82-11391

Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the IAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the IAA or STAR section.

AF PROJ. 2003	N82-11062	NAS3-20643	A82-11999
AF PROJ. 2301	N82-10033	NAS3-21727	N82-10040
AF PROJ. 2403	N82-11048	NAS3-21977	N82-11224
AF PROJ. 2480	N82-11228	NAS3-21995	N82-10037
AF PROJ. 3048	N82-10033	NAS3-22045	N82-10038
AF PROJ. 3145	N82-10034	NAS3-22062	N82-11230
	N82-10326	NAS3-22134	A82-10457
	N82-11072	NAS3-22149	N82-10339
AF-APOSER-0223-80	N82-10033	NAS3-22149	N82-11068
DA PROJ. 1L2-62202-AH-85	N82-11064	NAS4-2518	N82-11078
	N82-11065	NAS6-3072	A82-10411
DA PROJ. 4A7-62719-AT-40	N82-11498	NAS7-100	A82-11177
DAAG29-C-027	A82-11300		N82-10286
DAAK80-79-C-0270	N82-11064	NAS8-31377	N82-11514
	N82-11065		A82-10220
DE-AC04-76DP-00789	A82-10414	NAS8-33458	A82-10221
DNA001-80-C-0177	N82-11354		A82-10220
DTFA01-80-Y-10597	N82-10812	NGR-14-001-008	A82-10221
EPRI PROJ. 1079-3	N82-10254	NOAA-04-4-158-1	A82-10214
F29601-76-C-0051	N82-11313	NSF ATM-74-03406-A02	A82-10214
F33600-80-C-0473	A82-10081		A82-10220
F33615-68-C-3421	A82-10893	NSF ATM-76-24236	A82-10221
F33615-74-C-2037	A82-11721	NSF ATM-77-22384	A82-10292
F33615-76-C-1243	N82-11062	NSF ATM-78-01074	A82-12149
F33615-76-C-2088	N82-10034	NSF ATM-78-05743	A82-10214
F33615-77-C-2034	N82-11072	NSF ATM-78-12401	A82-12149
F33615-78-C-2200	A82-11721		A82-10220
F33615-78-C-3607	N82-11048	NSF ECS-80-12-565	A82-10221
F33615-80-C-2004	N82-10326	NSG-1296	N82-10058
F49620-79-C-0169	A82-12041	NSG-1377	A82-12028
NAG3-71	N82-10021	NSG-1480	N82-11039
NAG3-74	N82-12120	NSG-2142	N82-10032
NASW-3542	N82-11636	N00014-75-C-01444	N82-11071
NAS1-14611	N82-10059		N82-11078
NAS1-14693	N82-10028	N00024-81-C-5301	N82-10027
NAS1-15593	N82-11070	N62269-78-C-0069	N82-11063
NAS1-15730	A82-10455	N62269-79-C-0295	N82-11055
	N82-11859	N62269-80-C-0146	A82-10646
NAS1-15988	A82-10934	W-7405-ENG-36	N82-11046
NAS2-9410	N82-10043		N82-11066
			N82-11043
		500-42-62	N82-11033
		505-31-33-05	N82-11054
		505-31-41	N82-11860
		505-32-03-01	N82-10039
		505-32-42	N82-11339
		505-34-13-02	N82-10041
		505-34-33-06	N82-10042
			N82-10029
		505-42-71	N82-11013
		505-43-13-01	N82-10021
		505-44-12	

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