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# AERONAUTICAL ENGINEERING

## **A Continuing Bibliography**

### **Supplement 103**

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 November 1978 in

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



Scientific and Technical Information Branch

1978

**National Aeronautics and Space Administration**

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# INTRODUCTION

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

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 457 reports, journal articles, and other documents originally announced in November 1978 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.

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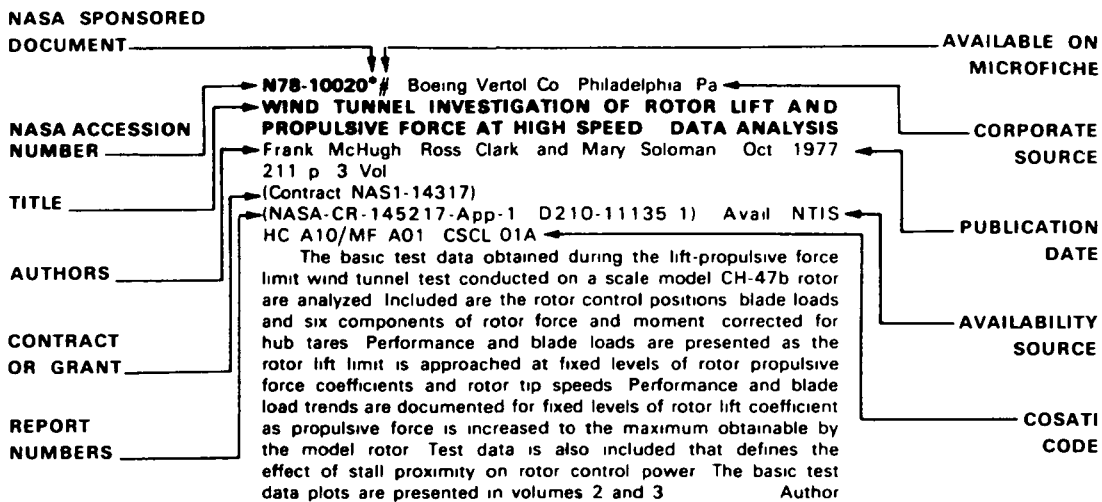
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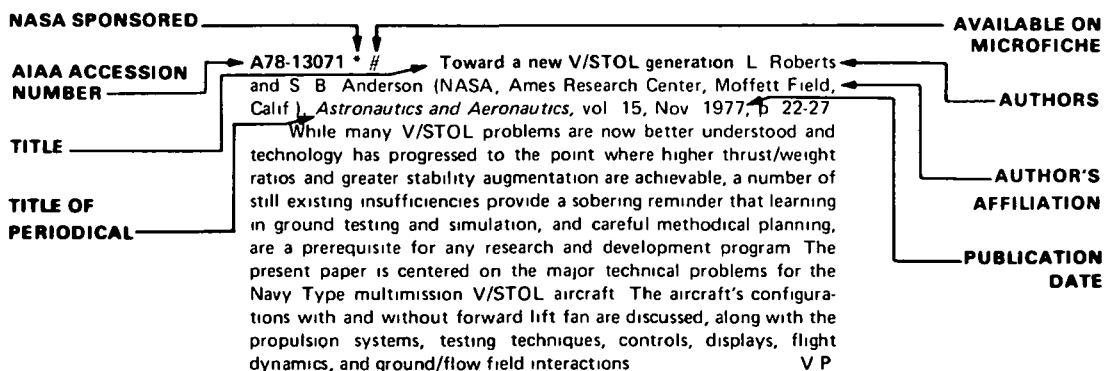
# TABLE OF CONTENTS

IAA Entries .....	507
STAR Entries .....	543
Subject Index .....	A-1
Personal Author Index .....	B-1
Contract Number Index .....	C-1

## TYPICAL CITATION AND ABSTRACT FROM STAR



## TYPICAL CITATION AND ABSTRACT FROM IAA



DECEMBER 1978

## IAA ENTRIES

**A78-46915**      **Methods available to ONERA for analysis of combustion chambers (Methodes disponibles à l'ONERA pour le calcul des chambres de combustion)** R Borghi, F Hirsinger, and H Tichtinsky (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *Entropie*, vol 14, May/June 1978, p 3-14 23 refs In French

The approaches described treat in a detailed manner not the global problem of combustion in a combustion chamber but rather the processes taking place in different regions of the chamber. The discussion covers the principle of decomposition of the combustors into different subsets to which the various methods apply, the different physical and chemical processes to be schematized under the dual requirements of accuracy and economy of calculation, two-dimensional steady analyses without recirculation, and an unsteady two-dimensional analysis with recirculation applied to ignition in a recirculation core P T H

**A78-46961 #**      **Constant-control rolling maneuver** T Hacker (Institute for Fluid Mechanics and Aerospace Design, Bucharest, Rumania) *Journal of Guidance and Control*, vol 1, Sept-Oct 1978, p 313-318 10 refs

Practical interest for supplementing stability analysis by domain-of-attraction considerations in studying constant-control maneuvers is pointed out. Implications in cost of computing work of the free parameter choice are estimated. A technique is presented for defining the entire safe range of maneuver in terms of regions of allowable and actually attainable roll rate values and the corresponding aileron inputs. Gravity effects are considered to define peak-value corrections of limits on the steady-state values of system variables and to estimate the maximum allowable duration of a rolling maneuver. An illustration of how a Lyapunov function provides estimate of the domain of attraction is given (Author)

**A78-46962 #**      **Digital control law synthesis in the w prime domain** R F Whitbeck and L G Hofmann (Systems Technology, Inc., Hawthorne, Calif.) *Journal of Guidance and Control*, vol 1, Sept-Oct 1978, p 319-326 11 refs Contract No F33615-77-C-3026

Utility of w prime transform domain analysis/synthesis procedures for linear, constant, single-rate sampled-data systems is explored. Basic properties of the w prime domain are reviewed and compared with corresponding z-, w-, and s-domain properties. The main contribution of the paper is recognition that sampling and data-hold operations are modeled exactly in the w prime domain, regardless of the sampling rate employed, and that the w prime variable is analogous to the s variable in the sense that all familiar frequency domain design concepts, procedures, and interpretations can be carried over directly. Moreover, the imaginary part of w prime approximates angular frequency for absolute values less than  $\pi/2T$ , which further facilitates interpretation. Two example applications illustrate the procedure and make clear (by means of transfer functions and Bode plots) the nonminimum phase effects of sampling and data-hold operations and of sampling rate. It is demonstrated that acceptable closed-loop performance can be achieved at sampling rates that are an order of magnitude less than those employed when an emulation design approach is used (Author)

**A78-46965 #**      **Stability augmentation by eigenvalues control and model matching** M N Wagdi (Cairo, University, Cairo, Egypt) *Journal of Guidance and Control*, vol 1, Sept-Oct 1978, p 381-383

Generally, when performing certain maneuvers, the aircraft stability is considerably degraded, thus limiting its performance capabilities. The utilization of a stability augmentation system permits the aircraft to perform the required maneuver with the desired stability requirements. A description is provided of a stability augmentation system which could be considered as a version of a digital fly-by-wire control system. The considered scheme differs fundamentally from the conventional model-following techniques. It requires knowledge of the model eigenvalues rather than the model coefficient matrix. A new approach for eigenvalues assignment is presented. It is valid for distinct as well as repeated eigenvalues, complex or real. The control vector is linearly related to the system state and to the command input through two gain matrices G R

**A78-47124**      **Neutralization problem for a Space Shuttle** H Kikuchi (Nihon University, Tokyo, Nagoya University, Nagoya, Japan) In International Symposium on Space Technology and Science, 12th, Tokyo, Japan, May 16-20, 1977, Proceedings Chofu, Tokyo, National Aerospace Laboratory, 1977, p 893-899 12 refs

An attempt is made to gain insight into the mechanism of Shuttle Orbiter charging and discharging during the operation of the electron gun, as well as to find some effective methods for charge neutralization, particularly for pulsed electron beams. If a pulsed or bunched electron beam rather than a pure continuous dc beam is used, the vehicle charge neutralization problem can be alleviated by increasing amplitude and decreasing duty cycle in beam pulses, because a high positive potential of the vehicle can be discharged or shorted through a distributed capacitance between the beam and conducting areas in the form of ac displacement current rather than dc current. The thermal insulator skin offers an ac short-circuit effect acting as a dielectric capacitor to facilitate ac neutralization. S D

**A78-47172 #**      **Trailing vortices II (Problem wirow zaskrzydlowych II)** J Staszek *Technika Lotnicza i Astronautyczna*, vol 33, July 1978, p 12 15 In Polish

The paper deals with the mechanisms of trailing vortex generation, and with vortex development and decay. The influence of the turbulence induced by wide-body airliners on smaller aircraft flying in their wake is examined, and a scheme for establishing safe separations between aircraft of various weight, in flight and in approaches to landing, is proposed. Means of suppressing the development of trailing vortices by modifying their structure are discussed V P

**A78-47173 #**      **Progress in propeller aerodynamics (Wspolczesny rozwój aerodynamiki śmigła)** Z Brodzki *Technika Lotnicza i Astronautyczna*, vol 33, July 1978, p 25-29 11 refs In Polish

The paper is a review of the results of present studies concerning the thrust characteristics and aerodynamics of turboprops, ducted propellers, propellers, and propfans (the latter operating in a cross-wind). The structure of vortices trailing off propeller blades of various design is analyzed. Particular attention is given to the characteristics of an eight-blade propfan with sword shaped blades. The underestimation of the actual thrust of these advanced propeller designs is noted, and corrections to classical theory, based on the consideration of such factors as the Coriolis force, the complex structure of the trailing vortex, the scale factor, etc. is discussed V P

**A78-47175 # Operation of oil seals of aircraft piston engines under conditions of cavitation I (Praca olejowych uszczelnien silników pierścieniowych lotniczych w warunkach kawitacji I)** M Ostapkowicz (Instytut Techniczny Wojsk Lotniczych, Warsaw, Poland) *Technika Lotnicza i Astronautyczna*, vol 33, July 1978, p 33-35 In Polish

**A78-47242 \* An acoustic range for the measurement of the noise signature of aircraft during flyby operations** D A Hilton and H R Henderson (NASA, Langley Research Center, Hampton, Va) *Noise Control Engineering*, vol 10, May-June 1978, p 120-128 6 refs

The remotely operated multiple array acoustic range (ROMAAR), which has been developed to give direct measurement and display of aircraft noise in several measurement units during takeoff, landing, and flyby operations, is described. The ROMAAR, which provides information on the ground noise signature of aircraft, represents a unique combination of state-of-the-art digital and analog noise-recording methods, computer-controlled digital communication methods, radar tracking facilities, quick-look weather (profile) capabilities, and sophisticated data handling routines and facilities. The ROMAAR, which is operated by NASA, allows direct data feedback to the NASA Aircraft Noise Prediction Office. As many as 38 simultaneous noise measurements can be made for each aircraft overflight.

M L

**A78-47266 # The promise of tilt rotor** T H Thomason (Bell Helicopter Textron, Fort Worth, Tex) *Aircraft Engineering*, vol 50, July 1978, p 11-13

After a brief description of the principles of tilt rotor aircraft, the paper emphasizes its prospective applications. Such applications as point-to-point executive transportation, off-shore exploration, and short haul commercial air transportation are briefly discussed. Consideration is given to the noise-pollution and safety aspects of tilt rotor as well as to its principles of flight and historical development. The question of when tilt rotor will become available is discussed.

B J

**A78-47267 # Large electroformed nickel moulds for aircraft parts** P Spiro *Aircraft Engineering*, vol 50, July 1978, p 14-16

After a brief discussion of traditional tooling, the paper considers the use of electroformed nickel molds for glass-fiber-reinforced-plastic aircraft components (e.g., radomes). Attention is given to the electroforming process, the maximum size of the mold, the formation of masters, and the formation of molds. Several photographs of the nickel molds are presented.

B J

**A78-47268 # COMED - The cockpit display of the future** E W Hare (Ferranti, Ltd, Inertial Systems Dept, Edinburgh, Scotland) *Aircraft Engineering*, vol 50, July 1978, p 17-19

COMED (Combined Map and Electronic Display) is suitable for displaying both phototopographical and electronically generated graphical information, either separately or together. A moving map indicating the aircraft's present position can be shown on COMED with superimposed waypoints, command tracks, and any other data - either graphical or alphanumeric - that may be relevant. Battle intelligence could also be displayed electronically by superimposing on the COMED projected map such details as enemy SAM sites, defended areas, etc. The paper gives a detailed description of COMED and presents a close-up photograph of the COMED prototype as well as a picture of the COMED optical arrangement.

B J

**A78-47269 # Let's put fuel efficiency into perspective** J P Dow (Grumman American Aviation Corp, Savannah, Ga) *Aircraft Engineering*, vol 50, July 1978, p 24-27

The paper discusses several measures of fuel efficiency and examines the advantages of each as it applies to business aircraft. The measures of efficiency discussed are passenger miles, fuel consumption per mile or specific range, range factor (a measure of design efficiency), and specific fuel consumption (a measure of engine efficiency). Figures are presented illustrating changes of specific fuel consumption for four different conditions of net thrust definition.

Specific range comparisons are then presented for a mission of 500 nautical miles along with a range factor analysis for missions of the same distance.

B J

**A78-47346 # Flutter suppressor for transonic flight (Suppresseur de flottement en transsonique)** R Destuynder (ONERA, Division de Recherche, Châtillon sous Bagneux, Hauts-de-Seine, France) *La Recherche Aéronautique*, May-June 1978, p 117-123 In French

A dynamically similar model of the half-wing of a modern aircraft was equipped with weighted external tank in order to obtain flutter at transonic velocity. Flutter control is achieved by a classical aileron that produces a reduction in frequency of the lowest flutter mode through the effect of 'negative stiffness'. Significant gain in the critical dynamic pressure and Mach number have been achieved. Different values of the feedback phase were employed in order to determine the stability range as a function of feedback phase.

P T H

**A78-47347 # Linearized theory of plane, unsteady, supersonic flow through a cascade - Subsonic part of the leading edge (Théorie linéarisée de l'écoulement plan supersonique instationnaire à travers une grille - Lieu des bords d'attaque subsonique)** P Salaun (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *La Recherche Aéronautique*, May-June 1978, p 125-132 11 refs In French

Perturbation pressures are computed by a linearized theory from the starting point of an integral equation in which the unknown function is the pressure difference between two sides of a reference blade and the right-hand side is a known function of the motion. The integral equation is obtained from the boundary condition for the reference blade by setting up a pressure doublet distribution on the blades. Approximations made in a three-dimensional calculation are tested by this theory for the case of two-dimensional flow.

P T H

**A78-47348 # Calculation of exchange coefficients for high-temperature turbine blades (Calcul des coefficients d'échange sur les aubes de turbines à haute température)** P Michard and D Dutoya (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *La Recherche Aéronautique*, May-June 1978, p 133-137 6 refs In French

The paper gives the results of a finite element calculation of the velocity and temperature profiles, momentum thickness, wall fluxes, and the exchange coefficient from the equations of mass, momentum and energy conservation in parabolic form for high-temperature turbulent flow past a turbine blade. The exchange coefficient calculated is defined as the wall flux divided by the difference between the adiabatic wall temperature and the wall temperature. Experimental results for a distributor blade were compared with calculations, and the agreement is satisfactory.

P T H

**A78-47349 # Flight application of optical fiber transmission on a Falcon 10 aircraft (Utilisation en vol d'une transmission par fibre optique à bord d'un Falcon 10)** J Taillet (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) and J Reibaud (Avions Marcel-Dassault-Breguet Aviation, Vaucresson, Hauts-de-Seine, France) *La Recherche Aéronautique*, May-June 1978, p 139-141 In French

A device for measuring the current from a potential discharger uses optical fiber for digital transmission. The operation of the device mounted on an aircraft has been tested in flight. The first tests show that the signal-to-noise ratio is greatly improved over that of the conventional transmission system.

P T H

**A78-47402 # Solution of an adjoint problem of steady-state heat transfer associated with the cooling of gas-turbine blades, by means of a quasi-analog/digital system (Reshenie sopriazhennoi zadachi statsionarnogo teploobmena primentel'no k oklzhdaemym lopatkam gazovykh turbin s pomoshch'iu kompleksa - kvaziana-logovoi AVM-ETsVM)** A V Temnikov, V I Igonin, and Iu S Vytchikov. In *Simulation of nonstationary processes*.

Kiev, Institut Matematiki AN USSR, 1977, p 22-27 6 refs In Russian

**A78-47404 #** Application of electrical analogy to the substantiation and comparison of some analytical methods of determining temperature fields in gas-turbine blades (Primenenie elektricheskogo modelirovaniia dlia obosnovaniia i sravneniia s nekotorymi analiticheskimi metodami opredeleniia teplovykh polei v lopatkakh gazovykh turbin). V I Igonin, A V Temnikov, and V M Khorol'skii In Simulation of nonstationary processes 47401 21 59) Kiev, Institut Matematiki AN USSR, 1977, p 71-76 5 refs In Russian

**A78-47407 #** Probabilistic model of an instrument landing system (Veroiatnostnaia model' instrumental'noi posadki samoletov) L Ia Il'bitskii, A G Revuk and M I Fuzik In Simulation of nonstationary processes (v Kiev, Institut Matematiki AN USSR, 1977, p 124-127 In Russian

In the present paper, the model of an instrument landing system is treated as the guidance process involved in a rendezvous maneuver, complicated by a variable electromagnetic environment In this approach, there arises the problem of determining the probability that at a certain moment of time the aircraft will be situated either in a region corresponding to the zero-reading of the onboard indicator, or in a radio range of plus or minus 10 degrees (or between 10 and 35 degrees) from the specified track The problem is solved by using a model in the form of a sequence of random events characterized by five possible states V P

**A78-47423** The second generation of high-bypass turbofans - A market clouded by uncertainty J F Brindley *Interavia*, vol 33, Aug 1978, p 711 714

Second generation high bypass turbofan concepts for commercial aviation are reviewed in terms of performance and fuel economy The General Electric/SNECMA CFM56 is considered the most advanced, offering fuel savings on the order of 30% per passenger over older engines The CFM56 will be rated at 10,885 kp and could enter service by 1981 Other engines are also reviewed, including the RB 211 535, the JT10D, rated at 14,515 kp, to be used in a new Boeing trijet, and the CF6-32, which maintains the core of the Dash-6D2 while incorporating a new LP turbine and turbine mid-frame D M W

**A78-47424** RNAV Corporate operators set the pace E Wooten *Interavia*, vol 33, Aug 1978, p 722 727

Area navigation (RNAV) systems are discussed in terms of their suitability for the commercial aircraft market, and with attention to their capabilities in the vertical dimension Four RNAV categories are outlined course line, whereby a number of way-points (determined in advance) are entered into a computer, and steering and other guidance parameters are calculated to provide navigation from way-point to way-point, great circle, which provides point-to-point navigation along great circle routes, inertial, using updated but self-contained inertial guidance, and VLF/Omega systems, which permit manual or automatic updating of Omega signals to an accuracy of 2.8 km along track D M W

**A78-47452** Design philosophy for engine forgings J D Alexander (Rolls-Royce, Ltd, London, England) In Forging and properties of aerospace materials, Proceedings of the International Conference, Leeds, England, January 5-7, 1977 London, Metals Society, 1978, p 1-7

Design and control considerations in connection with the manufacture of engine components for jet engines are discussed It is pointed out that the design and control of these parts requires a detailed understanding of both the use and the material behavior of the involved component The design of a component is based on the required performance, the guaranteed life required, the space

available, weight, cost, knowledge of material behavior, and the mechanical properties Attention is given to the evaluation of new materials, questions of material characterization, the design of components which are subjected to high stresses, an assessment of the disk, objectives and implementation of quality control, and the conduction of tests to verify that design requirements have been met Forgings are chosen where the property and quality levels and consistency are the controlling factors in the use G R

**A78-47453** Design philosophy for airframes I L G Baillie and W P C Soper (British Aircraft Corp Ltd, Commercial Aircraft Div, Filton, Bristol, England) In Forging and properties of aerospace materials, Proceedings of the International Conference, Leeds, England, January 5-7, 1977 London, Metals Society, 1978, p 8-23

The technical requirements for modern civil and military aircraft entail a continual improvement in materials and their application The structural loading and airworthiness requirements background is explained in terms of aerodynamic loads and aircraft use with special reference to modern 'fail safe' airframe design concepts, leading to a defined range of properties which must be checked to be acceptable Suitable applications for forgings are detailed for the range of aluminum, titanium, steel and nickel alloy systems of interest, and the need for application of new techniques explored for airframe exploitation Emphasis is also placed on batch quality control aspects via national UK specifications (Author)

**A78-47481** Advances in inertial navigation P R Foggie (RAF, London, England) *Electronics and Power*, vol 24, Aug 1978, p 582-584

Inertial navigation systems in use and under development are discussed Navattack systems used in modern military aircraft rely on stabilized platform systems which are costly and, as a result of their complexity, not totally reliable The performance capabilities of Navattack systems, which are examples of integrated systems, are indicated Strap-down inertial systems, still in the developmental stage, are described, in these systems, both gyros and accelerometers are mounted rigidly on the aircraft structure One approach involves the electrostatic suspended gyro which has a ball spun within a closely surrounding spherical case without there being any mechanical connection between ball and case The laser gyro represents another approach, this gyro, which has no moving parts, is cheap, but its use is complicated by basic sources of errors, including frequency synchronization (lockin) M L

**A78-47490 \*** Ride quality evaluation IV - Models of subjective reaction to aircraft motion I D Jacobson and L G Richards (Virginia, University, Charlottesville, Va) *Ergonomics*, vol 21, July 1978, p 521-529 Grant No NGR 47-005-181

The paper examines models of human reaction to the motions typically experienced on short-haul aircraft flights Data are taken on the regularly scheduled flights of four commercial airlines three airplanes and one helicopter The data base consists of (1) a series of motion recordings distributed over each flight, each including all six degrees of freedom of motion, temperature, pressure, and noise are also recorded, (2) ratings of perceived comfort and satisfaction from the passengers on each flight, (3) moment-by-moment comfort ratings from a test subject assigned to each airplane, and (4) overall comfort ratings for each flight from the test subjects Regression models are obtained for prediction of rated comfort from rms values for six degrees of freedom of motion It is shown that the model  $C = 2.1 + 1.71 T + 1.72 V$  ( $T$  = transverse acceleration,  $V$  = vertical acceleration) gives a good fit to the airplane data but is less acceptable for the helicopter data S D

**A78-47570** From Challenger to winner *Air International*, vol 15, Sept 1978, p 111-116, 129, 130

The development and characteristics of the Canadair Challenger business jet are described, with the aircraft utilizing a modification of the LearStar 600. The aircraft will provide a range of 4,450 naut mls with a tolerance of 450 naut mls, a maximum speed of 505 kt with a 20-kt tolerance, and a cruising speed of Mach 0.86 (490 kt/hr). The fuselage diameter is 106 in, the wing area is 420 sq ft, and the gross weight is 32,500 lb. The engines, (modified ALF 502), give 7500 lb st for take-off and a thrust-to-weight ratio of 0.46. The wing is a highly complex design with a deeply scalloped undersurface, a built-in twist from root to tip, and changes of aerofoil along the wing. The first Challenger was completed in May 1978. Sales prospects and negotiations between Lear and Canadair are discussed. M L

**A78-47599 #** The influence of high twist on the dynamics of rotating blades. W F White, Jr (U S Army, Structures Laboratory, Hampton, Va.) *Associazione Italiana di Aeronautica ed Astronautica and Associazione Industrie Aerospaziali, European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, Sept 13-15, 1978, Paper 14* p 6 refs

A method is presented for determining the free vibration characteristics of a rotating blade having high twist and nonuniform spanwise properties. The equations which govern the bending and torsional motion of such a blade are solved using a generalized integration matrix as the basis of the method of solution. By using this matrix as an operator on the equations expressed in matrix notation, the differential equations are numerically integrated to eliminate the spatial dependence and reduced to familiar matrix eigenvalue form from which the dynamics of the blade are determined using standard eigenvalue extraction techniques. The application of this technique to problems of this type offers several computational advantages over other methods of solution. Numerical results using the present method of solution are in good agreement with experimental results. (Author)

**A78-47865** AIDS in engine management programmes. A E Davies (Rolls-Royce, Ltd, Derby, England) *Aeronautical Journal*, vol 82, June 1978, p 235-242. 5 refs

The paper examines the role of AIDS (airborne integrated data systems) in the total management program of an aircraft propulsion system. As a particular example, attention is given to the application of AIDS to the control system monitoring and low cycle fatigue monitoring of the Concorde engine. The applications of AIDS to helicopter engines and military aircraft engines are also discussed along with the future development of AIDS. B J

**A78-47866** AIDS in military aircraft. E Daley and A Delahunty (British Aerospace, Aircraft Group, Preston, Lancs, England) *Aeronautical Journal*, vol 82, June 1978, p 243-246

The paper reviews the development of AIDS (airborne integrated data systems) in the past 10-12 years with reference to military aircraft. Consideration is given to the operational requirements of AIDS, and to the use of AIDS, particularly BITE (built in test equipment) in three generations of aircraft: the in-service generation, aircraft presently under development, and the next generation. For aircraft now under development, emphasis is placed on continuous monitoring, interruptive testing, and test software, for the next generation, emphasis is placed on the computing system, display systems, and sensors. B J

**A78-47868** Air-to-air combat simulation. A G Barnes and D E A Houghton (British Aerospace, Warton Div, Preston, Lancs, England) *Aeronautical Journal*, vol 82, June 1978, p 255-260

Recent developments in air-to-air combat simulation are reviewed, and particular emphasis is placed on the Maneuver and Attack Simulator and the BACTAC model. The design of a single dome combat configuration with a human pilot versus a computer opponent is described. The uses of BACTAC for aircraft development and pilot training are considered. B J

**A78-47869** On the linear superposition of aerodynamic forces on wings in periodic gusts. M H Patel (University College, London, England) *Aeronautical Journal*, vol 82, June 1978, p 267-272. Research supported by the Ministry of Defence (Procurement Executive).

An experimental study has been made in a low speed gust tunnel of the lift forces and pitching moments on two wings immersed in periodic vertical gusts which consist of two frequency components. Systematic variations of the frequency pairs making up the incident gust, the 'phase' difference between the two components, and the amplitude components of each frequency for both wings at two test incidences show that the ability to build up aerodynamic load by superposition applies generally for any gust composed of the sum of two frequency components. This demonstration of the validity of superposition depends on the exclusion of any major changes in the state of the wing boundary layers during a cycle of the imposed oscillatory flow. B J

**A78-47887** On the theory of drag calculation and profile optimization in shockless near free molecular flow. R Monaco (Torino, Politecnico, Turin, Italy) *Acta Mechanica*, vol 29, no 1-4, 1978, p 275-282. 13 refs

A mathematical model is developed for the calculation of drag of axisymmetric bodies in quasi-free-molecular flow. In particular, the model is used to evaluate the ratio of the drag coefficient in quasi-free-molecular flow to that in free molecular flow for convex bodies. Numerical results agree well with experimental results for sharp as well as blunt bodies. The proposed model is improved over other models in that it takes correct account of gas-solid interface conditions and the effects of 'first and second collisions' between impinging and reemitted molecules. The model is very promising for axisymmetric profile optimization. B J

**A78-47899 #** Flight deck display trends. W R Denton *Aviation Review*, June 1978, p 5-8

Potential innovations in flight deck display equipment, which range from cathode ray tube and other forms of solid-state display to new state-of-the-art electromechanical and purely mechanical instruments, are discussed with attention to attitude director and horizontal situation display, air data displays, and engine management displays. It is concluded that, while advanced display technology is available, improvements in current display equipment will prolong the life expectancy of many of the instruments in service at present. The comparative advantages of modification and totally new design are considered, and the requirements of corporate aviation and feeder line aircraft are examined. M L

**A78-47900 #** Solid-state displays for fuel management systems. J W Aspinall *Aviation Review*, June 1978, p 11, 12

The design of several fuel management displays for aircraft is described. Examples discussed include a combined aircraft weight-total fuel indicator, a solid-state combined amplifier-indicator, a fuel-management display using fiber optics, and a LED fuel management display selector. Components, requirements, and future technology are considered. M L

**A78-47901 #** Gates Learjet Model 28/29, the first 'Longhorn' Learjet. P T Reynolds, W M Gertsen, and C G Voorhees (Gates Learjet Corp, Wichita, Kan.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1445* 6 p

In August 1977 the Gates Learjet Model 28 prototype became the first jet to fly with winglets. The paper discusses the theory and history of winglets and considers performance improvements, and stability and control characteristics of the winglet configuration. It is noted that the Model 28/29 test program is progressing rapidly and FAA certification is expected in late 1978. The winglets have contributed a great deal of drag reduction and have presented no significant problems. B J

**A78-47903 #** B-1 flight test progress report R N Broughton (Rockwell International Corp., Los Angeles, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78 1448* 6 p

The B-1 flight test program, since first flight in December 1974, has been carefully organized to supply engineering development information and provide for an evaluation of the weapon systems operational capability. This paper provides a resume of B-1 flight test activities over the past three and one-half years. It is intended to highlight some innovative approaches to technical and managerial applications that have produced a highly successful large-aircraft test program, and to show that the data generated to date are conclusive evidence that the aircraft can perform its design mission. (Author)

**A78-47904 \* #** Canard configured aircraft with 2-D nozzle R D Child (Rockwell International Corp., Los Angeles, Calif.) and W P Henderson (NASA, Langley Research Center, Propulsion Aerodynamics Branch, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78 1450* 12 p 10 refs

A closely-coupled canard fighter with vectorable two dimensional nozzle was designed for enhanced transonic maneuvering. The HiMAT maneuver goal of a sustained 8g turn at a free-stream Mach number of 0.9 and 30,000 feet was the primary design consideration. The aerodynamic design process was initiated with a linear theory optimization minimizing the zero percent suction drag including jet effects and refined with three-dimensional nonlinear potential flow techniques. Allowances were made for mutual interference and viscous effects. The design process to arrive at the resultant configuration is described, and the design of a powered 2-D nozzle model to be tested in the LRC 16-foot Propulsion Wind Tunnel is shown. (Author)

**A78-47905 #** The effect on block fuel consumption of a strutted versus cantilever wing for a short-haul transport including strut aeroelastic considerations P H Park (Boeing Aerospace Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1454* 7 p 11 refs

A preliminary design of a short-haul aircraft using a strut-braced wing was made to study the possibility of block fuel savings due to the decrease in wing weight allowed by the use of a strut. A computer-aided wing loads and stress analysis was performed to determine the wing weight savings. It was found that the wing weight savings are not large in this aircraft and the induced drag decrease is offset by the strut parasite drag. The final cantilever and strutted configurations have essentially equal block fuel consumptions. A calculated strut flutter velocity was close enough to the flight envelope to warrant design consideration. (Author)

**A78-47906 #** Teaching design at all levels H W Smith (Kansas, University, Lawrence, Kan.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1455* 9 p 50 refs

Some important job functions of designers in industry and government are described in an attempt to put the central role of design courses in the engineering curriculum in proper perspective. It is shown that all designs, regardless of their type and nature, bear the common hallmark of 'inventiveness', or the creation of something starting with nothing, and that each type of design is related to each

other kind in a chronological chain. The need to include design courses at the baccalaureate level is emphasized. V P

**A78-47907 \* #** Some observations on the mechanism of aircraft wing rock C Hwang and W S Pi (Northrop Corp., Aircraft Div., Hawthorne, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1456* 11 p 6 refs Contract No. NAS2-8734

A pressure scale model of Northrop F-5A was tested in NASA Ames Research Center Eleven-Foot Transonic Tunnel to simulate the wing rock oscillations in a transonic maneuver. For this purpose, a flexible model support device was designed and fabricated which allowed the model to oscillate in roll at the scaled wing rock frequency. Two tunnel entries were performed to acquire the pressure (steady state and fluctuating) and response data when the model was held fixed and when it was excited by flow to oscillate in roll. Based on these data, a limit cycle mechanism was identified which supplied energy to the aircraft model and caused the Dutch roll type oscillations, commonly called wing rock. The major origin of the fluctuating pressures which contributed to the limit cycle was traced to the wing surface leading edge stall and the subsequent lift recovery. For typical wing rock oscillations, the energy balance between the pressure work input and the energy consumed by the model aerodynamic and mechanical damping was formulated and numerical data presented. (Author)

**A78-47908 #** The HiMAT RPRV system L E Brown, Jr., M H Roe, and C D Wiler (Rockwell International Corp., Los Angeles, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1457* 13 p 8 refs

Two remotely piloted research vehicles (RPRVs) which are 44% scale versions of an advanced highly maneuverable fighter design have been delivered to NASA for flight testing. These research airplanes will demonstrate the contribution to the future air-to-air fighter of several advanced technologies, including aeroelastic tailoring, supercritical airfoils, close-coupled canard, variable camber, and advanced composite materials. Digital fly-by-wire control technology is employed with the control laws being implemented in a ground based computer. The HiMAT is designed with a 12-g limit load factor and can perform sustained maneuvering at 8 g at 0.9 M at 25,000-foot altitude. The HiMAT has been designed and fabricated with a modular approach which facilitates modification for testing of other structural, aerodynamic, propulsion, or flight-control concepts. The HiMAT RPRVs will be launched from a B-52 and flown through their test flight mission by a ground based pilot. Landings will be made on a dry lake bed, utilizing skids rather than wheels on the landing gear. (Author)

**A78-47909 #** Wing/store active flutter suppression - Correlation of analyses and wind tunnel data T E Noll and L J Huttzell (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1459* 10 p 8 refs

Through analyses and recent wind tunnel tests, active flutter suppression has been shown to be a promising technique for preventing wing/external store flutter restrictions. Data measured in the wind tunnel have been used to evaluate the validity of a method employed for the design and analysis of active feedback control systems. The results of an analytical effort to study the behavior of an active flutter suppression wind tunnel model will be presented and compared with available test data. For this application, the model was aerodynamically represented by subsonic doublet lattice theory and stability was evaluated using modified Nyquist criteria. (Author)



**A78-47910 # Evolution of a cost-effective, task-oriented, lateral-directional SAS for the A-10 aircraft.** G Brandeau (Fairchild Republic Co., Farmingdale, N Y.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1460* 10 p

The reported investigation is concerned with the development of a task-oriented stability orientation system (SAS) having the most important functional requirements, together with cost-effectiveness as a basis. Attention is given to a kinematic analysis, a simplified scenario system synthesis, preliminary simulator studies, system definition and parameter selection, manned simulator studies, run data and pilot evaluations, and the results of a manned simulator performance evaluation. A flight test performance evaluation is also discussed, taking into account abrupt heading change data, curvilinear strafe data, and a gun camera film analysis of curvilinear strafes. G R

**A78-47911 # Integrated test mission control - Present and future at the Air Force Flight Test Center.** C E Adolph (USAF, Flight Test Center, Edwards AFB, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1461* 6 p 6 refs

The flight test and evaluation programs conducted on USAF aircraft have gravitated over the past two decades from what were largely independent, sequential test programs by the contractor, Air Force development, and operational test agencies to programs conducted on a concurrent basis from a single test location. Integrated mission control elements are examined, taking into account aspects of test activity consolidation, test range integration, test planning factors, and real-time mission control. Integrated systems testing is considered along with flutter tests, questions of aircraft performance, propulsion stability and control, flight envelope expansion/multiple discipline testing, data processing, and a uniform flight test analysis system. Attention is given to plans for improving the test capability. G R

**A78-47912 # Use of onboard computerized flight test analysis systems.** E L Wallace (Boeing Commercial Airplane Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1462* 8 p

In response to the challenge for increased efficiency, productivity, and cost effectiveness in the conduction of flight tests, new approaches involving a use of real time onboard analysis and monitoring of test data have been developed. In 1974 the Airborne Data Analysis and Monitor System (ADAMS) was implemented for an employment in conjunction with a high speed serial PCM data acquisition system. The ADAMS proved to be an extremely useful tool for the flight test engineer. The heart of ADAMS is a minicomputer. It is a 16 bit machine that internally processes 32 bit microinstructions at a 5 MHz rate. The computer is equipped with 32k of core memory and a floating point processor option. Analysis programs which have been developed for ADAMS provide information regarding basic aircraft parameters, cruise performance, stall and minimum speed performance, loads performance, takeoff performance, and power plant parameters. G R

**A78-47913 # Software engineering a must for success in computerized flight test.** J P Mayfield and R E Smith (Teledyne Ryan Aeronautical, San Diego, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1463* 7 p 15 refs

Software development problems in connection with the utilization of software systems in flight test applications are found to be related partly to the low level of maturity of the entire digital world

and to a tendency to underestimate problem complexity when dealing with software systems. These development problems are, however, being overcome as a result of new approaches. One approach considered involves basically the application of a disciplined software management plan in which each development software life cycle phase culminates in the production of one or more documents or configuration items. A phase is not considered to be complete unless the appropriate documents/items are available. Attention is given to the requirements definition phase, the design phase, the implementation and static test phase, the dynamic test phase, the software/hardware integration phase, the flight test phase, the maintenance phase, the development support library, and aspects of configuration control. G R

**A78-47914 # The role of the computer in the flight testing of general aviation aircraft.** P Leckman (Rockwell International Corp., General Aviation Div., Bethany, Okla.) and G Bennett (Mississippi State University, Mississippi State, Miss.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1465* 9 p 10 refs

A description is presented of the use of a minicomputer in flight test programs conducted by an American aerospace company. In one program the computer was used during 235 flights and 400 flight hours. Types of flight tests for which the computer was utilized in recording data included primarily engine development tests and aerodynamic drag evaluations. Approximately 70 parameters were measured at a maximum possible scan rate of 35 times per second. Attention is given to a system description, the operating procedures, the performed functions, the utilization rate, the realized advantages, implementation problems, and application similarities to a management information system within companies. It is pointed out that the computer has made possible flight experiments of constantly increasing complexity with a modest expenditure of funds. Current developments in microprocessor systems promise to further expand the research possibilities at a reduced cost. G R

**A78-47915 # Conceptual design study of power augmented ram wing in ground effect aircraft.** J W Moore (Lockheed-Georgia Co., Marietta, Ga.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1466* 14 p 15 refs

Conceptual design study results of a power augmented ram wing in ground effect (PAR-WIG) logistics transport aircraft are presented. The PAR-WIG aircraft examined incorporates four unique characteristics. First, power augmented ram lift is provided during all takeoff and landing maneuvers, second, cruise flight occurs only in ground effect, third, all operations are accomplished on or above the ocean surface, and, fourth, payload containment is provided within the wing contour and is distributed across the wing span. (Author)

**A78-47916 \* # Quiet, Short-Haul Research Aircraft - Current status and future plans.** J A Cochrane and A G Boissevain (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1468* 11 p

The Quiet Short-Haul Research Aircraft (QSRA) is a new research aircraft which NASA will use as a flight-test facility for advanced flight experiments in terminal area operations. The data resulting from the QSRA flight research program will be used by the US aircraft industry to establish design criteria and by regulatory agencies to establish certification criteria for advanced STOL aircraft. The total funding for the QSRA was established at \$29 million in

January 1974 Attention is given to an aircraft description, wind-tunnel results, simulation, predicted aircraft performance, initial airworthiness flight tests, design configuration studies, and training studies  
G R

**A78-47917 # L-1011 flight data recording systems - Background, features, implications and benefits** W R Beckman (Lockheed-California Co, Burbank, Calif) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1471* 9 p

In connection with the introduction of the large wide-body transports, it was recognized by FAA and the airline industry that the complexity and high cost of these new aircraft dictated the need for recording additional flight data parameters for accident-incident investigations. With reliable digital recording systems available, these additional requirements were enacted into the Federal Aviation Regulations of the US and into the Air Navigation Orders of the UK. Parameters to be recorded on the expanded flight data recorders are related to time, altitude, airspeed, vertical acceleration, heading, pitch attitude, roll attitude, lateral acceleration or sideslip angle, control column or pitch control surface position, control wheel or lateral control surface position, rudder pedal or yaw control surface position, thrust of each engine, position of each thrust reverser, angle of attack, and pitch trim position. The flight data systems developed to record the parameters are discussed  
G R

**A78-47918 # TF41-A-2/A7E inflight engine condition monitoring system /IECMS/** L R DeMott (General Motors Corp, Detroit Diesel Allison Div, Indianapolis, Ind) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1472* 10 p

An engine condition monitoring system for the TF41-A-2 engine installed in the A7E aircraft has been developed by Detroit Diesel Allison under Navy contract. The system, designated as Inflight Engine Condition Monitoring System (IECMS), is designed to continuously monitor engine health, record pertinent information and provide diagnostic information to operating personnel. The system has been developed in several phases from prototype to the present production configuration now installed in 24 aircraft assigned to Navy Attack Squadrons VA-46 and VA-72. Over 15,000 total flight hours have been accumulated to date and the system has met all operational requirements. Future additional retrofits to the A7E are contingent on availability of funding. Advances in state-of-the-art computer and sensor technology can result in a vast improvement in system cost versus effectiveness in the future.  
(Author)

**A78-47919 # Detecting abnormal turbine engine deterioration using electrostatic methods** R P Couch (USAF, Aeronautical Systems Div, Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1473* 18 p 8 refs

A method of detecting abnormal turbine engine deterioration has been developed and tested. The method observes pulse electrostatic signals in the exhaust which have been determined to originate from component rubbing, chaffing, erosion and burning (i.e., various forms of deterioration). The normal (healthy engine) deterioration rate is first studied as a function of engine cycling and power. This deterioration rate is then normalized with an engine power and an engine cycling parameter. Tenfold increases in the normalized deterioration rate are then used as an indication of impending component failure. Experience shows that about two out of three turbine engine gas path failures can be predicted four or more hours ahead of time by this method. The false alarm rate is estimated to be about 5%.  
(Author)

**A78-47920 # Sensor technology for turbine engine monitoring systems** J A Davis (Ohio State University, Columbus, Ohio) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1474* 13 p 32 refs

The Turbine Engine Monitoring System (TEMS) is proposed as a system to continuously monitor turbine engines in the USAF operational environment. Attention is given to instrumentation requirements, transducer designs, accelerometers, position indicators, flow meters, rotary speed transducers, function switches, pressure transducers, temperature sensors, an uncertainty calculation and error source discussion, aspects of sensor failures and detection, questions of sensor reliability, and advanced sensor techniques. It is found that present state-of-the-art sensors are acceptable for the envisioned TEMS applications from both accuracy and reliability standards. The instrumentation systems proposed are adequate from the sensor accuracy standpoint, and software corrections to measured data, using cross-parameter correction schemes and detailed calibration data, can improve the accuracy.  
G R

**A78-47921 # Engine vibration in flight** H J Rubel, K I Peck, and J A McInturff (Lockheed-Georgia Co, Marietta, Ga) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1475* 6 p

The system described differentiates between true rotor unbalance and system malfunctions. The flight crew can react appropriately to the indicated malfunction to minimize in-flight shutdowns. Typical data are presented as well as two cases of large unbalance, one as a result of a bird strike and the other due to the loss of a turbine blade. This monitoring system is designed to detect and record vibration frequencies in the range of the rotors, i.e., fan and core. Harmonics, noise and other vibrations within the bandpass of the filter will also be detected. The processor, utilizing a modified Fourier routine, determines amplitude and outputs appropriate messages.  
(Author)

**A78-47922 \* # Correlation of model and airplane spin characteristics for a low-wing general aviation research airplane** J S Bowman, Jr, H P Stough, S M Burk, Jr, and J M Patton, Jr (NASA, Langley Research Center, Hampton, Va) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1477* 13 p

**A78-47923 # Whitcomb winglet applications to general aviation aircraft** J F Marchman, III, D Manor (Virginia Polytechnic Institute and State University, Blacksburg, Va), and H F Faery, Jr (Virginia Polytechnic Institute and State University, Blacksburg, Va, U.S. Military Academy, West Point, N.Y.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1478* 7 p 5 refs

A study was conducted to examine several of the aspects of Whitcomb winglet applications to low speed, general aviation aircraft. Both supercritical and laminar flow airfoil section winglets were tested on straight and tapered symmetrical wings. Aerodynamic parameters were measured for a wide range of wing angles of attack and for several winglet angles. Tests were run to determine the low speed effect of the wing on the winglet and of the winglets on the wing. Towing tank and wind tunnel tests were run to examine the trailing vortices from the wing-winglet combinations. The tests showed that winglets are effective at low speeds, however a tapered wing planform results in a reduction of the winglet effectiveness. Symmetrical winglets were shown to be effective at low speed. Tests also indicated that a proper choice of winglet angle can reduce the strength of the wing wake turbulence.  
(Author)

**A78-47924 \* #** Section drag coefficients from pressure probe traverses of a wing wake at low speeds L C Montoya, P F Bikle, and R D Banner (NASA, Flight Research Center, Edwards, Calif ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1479* 12 p 20 refs

**A78-47925 \* #** Some sound transmission loss characteristics of typical general aviation structural materials J Roskam, C van Dam, F Grosveld (Kansas, University, Lawrence, Kan ), and D Durenberger (General Dynamics Corp , Fort Worth, Tex ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1480* 10 p Grant No NsG-1301

Experimentally measured sound transmission loss characteristics of flat aluminum panels with and without damping and stiffness treatment are presented and discussed The effect of pressurization on sound transmission loss of flat aluminum panels is shown to be significant (Author)

**A78-47926 \* #** Status of aerial applications research in the Langley Vortex Research Facility and the Langley full-scale wind tunnel F L Jordan, Jr , H C McLemore (NASA, Langley Research Center, Dynamics Stability Branch, Hampton, Va ), and M B Bragg (Illinois, University, Urbana, Ill ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1481* 12 p 16 refs

**A78-47927 \* #** Integrated avionics for future general aviation aircraft D G Denery, C T Jackson, Jr , G P Callas, B K Berkstresser, and G H Hardy (NASA, Ames Research Center, Moffett Field, Calif ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1482* 13 p 18 refs

The program described was initiated in 1975 to provide the critical information for the design of an advanced avionics system suitable for general aviation Emphasis is on the use of data busing, distributed microsensors, shared electronic displays and pilot entry devices, innovative low-cost sensors, and improved functional characteristics Design considerations include cost, reliability, maintainability, and modularity V P

**A78-47928 #** The design process D D Meyer, G L Anderton, H A Crowell, and J W Southall (Boeing Commercial Airplane Co , Seattle, Wash ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1483* 12 p 5 refs

The paper describes the results of an effort made to document the design process and extract from it a set of requirements for a computer system that will integrate and manage the design product data, program management information and technical computation and engineering data management activities of the aerospace design process Design activities were grouped chronologically and explored for activity, interface, data quantity and data flow Design levels examined included research, preliminary design, detail design, manufacturing, product verification, and product support (Author)

**A78-47929 \* #** Drones for aerodynamic and structural testing /DAST/ - A status report H N Murrow and C V Eckstrom (NASA, Langley Research Center, Hampton, Va ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1485* 9 p 13 refs

A program for providing research data on aerodynamic loads and active control systems on wings with supercritical airfoils in the transonic speed range is described Analytical development, wind tunnel tests, and flight tests are included A Firebee II target drone

vehicle has been modified for use as a flight test facility The program currently includes flight experiments on two aeroelastic research wings The primary purpose of the first flight experiment is to demonstrate an active control system for flutter suppression on a transport-type wing Design and fabrication of the wing are complete and after installing research instrumentation and the flutter suppression system, flight testing is expected to begin in early 1979 The experiment on the second research wing - a fuel-conservative transport type - is to demonstrate multiple active control systems including flutter suppression, maneuver load alleviation, gust load alleviation, and reduce static stability Of special importance for this second experiment is the development and validation of integrated design methods which include the benefits of active controls in the structural design (Author)

**A78-47930 \* #** Application of advanced high speed turboprop technology to future civil short-haul transport aircraft design J A Conlon (U S Army, Research and Technology Laboratories, Moffett Field, Calif ) and J V Bowles (NASA, Ames Research Center, Moffett Field, Calif ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1487* 13 p 8 refs

With an overall goal of defining the needs and requirements for short-haul transport aircraft research and development, the objective of this paper is to determine the performance and noise impact of short-haul transport aircraft designed with an advanced turboprop propulsion system This propulsion system features high-speed propellers that have more blades and reduced diameters Aircraft are designed for short and medium field lengths, mission block fuel and direct operating costs (DOC) are used as performance measures The propeller diameter was optimized to minimize DOC Two methods are employed to estimate the weight of the acoustic treatment needed to reduce interior noise to an acceptable level Results show decreasing gross weight, block fuel, DOC, engine size, and optimum propfan diameter with increasing field length The choice of acoustic treatment method has a significant effect on the aircraft design (Author)

**A78-47931 #** The use of the AIAA-Bendix Design Competition in aerospace design courses J F Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, Va ) and J J Irons (American Institute of Aeronautics and Astronautics, Inc , New York, N Y ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1488* 8 p

The evolution and refinement of the AIAA-Bendix Design Competition since its beginning in 1972 is examined The criteria for selection of design competition RFP's and the standards for design proposal evaluation are discussed in detail The use of the AIAA-Bendix Competition as a basis of a typical aerospace engineering design course is examined with a detailed look at its use in the design course in Aerospace and Ocean Engineering at Virginia Polytechnic Institute and State University It is concluded that the competition can be and has been used successfully to boost the quality of aerospace engineering design education at many universities and that the competition is responsive to the desire of industry for a realistic simulation of the industrial design process in undergraduate design classes (Author)

**A78-47932 #** Aeronautical procurement - The primary specification system J L Weingarten (USAF, Aeronautical Systems Div , Wright-Patterson AFB, Ohio ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1489* 7 p 5 refs

The various procurement techniques which have been tested by the Department of Defense have not resolved the problem of procuring aeronautical equipment The present paper deals with a promising system developed to ensure that requirement statements are in terms of system/equipment performance related to operational

needs, rather than dictating specific solutions, to provide an overall specification system that marries the current military specifications and the type of specifications defined by MIL-STD-490, and to provide the rationale for the requirement statements contained in specifications/standards V P

**A78-47933 #** A computerized undergraduate aircraft design course G T Matsuyama (US Air Force Academy, Colorado Springs, Colo) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1492* 8 p 5 refs

The integration of a computer program with an undergraduate aircraft design course is described with emphasis on the computer program known as AERO464RPV, which was written specifically for the course. Inputs include basic vehicle geometry, aerodynamic coefficients, and a mission profile. The program computes weight/fuel fractions and 'flies' the vehicle while attempting to achieve convergence with a historical empty weight. Program capabilities include fuel tank sizing and fuel sequencing. Output includes weight, static margin, and a flight profile vs time. Successful implementation has been demonstrated over 3 semesters, with modifications including changes to both mission profiles and engine data. (Author)

**A78-47934 #** The value of aerospace design synthesis courses as viewed by aerospace professionals R S Shevell (Stanford University, Stanford, Calif) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1493* 5 p

The Stanford University Department of Aeronautics and Astronautics offers a course in Aerospace Systems Synthesis and Analysis. The course has evolved into an advanced design approach teaching the blend of aerodynamic and structural theory and empiricism, engineering and economics, aircraft requirements and ground system limitations which must be integrated and optimized to produce a satisfactory aircraft system. A recent survey of former students now working as aerospace professionals was conducted to determine the value of the design synthesis course. This paper summarizes the course concepts and the survey methods and results. In general, the aerospace engineers felt the design synthesis course was a highly useful part of their education. (Author)

**A78-47935 #** Improving the accuracy of HUD approaches in windshear with a new control law J R Lowe (Douglas Aircraft Co, Long Beach, Calif) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1494* 6 p 6 refs

Current landing approach HUDs present the information required by the pilot during the landing operation and provide excellent guidance in the vast majority of conditions. Unfortunately, however, the velocity vector, if airmass derived, contains wind-produced errors which can mislead the pilot in a severe environment. A description is presented of a new concept which eliminates the velocity vector and its attendant wind-produced errors. It is suggested that the visual approach HUD control law should be designed to the level of sophistication of the autopilot and flight director, which are designed as feedback compensated control systems. Applying the concept, called Feedback Compensated Control HUD, the only measured angle is the selected flight path. Rate lead, previously provided by the velocity vector, is provided by aircraft vertical motion measurements that are not sensitive to wind. G R

**A78-47936 #** The airborne detection of low level wind shear R A Greene (Safe Flight Instrument Corp, White Plains, N Y) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1495* 11 p 21 refs

Recent studies of accidents/incidents attributed to wind shears encountered during takeoff or during landing approach, have indicated the requirement to quantify the performance loss due to vertical downdraft combined with that due to horizontal wind shear. This paper discusses the development of a system to compute and display to the flight crew this loss of performance capability. Data are presented from simulation, flight test and in service evaluation. These are discussed in terms of performance margins and implications for flight crew technique in the recovery from a severe encounter. (Author)

**A78-47937 #** Effects of wind on aircraft cruise performance F J Hale (North Carolina State University, Raleigh, N C) and A R Steiger (Booz, Allen and Hamilton, Inc, Bethesda, Md) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1496* 7 p

Analytic expressions are developed that predict the improvements in range, flight time, and fuel consumption that can be achieved by appropriate corrections to the no-wind best-range airspeed. Input data required are type of power plant, no-wind best range airspeed, and magnitude of the headwind or tailwind component. Application of these expressions to a series of typical aircraft, ranging from a wide-body turbofan to a single-engine piston-prop, shows that the possible fuel savings are such that the effects of wind on fuel consumption might warrant more consideration in flight planning. (Author)

**A78-47938 #** Effect of performance objectives on the design and cost of future USAF pilot training aircraft G F Quinn and D P Breidenbach (USAF, Aeronautical Systems Div, Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1498* 8 p

The influence of performance objectives on the airframe/engine design characteristics for future trainer aircraft is examined. It is shown that a new primary trainer aircraft design, optimized for minimum life cycle cost would have a turbofan engine with a by-pass ratio of approximately 4. The wing aspect ratio would be approximately 6. A twin engine aircraft would meet the performance objectives with a design takeoff gross weight of about 8,000 pounds and would have an engine thrust of 2050 pounds. The study points toward the possibility of using a common engine for the primary and intermediate-phase aircraft, provided the primary trainer is a single-engine configuration. V P

**A78-47939 \* #** Improved aircraft dynamic response and fatigue life during ground operations using an active control landing gear system J R McGehee, H D Carden (NASA, Langley Research Center, Hampton, Va), and R Edson (Hydraulic Research, Valencia, Calif) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1499* 10 p 7 refs

A three degree-of-freedom aircraft landing analysis incorporating a series-hydraulic active control main landing gear has been developed and verified using preliminary experimental data from drop tests of a modified main landing gear from a 2722 kg (6000 lbm) class of airplane. The verified analysis was also employed to predict the landing dynamics of a supersonic research airplane with an active control main landing gear system. The results of this investigation have shown that this type of active gear is feasible and indicate a potential for improving airplane dynamic response and reducing structural fatigue damage during ground operations by approximately 90% relative to that incurred with the passive gear. (Author)

**A78-47940 #** Rolling tail design and behavior as affected by actuator hinge moment limits J N Ball (Calspan Corp, Los Angeles, Calif) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif, Aug 21-23, 1978, Paper 78-1500* 7 p

A high degree of roll maneuverability is required for the low-altitude, high-speed (LAHS) condition of the B-1 high performance bomber. It was found that the spoilers alone would be insufficient for meeting the roll requirements of the LAHS condition. Additional roll control effectiveness was, therefore, to be provided by using differential stabilizer deflections. This is the 'rolling tail' arrangement. When the wings are swept back the rolling tail's contribution becomes important. At a representative lateral stick deflection of two inches, it accounts for about two-thirds of the total applied rolling moment. The B-1 design is used as an example to illustrate some problems that can be encountered with rolling tails. Particular attention is given to the effect of reaching the stabilizer hinge moment limit. G R

**A78-47941 #** Investigation of electrostatic discharge in aircraft fuel tanks during refueling. E Radgowski and R Albrecht (Fairchild Republic Co., Farmingdale, N.Y.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1501* 8 p. USAF-supported research.

High levels of electrostatic charge on JP 4 fuel during aircraft refueling, due to both the flow of fuel and the charge buildup generated by fuel contacting the explosion suppression foam installed in some aircraft fuel tanks, were eliminated in the test installation using a multihole-design fuel inlet resembling a piccolo. This is an adaptation of a manifold inlet design investigated by various agencies as a means of reducing electrostatic charge. The 'piccolo' inlet was selected as the result of a test program conducted to evaluate several fuel inlet configurations, in conjunction with two generic types of polyurethane foam polyester, presently used in aircraft fuel tanks, and polyether, proposed as a replacement for the polyester foam. Of the two types of foam tested, the polyether foam indicated a greater potential for producing static discharges than the polyester foam. (Author)

**A78-47942 #** Nacelle effects on stability of VSTOL configurations including conventional, canard, and tandem wing arrangements. J Wolkovitch and R L Fortenbaugh (Vought Corp., Dallas, Tex.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1504* 14 p. 12 refs.

Nacelle effects on stability of conventional, canard, and tandem wing subsonic VSTOL aircraft are discussed. Theoretical predictions of nacelle effects on stability are compared with wind tunnel results. The increased tail areas required to overcome the destabilizing effects of the nacelles induce performance penalties. Canard or tandem wing configurations may reduce these penalties. Low speed wind tunnel data on a tandem wing configuration are presented, and a new tandem wing configuration which employs extreme gull-type dihedral and anhedral on the rear wing is described. This configuration yields low induced drag and small wetted area. (Author)

**A78-47943 #** Experimental determination of propulsion induced ground effects of typical three fan type A V/STOL configurations. W B Weber and R W Williams (McDonnell Aircraft Co., St. Louis, Mo.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1507* 10 p.

A description is presented of one approach to the experimental determination of the suckdown and fountain effects on a typical V/STOL aircraft configuration using powered models. The test technique was used on two different V/STOL models (10% scale) and included careful calibration of the 5.5 inch fans used to provide inlet and nozzle flow simulation. On one of these models, an extensive pressure survey was made on the underside of the model in order to increase the understanding of the fountain and suckdown forces. The test facility, the fan calibration procedures, the test configurations, instrumentation, and procedures are briefly described. Aspects of data reduction are discussed and the test results are presented. The presented results are compared with results obtained using a nonmetric nozzle test technique. G R

**A78-47945 #** An analytical and experimental investigation of diffusers for VSTOL thrust augmenting ejectors. M R Seiler and E F Schum (Rockwell International Corp., Aircraft Div., Columbus, Ohio.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1509* 10 p. 12 refs.

A thrust augmented ejector is a pneumatic device which increases the thrust by transferring the energy of the turbojet engine exhaust flow to a large mass of air drawn in from the atmosphere. Energy transfer is obtained by the turbulent mixing of two streams. In the study described in the present paper, a VTOL prototype aircraft was used to demonstrate that additional direct lift required for VTOL operation can be obtained from the cruise engine itself. Specifically, it is shown that cambered flaps can provide a higher augmentation ratio than straight flaps, for a baseline ratio of 1.48, this improvement is 0.12 (owing to increased internal diffusion and greater secondary mass flow). The best location for the wall jet nozzle is upstream of the throat on the Coanda surface. Both jet momentum and augmentation ratio can be increased by distributing primary air nozzles near the augments exit. V P

**A78-47946 \* #** Studies of aerodynamic technology for VSTOL fighter/attack aircraft. W P Nelms (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1511* 32 p. 17 refs.

The paper summarizes several studies to develop aerodynamic technology for high performance VSTOL aircraft anticipated after 1990. A contracted study jointly sponsored by NASA-Ames and David Taylor Naval Ship Research and Development Center is emphasized. Four contractors analyzed two vertical-attitude and three horizontal-attitude takeoff and landing concepts with gross weights ranging from about 10433 kg (23,000 lb) to 17236 kg (38,000 lb). The aircraft have supersonic capability, high maneuver performance (sustained load factor 6.2 at Mach 0.6, 3048 m (10,000 ft)) and a 4536 kg (10,000-lb) STO overload capability. The contractors have estimated the aerodynamics and identified aerodynamic uncertainties associated with their concept. Example uncertainties relate to propulsion-induced flows, canard-wing interactions, and top inlets. Wind-tunnel research programs were proposed to investigate these uncertainties. (Author)

**A78-47947 \* #** Flight experience on the need and use of inflight leading edge washing for a laminar flow airfoil. D F Fisher (NASA, Flight Research Center, Edwards, Calif.) and J B Peterson, Jr (NASA, Langley Research Center, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1512* 11 p. 5 refs.

An investigation of leading-edge contamination by insects was conducted at the NASA Dryden Flight Research Center with a JetStar airplane instrumented to detect transition on the outboard leading-edge flap and equipped with a system to wash the leading edge in flight. The results of airline-type flights with the JetStar indicated that insects can contaminate the leading edge during take-off and climbout at large jet airports in the United States. The results also showed that the insects collected on the leading edges at 180 knots did not erode at cruise conditions for a laminar flow control airplane and caused premature transition of the laminar boundary layer. None of the superslick and hydrophobic surfaces tested showed any significant advantages in alleviating the insect contamination problem. While there may be other solutions to the insect contamination problem, the results of these tests with a washer system showed that a continuous water spray while encountering the insects is effective in preventing insect contamination of the leading edges. (Author)

**A78-47952 #** Safety of space flights (O bezopasnosti kosmicheskikh poletov). L S Khachatryan and E V Khrunov. In

Characteristics of cosmonaut activities during flight  
 Moscow, Izdatel'stvo Mashinostroenie, 1976, p 5-12  
 In Russian

Illustrative examples are provided to demonstrate that the safety of space flights involves a large number of particular problems which are closely related to the effectiveness and reliability of spacecraft engineering. Analysis of the psychophysiological structure of the activity of a human operator engaged in space flight reveals a number of stages in which the flight safety decreases substantially, especially in time-deficit situations where decisions must be made without delay. It is suggested that in order to evaluate flight safety, it is necessary (1) to determine the conversion factor defined as the ratio of time required to perform a specific operation in space to time required to perform the same operation on the ground and (2) after completing emotionally stressed flight tasks, spare time should be allowed for rest. S D

**A78-47978 #** Operator work capacity during parachutist free-fall (Operativnaia rabotosposobnost' v period svobodnogo padeniia parashiotista) L P Grimak, G M Kolesnikov, V A Sutormin, V K Filosofov, and L S Khachaturiants. In Characteristics of cosmonaut activities during flight. Moscow, Izdatel'stvo Mashinostroenie, 1976, p 170-180. In Russian.

Parachute jumps are a training measure used to adapt cosmonauts to stresses they will experience in space flight. The present paper describes experiments performed to evaluate operator work capacity under various conditions of parachute jump, particular attention is given to the quality of operator performance in free fall. The main experiment involved the measurement of the capacity of the free-falling subject to track signals produced by a device strapped to his back. It was found that the tracking performance of the operator deteriorates in free fall. The quality of the operator in receiving and processing semantic data under parachute-jump conditions also deteriorates, emotional tension of the operator is accompanied by a lowering of the tactile sensitivity thresholds. B J

**A78-48051** Synthesis of social surveys on noise annoyance. T J Schultz (Bolt Beranek and Newman, Inc., Cambridge, Mass.) *Acoustical Society of America, Journal*, vol 64, Aug 1978, p 377-405. 89 refs. Research supported by the U.S. Department of Housing and Urban Development.

Since noise was first recognized as a serious environmental pollutant, a number of social surveys have been conducted in order to assess the magnitude of the problem and to develop suitable noise ratings, such that, from a measurement of certain physical characteristics of community noise, one could reliably predict the community's subjective response to the noise. Recently, the author has reviewed the data from social surveys concerning the noise of aircraft, street traffic, expressway traffic, and railroads. Going back to the original published data, the various survey noise ratings were translated to day-night average sound level, and an independent judgment was made, where choice was possible, as to which respondents should be counted as 'highly annoyed'. The results of 11 of these surveys show a remarkable consistency. It is proposed that the average of these curves is the best currently available relationship for predicting community annoyance due to transportation noise of all kinds. (Author)

**A78-48052** Long-distance focusing of Concorde sonic boom. L Liszka (Kiruna Geophysical Institute, Kiruna, National Board of Occupational Safety and Health, Umea, Sweden). *Acoustical Society of America, Journal*, vol 64, Aug 1978, p 631-635. 9 refs.

Infra acoustic signals from supersonic flights of Concorde are regularly recorded in northern Sweden at distances up to 5000 km from the aircraft. Relatively high signal amplitudes (up to 0.1 N/sq m) are explained by a kind of long-distance focusing effect. Principle and consequences of the focusing effect are discussed. (Author)

**A78-48062** On the use of zirconium 95 data from Chinese atmospheric thermonuclear explosions to study stratospheric transport in a one-dimensional parameterization. E Bauer, R C Oliver, and W Wasyliwskyj (Institute for Defense Analyses, Arlington, Va.) *Journal of Geophysical Research*, vol 83, Aug 20, 1978, p 4019-4028. 27 refs. U.S. Department of Transportation Contract No. FA76WA-3157, No. FA77WA-3965.

Data on the transport of Zr-95 from five Chinese 3-Mt thermonuclear explosions which deposited their debris clouds at approximately 18-km altitude and location (40 deg N, 90 deg E) are analyzed in terms of one-dimensional diffusive transport into the troposphere. The motivation for the work is that the dynamics of oxides of nitrogen and other materials injected into the lower stratosphere by supersonic transport aircraft in the general region of 15- to 18-km altitude, 40-60 deg N latitude, is not well known, and different parameterizations of the transport by different authors vary substantially. A technique is developed that allows data from pulsed sources at different seasons to be used to parameterize stratospheric motions in terms of a mean stratospheric eddy diffusivity and a mean tropopause height (which characterizes an effective height of injection above the local tropopause) and thus to estimate the atmospheric residence time (equal to burden divided by flux) and also the 'injection coefficient' of McElroy et al (1974) for continuous sources. A correction is made for the sedimentation of the particulate tracers used. (Author)

**A78-48100 #** Aerodynamic hull design for HASPA LTA optimization. F R Goldschmied (Westinghouse Research and Development Center, Pittsburgh, Pa.) *Journal of Aircraft*, vol 15, Sept 1978, p 634-638. 16 refs. Research supported by Westinghouse Electric Corp.

The present design estimates for the Navy concept of a high-altitude superpressure powered aerostat (HASPA) are 800,000 cu ft hull volume at an altitude of 70,000 ft, with a maximum required speed of 30 knots. Both the hull weight and the propulsion power must be minimized for a successful vehicle design. On the basis of extensive wind-tunnel tests at the HASPA volume Reynolds number of 2.16 times 10 to the 6th, a 3.1 body has been selected for minimum hull weight, and its propulsion power requirements are 1.80 kW, including appendage drag and stern wake propeller efficiency. Passive boundary-layer control is applied to the aftbody by means of a Ringleb cusp at 82% length. On the forebody, the boundary layer remains laminar up to 77% length, as shown by China Clay wind-tunnel flow visualization at the exact HASPA Reynolds number. (Author)

**A78-48209** Super-element method for helicopter fuselage analysis. O M Aksekov and Z I Burman (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 12-17). *Soviet Aeronautics*, vol 20, no 2, 1977, p 7-11. 7 refs. Translation.

In the finite element technique proposed, the helicopter fuselage is broken down into bays in the frame planes. These super-elements are then joined to a precision equal to that of a 'nonpartitioning' scheme. Using the method of forces, a theory and a general matrix algorithm for calculating a helicopter fuselage are developed. Cutouts are taken into consideration by the principle of superposed initial strains, either before or after joining. For illustration, the method is applied to the calculation of an actual fuselage. V P

**A78-48212** Analysis of GTE tolerance monitoring parameter formation. M Kh Bikhchantaev and Iu V Kozhevnikov (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 31-35). *Soviet Aeronautics*, vol 20, no 2, 1977, p 23-26. Translation.

Formulas are derived for calculating the tolerances of gas turbine-engine parameters. The determination of tolerances as a function of measurement errors and of permissible values of the engine parameters is analyzed on the basis of extensive computational data, assuming that the permissible values are symmetrical with respect to the mathematical expectation. V P

**A78-48215** Optimal control synthesis in distributed systems with incomplete information. G L Degtiarev and T K Sirazetdinov (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 45-49) *Soviet Aeronautics*, vol 20, no 2, 1977, p 36-40 Translation

In the present paper, the optimal control law for a system with distributed parameters is derived as a function of the measured variables, expressing the latter in terms of certain functionals defined on the system's state. The results are shown to be useful in the synthesis of a control system for aircraft with elastic elements or aircraft experiencing thermal processes. V P

**A78-48216** Modeling ground plane influence on wing aerodynamic characteristics using a finite plane screen. S D Ermolenko and Iu A Rogozin (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 50-54) *Soviet Aeronautics*, vol 20, no 2, 1977, p 41-44 Translation

**A78-48221** Distribution of reliability characteristics among airplane system units to ensure given flight safety level. G N Kotel'nikov (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 80-84) *Soviet Aeronautics*, vol 20, no 2, 1977, p 66-70 Translation

**A78-48222** Definition of airplane fuselage longitudinal lines by the special contour method. S I Leliushenko and F K Chistiakov (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 85-88) *Soviet Aeronautics*, vol 20, no 2, 1977, p 71-73 Translation

In order to optimize a complex program of designing 'fuselage nacelle' type surfaces, it is proposed to calculate all transverse and longitudinal lines of an aircraft fuselage by the special-contour method. A block diagram for computing longitudinal lines is given as a complement to the block diagram for designing a complex surface that satisfies a priori optimality criteria. V P

**A78-48224** Uniformly exact conformal transformation of exterior of circle onto exterior of wing profile. N M Monakhov (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 94-98) *Soviet Aeronautics*, vol 20, no 2, 1977, p 78-82 Translation

In the present paper, the local irregular part of the conformal mapping function is determined with a precision to quantities of second-order smallness, for the conformal mapping of the exterior of the sharp trailing edge of a wing section. Using an irregular conformal mapping function it proved possible to map the entire region with a precision to quantities of fifth-order smallness. The zero-lift angle which affects all the aerodynamic characteristics of the wing section is determined with a precision to quantities of fourth-order smallness. V P

**A78-48228** Evaluating avionics weight efficiency. V P Gogolin and I A Iskhakov (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 118, 119) *Soviet Aeronautics*, vol 20, no 2, 1977, p 100, 101 Translation

**A78-48229** Influence of slots on effectiveness of wing mechanization and control surfaces with separated flow. V V Guliaev, A A Mikhailov, and M I Nisht (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 119-121) *Soviet Aeronautics*, vol 20, no 2, 1977, p 102-104 Translation

**A78-48231** Fatigue crack growth in pressurized fuselage panel. A B Kaplun and V D Kuliev (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 124-127) *Soviet Aeronautics*, vol 20, no 2, 1977, p 108-110 Translation

In the present paper, the growth of fatigue cracks in an airliner panel under the combined effect of acoustic-pressure stresses and stresses associated with the difference in external and internal pressure is analyzed within the framework of fracture mechanics. The spectrum of alternating stresses generated by acoustic pressure is described by a Rayleigh distribution. A method of evaluating the influence of acoustic-pressure stresses on the growth of fatigue cracks in a fuselage panel is proposed. It is shown that under certain conditions, the influence of acoustic loads on crack growth exceeds by far that of the pressure difference. V P

**A78-48234** Experimental determination of parameters of mathematical model of airplane cabin as regulated object with respect to air temperature in the cabin. V I Krutov, V G Voronin, and A V Shcherbakov (*Aviatsionnaia Tekhnika*, vol 20, no 2, 1977, p 133-136) *Soviet Aeronautics*, vol 20, no 2, 1977, p 119-122 Translation

**A78-48244** Investigation of nonequilibrium two-phase flows in axisymmetric Laval nozzles. A A Glazunov and A D Rychkov (*Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov-Dec 1977, p 86-91) *Fluid Dynamics*, vol 12, no 6, July 1978, p 887-892 11 refs Translation

In the present paper, the influence of the second phase (solid particles) on such nozzle characteristics as specific impulse, impulse losses, and the discharge coefficient is analyzed, in the two-dimensional case, for the subsonic, transonic, and supersonic regions of the Laval nozzle. The calculations are carried out by a modification of the Lax-Wendroff method, using Mac Cormack's (1969) explicit finite difference scheme. The losses in specific impulse are compared with values calculated in a quasi one-dimensional approximation. V P

**A78-48245** Method of calculating aerodynamic coefficients of some three-dimensional bodies with arbitrary cross section. G G Skiba and B N Fedotov (*Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov-Dec 1977, p 92-98) *Fluid Dynamics*, vol 12, no 6, July 1978, p 892-897 Translation

Using the computer aided method proposed for calculating the aerodynamic coefficients of bodies of arbitrary cross section, the problem can be reduced to the solution of a nonlinear and a linear system of equations for the proper boundary conditions. The procedure is illustrated by applying it to bodies of various shape and aspect ratio. The results obtained by this method are shown to correlate well with the experiment. V P

**A78-48248** Asymptotic theory of a wing moving near a solid wall. K V Rozhdestvenskii (*Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov-Dec 1977, p 115-124) *Fluid Dynamics*, vol 12, no 6, July 1978, p 910-918 5 refs Translation

In the present paper, the method of matched asymptotic expansions is applied to the approximate solution of the problem of unsteady motion of a lifting surface in ground effect. The flow region is conditionally broken down into characteristic zones in which asymptotic expansions for the velocity potential are obtained in the corresponding coordinates, the expansions are then matched in regions of general validity. In the first approximation (very small flight altitudes), the problem is reduced to the solution of the Poisson equation in a plane bounded by the planform of the wing for boundary conditions obtained by matching. V P

**A78-48250 Induction of subsonic wind tunnels with slight perforation** N A Marevtseva (*Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov-Dec 1977, p 130-136) *Fluid Dynamics*, vol 12, no 6, July 1978, p 922-928 Translation

In the present paper, the perforations are assumed to be very small compared to the test section itself, while the flow boundaries are broken down into two regions with different boundary conditions. The boundary conditions hold for any Mach number. The two-dimensional limiting boundary value problem for supersonic flow past a dipole is solved, in elementary functions, under the assumption of a small perforation factor and small velocity disturbances at the flow boundary. The solution provides a simple rule for determining the induction. V P

**A78-48374 # Noise in airports, its measurement, and its effect on the communities in the vicinity (Ruido en aeropuertos, su medida y afectación a las comunidades vecinas** L Marquina Sanchez *IAA/Ingeniería Aeronáutica y Astronáutica*, vol 30, May 1978, p 5-19 In Spanish

An investigation is conducted regarding noise problems which have arisen in connection with the evolution of modern air traffic. Developments related to the description of noise, noise measurement, and the establishment of aviation regulations with respect to aircraft noise emission are examined, taking into account the time period beginning with the introduction of jet aircraft in the early 1950s. The development of indices indicating noise exposure levels is considered. Sonic pressure levels as a function of frequency for various aircraft are shown in a graph. Attention is given to the composite noise rating, aspects of noise exposure prediction, the noise and number index, a French noise exposure index, and indices developed in the Netherlands, Germany, and South Africa. A description is presented of the calculation of noise exposure levels in the vicinity of airports. Approaches of various types for the reduction of aircraft produced noise are also discussed. G R

**A78-48451 # The impact of contingency power concepts on V/STOL aircraft take-off-gross-weight** R A Musselwhite (United Technologies Corp, Pratt and Whitney Aircraft Group, West Palm Beach, Fla) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev, July 25-27, 1978, AIAA Paper 78-926* 6 p

The paper presents the analytical assessment of the impact of several contingency power/engine cycle concepts on aircraft take-off-gross-weight. A two-engine propulsion system was chosen for evaluation to illustrate maximum system benefits. The four evaluated concepts are (1) increased combustor exit temperature at the vertical engine-out landing condition, (2) modulation of core engine primary nozzle area, (3) modulation of turbine cooling air levels, and (4) increased fan root pressure. Each concept was evaluated for propulsion system performance and size variations. Integration of these propulsion system changes with the airframe resulted in aircraft take-off-gross-weight reductions. Consideration was given to evaluating propulsion systems that would provide improved vertical emergency landing capability with minimum performance and size penalties without sacrificing durability and reliability. (Author)

**A78-48452 \* # NASA engine system technology programs - An overview** H W Johnson (NASA, Aeronautical Propulsion Div, Washington, D C) and E W Conrad (NASA, Lewis Research Center, Energy Conservation Engines Office, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev, July 25-27, 1978, AIAA Paper 78-928* 5 p

The various propulsion systems technology programs are examined. The Stratospheric Cruise Emission Reduction program has the objective to explore and demonstrate advanced technology fuel preparation and combustion systems which produce very low emission levels, particularly with respect to the oxides of nitrogen, during high altitude cruising flight. Other programs considered include the Quiet, Clean, General Aviation Turbofan program, the Variable Cycle Engine Technology program, the Helicopter Transmission Technology program, the Broad Specification Fuels Technology program, the Engine Component Improvement program, the Advanced Turboprop Technology program, the Supersonic Cruise Propulsion Technology program, the Materials for Advanced Turbine Engines program, and the Aeroelasticity of Turbine Engines program. G R

**A78-48453 \* # Propulsion test facilities - Capabilities and use** J S Kamchi (USAF, Washington, D C) and F E Comptello (NASA, Washington, D C) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev, July 25-27, 1978, AIAA Paper 78-933* 11 p 16 refs

A review is conducted of the additional test facilities required in connection with the National Aeronautical Facilities Program and of other new propulsion test facilities. Attention is given to the National Transonic Facility, the AMES wind tunnel, the Turbine Engine Load Simulator, facilities for the conduction of compressor research, a fuels and lubricants laboratory, and test facilities in the UK, France, and Germany. It is pointed out that there is a need for government and industry to support the facility investment necessary to make progress in aerospace technology. Aspects of international cooperation are also discussed. G R

**A78-48454 # Ground test facility for integral rocket ramjets** T D Myers and G F Stromberg (United Technologies Corp, Chemical Systems Div, Sunnyvale, Calif) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev, July 25-27, 1978, AIAA Paper 78-934* 17 p

The advent of high performance integral rocket ramjet (IRR) propulsion systems has introduced a new set of ground test facility requirements. CSD has constructed a modern ground test facility specifically designed and developed to handle these advanced IRR propulsion systems. The CSD facility provides two important new test capabilities. First, rocket-to-ramjet transition tests with simulated or live full-scale integral booster motors can be conducted. Second, complete ramjet flight trajectories can be simulated, with automatic computer control of the altitude simulation apparatus, airflow and total temperature simulation, ramjet fuel flow, and external aerodynamic heating simulation. (Author)

**A78-48455 # Ramjet engine testing and simulation techniques** L C Dunswoth and G J Reed (Marquardt Co, Van Nuys, Calif) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev, July 25-27, 1978, AIAA Paper 78-935* 8 p

Simulation of flow conditions within the operating regime of ramjet engines requires unique ground test capabilities. The blow-down facility is an economical method of meeting the high air mass flow and pressure ratio requirements. Vitiated air heaters provide a flexible and cost effective method of simulating trajectory temperature variation. Adequate simulation of the inlet flow conditions in freejet tests plays an important role in engine development. Ramjet engine ground test requirements are discussed. Methods of simulating



the applicable parameters in direct connect and freejet tests are reviewed. Techniques and devices that have proven beneficial in meeting aerodynamic simulation requirements are described.

(Author)

**A78-48456 #** Center-loaded duct integral rocket-to-ramjet transition testing. H J Readey, Jr and E R Cobb (Martin Marietta Aerospace, Orlando, Fla.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-937* 9 p

This paper describes the facility test equipment and techniques that have been developed for efficient integral rocket-to-ramjet transition testing. The facility and test procedures were successfully demonstrated with the use of representative advanced cruise missile test hardware and test conditions to establish the feasibility of the high-performance center-loaded duct propulsion concept. This concept requires that the ramjet flameholder and fuel injectors be stationed between two solid propellant rocket grains. The transition test method was selected because it produces the true thermal/time history for both the test hardware and the environment. The test series included component checkout tests, ramburner firings to establish baseline performance, simulated transition tests to verify facility operation, and full rocket-to-ramjet transition firing for design verification.

(Author)

**A78-48469 #** Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions. G K Richey, D L Bowers (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), L C Kostin (Rockwell International Corp., Aircraft Div., Los Angeles, Calif.), and E A Price, Jr (ARO, Inc., Arnold Engineering Development Center, Arnold Air Force Station, Tenn.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-989* 8 p

The B-1 Wind Tunnel/Flight Test Correlation Program had the objective to investigate the B-1 propulsion nacelle flow field differences between wind tunnel and flight test and determine the sources of these differences. The wind tunnel and flight tests of the program are discussed and a description is presented of the corresponding nacelle afterbody/nozzle instrumentation. A 0.06 scale B-1 nozzle afterbody model was used as wind tunnel model. Flight data were obtained during the B-1 No. 2 structural test flight development program. The test results obtained in the investigations provide a good data base for the study of the flow characteristics in transonic flow and differences/similarities between wind tunnel and flight for an exhaust nozzle/aftbody system which is closely integrated with the wing and fuselage.

G R

**A78-48470 \* #** Status of a nozzle-airframe study of a highly maneuverable fighter. J Nugent, N V Taillon (NASA, Flight Research Center, Edwards, Calif.), and O C Pendergraft, Jr (NASA, Langley Research Center, Hampton, Va.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-990* 18 p

NASA is sponsoring a research program that uses coordinated wind tunnel and flight tests to investigate nozzle-airframe flow interactions. The program objective is to compare transonic flight and wind tunnel measurements over a wide Reynolds number range. The paper discusses the progress of the program and the coordination of the wind tunnel and flight tests with regard to program elements, model-airplane differences, instrument locations, and test conditions. The real-time feedback techniques used to obtain steady flight conditions are presented. Available wind tunnel results are presented for the jet effects model showing the influence of the rear-end geometry and test variables on nozzle drag. Available flight results show the effect of the variable inlet ramp angle and angle of attack on fuselage pressures and upper surface boundary layers.

(Author)

**A78-48471 #** An experimental and numerical study of three-dimensional turbulent jets. J M Barton, S F Birch, G C Paynter, and R W Crouch (Boeing Aerospace Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-994* 10 p 15 refs

A numerical method which solves the parabolized 3-D Navier-Stokes equations with a two-equation turbulence model is used to predict three complex subsonic exhaust nozzle flows. The first is the jet from a model-scale multi-element nozzle with a quiescent ambient. The second is the jet decay behind a full-scale 727 jet airplane stationary on the runway. Predicted mean flow properties are in good agreement with test data for the two flows. The third flow is the jet development from a twin-podded B-52 airplane nozzle at flight conditions. No test data are available for this flow. The computed results are presented to indicate the applicability of the analysis to 'wind on' flows. Major prerequisites for successful application of the analysis to 3-D jet flows are outlined.

(Author)

**A78-48481 #** The effect of thrust vectoring and attitude control concepts on the propulsion system of V/STOL aircraft. G W. N Lampard (Boeing Aerospace Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1020* 8 p

V/STOL aircraft design and mission performance requirements and configuration features of the propulsion system are identified. In the configurations analyzed, an odd number of engines leads to one engine being mounted in the fuselage. This is undesirable as it restricts payload volume and otherwise encumbers the body. Thus, most designs are based on two or four engines mounted in two nacelles. Thrust control concepts are discussed relative to variable geometry fans, fan flow transfer, thrust spoiling, thrust vectoring, and compressor bleed flow transfer. The resulting propulsion system is compared in terms of weight, fuel consumption and required advanced technology components and subsystems. Design of engines with high bleed capability for attitude control is stressed.

S D

**A78-48482 #** Installed performance of vectoring/reversing non-axisymmetric nozzles. P E Hiley, D E Kitzmiller, and C M Willard (McDonnell Aircraft Co., St. Louis, Mo.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1022* 11 p 15 refs

A description is presented of wind tunnel tests conducted in a transonic propulsion wind tunnel in connection with a program concerned with the experimental evaluation of nonaxisymmetric exhaust nozzles. Five 2-D nozzles were tested, representing first generation, low aspect ratio designs. The types of exhaust nozzles tested include 2-D convergent-divergent nozzles with internal expansion only, a 2-D single expansion ramp with combined internal/external expansion, and a 2-D plug with combined internal/external expansion. Installed performance was determined for all 2-D nozzle installations at dry and low Mach afterburning power. The aerodynamic performance characteristics of the nozzle concepts were evaluated for unvectored, vectored, and reverse thrust conditions. A wide disparity in transonic maneuver performance was demonstrated for unvectored conditions, but nearly equal performance resulted with optimum vector angle settings.

G R

**A78-48483 #** Non-axisymmetric nozzle design and evaluation for F-111 flight demonstration. G F Goetz, J E Petit, and M B Sussman (Boeing Aerospace Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1025* 13 p Contract No F33615-76-C-3107

A previous 2D nozzle design study has been extended to evaluate the impact of thrust vectoring during afterburning and structural integration with the aircraft. The impact of one such installation on the performance and flight control characteristics of an F-111 aircraft modified for flight demonstration was evaluated. Preliminary design layouts showed the feasibility of the concept and key considerations for appropriate flight research are discussed.

(Author)

**A78-48486 # Propulsion for future supersonic transports - 1978 status** G B Evelyn, P E Johnson, and A Sigalla (Boeing Commercial Airplane Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1051* 14 p 13 refs

Results of several studies that have taken place since the cancellation of the United States SST program in 1971 have shown significant progress in the technology that may make such an airplane eventually possible. Advances in propulsion technology have been a strong element of this progress. The state of propulsion technology, as applicable to a future SST, is reviewed, with emphasis on the progress and changes that have occurred since 1971. The review includes discussion of the basic technology that affects thermodynamic and mechanical characteristics of supersonic engines, competitive types of engine cycles, the state of supersonic intake technology and candidate concepts, and supersonic engine nozzles. Emphasis is placed on the interactions of the propulsion system with the rest of the airplane and on the assessment of the propulsion system in terms of airplane performance and noise.

(Author)

**A78-48487 # Advanced supersonic transport engine integration studies for near-term technology readiness date** R D Fitz Simmons, W T Rowe, and E S Johnson (Douglas Aircraft Co., Long Beach, Calif.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1052* 8 p 12 refs

The identification of the proper engine cycle, or cycles, is the most critical task facing the advanced supersonic technology teams today. It determines research requirements in propulsion, acoustics and aerodynamics plus overall program timing, requirements, funding and, eventually, airline acceptance. This paper compares the results of a near-term engine-airframe integration study covering four U.S. engine company low-bypass-ratio turbojet engine designs that have technology readiness dates from 1978 to 1982 for program go-ahead. The effects of changes in technology readiness dates are described and compared with variable-cycle engines of more advanced technology reported on earlier. In addition, study results of a European engine design with a 1982 technology readiness date are included. A typical low-bypass-ratio engine cycle is chosen to illustrate the effect on airplane performance caused by optimum inlet-engine airflow matching. A new Douglas Aircraft Company baseline airplane designed to carry 225 passengers in an all metal airframe which can be ready for an early- to mid-1980 go-ahead is used for the detailed integration studies.

(Author)

**A78-48488 # Propulsion system airframe integration studies - Advanced supersonic transport** J R Wilson and J L Benson (Lockheed California Co., Burbank, Calif.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1053* 7 p

One of the objectives of the considered integration studies is related to the identification of engine/airframe configurations which offer the best performance potential within environmental constraints. Other objectives include the identification of engine cycle and geometry improvements, the development of practical preliminary designs of most promising configurations, and the identification of test and development program requirements. The variables examined in the study are related to the engine nacelle location, the inlet configuration, the engine cycle/configuration, engine-inlet

airflow match, engine thrust schedule, and engine accessory location. Attention is given to propulsion system configurations, tradeoff studies, engine-inlet matching studies, aspects of nacelle design integration, and engine operational procedures.

G R

**A78-48494 # Important simulation parameters for the experimental testing of propulsion induced lift effects** E P Schuster and J D Flood (McDonnell Aircraft Co., St. Louis, Mo.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1078* 10 p

The demanding performance requirements for  $\bar{V}/\bar{S}$ TOL aircraft have made it important to accurately evaluate aircraft forces and moments in ground effect. Sizeable forces may be induced on the airframe due to interactions with the flow field formed by the propulsion system exhausting in close proximity to the ground. This paper examines experimental results obtained during a number of scale model tests on several V/STOL aircraft designs currently under investigation. Induced force and moment data, exclusive of the propulsion system thrust, are presented as a function of ground height and represent the primary test information. Airframe lower surface pressure measurements recorded during the tests are also presented. These pressure measurements have been a significant aid in understanding the force and moment results. The relative importance of simulation test parameters, such as nozzle exhaust profile, nozzle geometry and model dimensional details, is identified.

(Author)

**A78-48495 # Evaluation of inlet reingestion for large bypass ratio V/STOL aircraft** C R Limage (Vought Corp., Dallas, Tex.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1079* 8 p 9 refs

A parametric test program was conducted at Vought to evaluate reingestion characteristics of large bypass ratio V/STOL aircraft. Ejectors were used to simulate the propulsion flows of two, three and four jet configurations over a range of ground heights and angle of attack. Effects of number of jets, jet and inlet locations and inlet shields on inlet reingestion were evaluated. The test results show the importance of jet and inlet location on the amount of inlet reingestion incurred for the configurations tested. By creating a favorable near ground flow field through correct location of jets, inlets, and aerodynamic surfaces, the amount of reingestion, can be significantly reduced.

(Author)

**A78-48496 # Vectoring non-axisymmetric nozzle jet induced effects on a V/STOL fighter model** W C Schnell and R L Grossman (Grumman Aerospace Corp., Bethpage, N.Y.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1080* 19 p 7 refs

An experimental program sponsored by the Air Force Flight Dynamics Laboratory, utilizing a 1/8th scale advanced twin engine, thrust vectoring, V/STOL fighter wind tunnel jet effects model developed for the Naval Air Propulsion Test Center, was completed in June of 1977 at the Arnold Engineering Development Center. The experimental program consisted of three primary parts: (1) measurement of the static internal performance characteristics of several non-axisymmetric nozzles and a baseline axisymmetric nozzle, (2) comparison of the installed dry power performance of the non-axisymmetric nozzles with the axisymmetric nozzle, and (3) measurement of the inflight thrust vectoring propulsion induced aerodynamic effects of the nonaxisymmetric nozzle installations. This paper describes the results from part (3) of this program. Results from parts (1) and (2) were presented in a prior publication. The part (3) findings show significant aircraft performance improvements when the nonaxisymmetric nozzles are vectored. The overall program clearly produced a major contribution to the developing nonaxisymmetric nozzle/airplane installation data base.

(Author)

**A78-48497 # Design for durability - The F101-GE-100 engine** T L Hampton and W E Schoenborn (General Electric Co., Evendale, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1084* 19 p 6 refs

In connection with the occurrence of turbine engine structural problems in the late sixties, it was recognized that the existing Air Force and Navy specification requirements included inadequate specific criteria for the structural design of engines. The result of this recognition was the formulation of the Engine Structural Integrity Program (ENSIP) philosophy of structural design, verification and life management, with the objective of providing the using services with more durable engines. The first application of the ENSIP philosophy was in the 1969 Request for Proposal for an engine to power the B-1 bomber. The resulting competition led to the selection of the F101-GE-100 Augmented Turbofan engine. The design and test verification phases of the ENSIP philosophy were subsequently carried over into the Prime Item Development Specification for the F101 engine. G R

**A78-48499 # Boundary layers in axisymmetric inlets at angle of attack I - Measurements** M D Breer (Boeing Wichita Co., Wichita, Kan.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1109* 7 p

A 34%-contraction-ratio axisymmetric inlet model was tested in a 9 x 9 ft low-speed wind tunnel for the purpose of measuring boundary-layer profiles at angles of attack ranging from 0 to 40 deg. Boundary-layer total pressure profiles were measured at four circumferential and four axial positions in the inlet diffuser. Variations in tunnel wind speed, angle of attack, and model airflow resulted in 448 individual profiles. Tests to establish flow separation were also conducted under seven different conditions. The interaction of shock waves with the boundary layer caused a significant increase in profile thickness. A 'quickie' method was found to determine the boundary in an inlet design envelope between separated and attached flows. The test data were used to evaluate potential-flow and boundary layer analytical methods. (Author)

**A78-48504 # Optimization techniques for air traffic control problems (Metody optimizatsii protsessov upravleniia vozdušnym dvizheniem)** G A Kryzhanovskii and V A Solodukhin (Moscow, Izdatel'stvo Transport, 1978) 152 p 159 refs. In Russian

The book addresses the problem of modeling the various processes involved in air traffic control, and describes methods of solving the resulting optimization problems. Optimization of both static and dynamic processes in air traffic control systems is considered. Special methods treated include a method of solving linear programming problems without the requirement of sign definiteness of the variables, a combined method of solving problems of optimization of static nonlinear processes, a method for optimizing dynamic processes in air traffic control with allowance for time delay and incomplete measurements, and the principle of equivalence of parametric equations in dynamic optimization problems. The principles of programming hybrid computer systems to solve certain problems in optimization are set forth. P T H

**A78-48518 # Extending the service life of aircraft components made of high-strength steels (Povyshenie resursa aviatsionnykh detalei iz vysokoprochnykh stali)** A Ia Riaboi and L D Bronz. Moscow, Izdatel'stvo Mashinostroenie, 1977) 104 p 43 refs. In Russian

The book deals with methods of extending the service life of chromium plated aircraft steels. The factors responsible for the pronounced decrease in durability of high-strength steels due to chromium plating are examined, along with methods of avoiding this

effect. Some aspects of intensifying the chromium plating process and of preparing hermetic chromium coatings are discussed. The influence of residual stresses in the surface layer on fatigue strength is examined. V P

**A78-48523 # Communication and navigation antennas for aircraft (Sviaznye i navigatsionnye anteny samoletov)** A A Bolbot, L Ia Il'nikskii, and I I Kupriyanov (Moscow, Izdatel'stvo Transport, 1978) 176 p 46 refs. In Russian

The book discusses the principles of operation and design of antennas for civil aircraft and provides material on the allocation and application of antennas on the aircraft. Basic theory on the operation of each type of antenna is given, and the main operating characteristics, parameters, and features of use of the antennas are described. Topics studied include the radiation pattern, the directivity and gain coefficients, measurement of the standing wave ratio and input impedance, measurement of antenna efficiency, electromagnetic compatibility of onboard antennas, stiff wire antennas, folded dipole antennas, upper feed antennas, slot antennas, antennas for communication with artificial earth satellites, close feed stub antennas, surface wedge antennas, close range communication antennas for helicopters, radio compass antennas, radio altimeter antennas, and marker receiver antennas. P T H

**A78-48736 # Interscan - A new microwave approach and landing guidance system** H C Minnett (Commonwealth Scientific and Industrial Research Organization, Div of Radio Physics, Sydney, Australia) and G H Boyd (Department of Motor Transport, Melbourne, Australia) *Navigation (Australia)*, vol 5, Dec 1977, p 583-594

Interscan is a proposed system for approach and landing guidance operating in C-band, designed to meet new CAO operational requirements. Wide sectors of azimuth and elevation angular guidance and also low-level height information for flare guidance are transmitted to aircraft from ground-based subsystems. The complete system comprises six subsystems providing these functions: approach guidance in horizontal plane, missed approach and takeoff guidance in horizontal plane, approach guidance in vertical plane, missed approach guidance in vertical plane, low-level vertical guidance for landing, and distance information throughout the coverage volume. The system operates in a TDM format requiring a bandwidth of only 300 KHz for each channel, thus providing growth potential. The principle of angle guidance is the time-reference scanning-beam. Rapid scanning of either planar or conical beams is required. Results of ground and flight tests are presented which demonstrate the high-quality angle guidance provided by Interscan. P T H

**A78-48864 Large deflection static analysis of typical tail-wheel structure of light aircraft by finite element method** P N Raju and M R Shanbhag (Hindustan Aeronautics, Ltd., Bangalore, India) *International Journal for Numerical Methods in Engineering*, vol 12, no 8, 1978, p 1203-1212

The static analysis of the tail-wheel structure of a typical light aircraft yields load-deflection characteristics, which in turn yield the energy absorbed by the structure during landing. A straight beam element with two end nodes and three degrees of freedom at each node point is used as a building block to represent the finite element model of the structure. The analysis is based on the theory of incremental linearization, in which changes in geometry as loading progresses are taken into account. B J

**A78-48982 Application of cryogenics in experimental aerodynamics (Anwendung der Tieftemperaturtechnik im strömungs-technischen Versuchswesen)** T Hottner (Stuttgart, Universität, Stuttgart, West Germany) *Ingenieur-Archiv*, vol 47, no 4, 1978, p 241-256) 13 refs. In German

Difficulties concerning the study of the models of large aircraft in the wind tunnel are related to the huge energy requirements for

the performance of the tests. These requirements can be reduced by decreasing the kinematical viscosity. This can be done by increasing the static pressure or by reducing the operational temperature. The current status of aerodynamic simulation technology is examined and a description is provided of a cryogenic wind tunnel with closed-design characteristics for quasi-continuous operation. Attention is given to an application of cryogenic technology in the case of blow-down storage wind tunnels, the employment of cryogenics for a hybrid tunnel, and the use of heavy gases (CF<sub>2</sub>Cl<sub>2</sub>) as test gas.

(Author)

**A78-49025 #** Effect of jet fuel autooxidation products on thermooxidation stability (Vlianiye produktov avtookisleniya reaktivnykh topliv na termookislitel'nyuu stabil'nost') N Ia Chertkova and A A Gureev (Moskovskii Institut Neftekhimicheskoi i Gazovoi Promyshlennosti, Moscow, USSR) *Khimiia i Tekhnologiya Topliv i Masel*, no 8, 1978, p 48-52. 14 refs. In Russian.

Isooctane, benzol, and methanol oxygen compounds were extracted from T-7 jet fuel stored for a long period of time in iron tanks and were then added in measured concentrations to T 7 fuel that was initially free of oxygen compounds in order to study the effect of the autooxidation products on thermooxidation stability. It was found that alcohols formed during low temperature liquid phase oxidation of hydrogenization fuels plays the role of inhibitor of further fuel oxidation at a certain concentration and up to a certain temperature limit. The effectiveness of the alcohols is maintained up to 120-150 C. At 150 C their structure begins to change with formation of more high-molecular densification products. P T H

**A78-49163 #** Highly survivable integrated avionics J J Deyst, Jr and A L Hopkins, Jr (Charles Stark Draper Laboratory, Inc., Cambridge, Mass.) *Astronautics and Aeronautics*, vol 16, Sept 1978, p 30-41. 15 refs.

A system of highly-survivable integrated avionics is presented. The distributed information-processing hierarchy is outlined with reference to sensor/effector components, regional computers, hierarchical-redundant data communications, and the fault-tolerant computer. The three major elements of wholly integrated avionics systems are described in detail: sensors, computers, and actuator/controls. S C S

**A78-49169** Mirage 2000 - Dassault's better delta D Richardson, J M Ramsden, D Velupillai, and G Warwick *Flight International*, vol 114, Aug 26, 1978, p 637-640.

The circumstances that lead to the cancellation, in 1975, of the Super Mirage in favor of the Delta 2000 powered by a single M53-5 turbofan are reviewed. The advantages of Dassault's new delta concept over the conventional delta are pointed out. V P

**A78-49175 #** 10 years of contract research for the pump/compressor industrial concern (10 Jahre Vertragsforschung für das Kombinat Pumpen und Verdichter) H J Kleinert (Dresden, Technische Universität, Dresden, East Germany) *Dresden Technische Universität, Wissenschaftliche Zeitschrift*, vol 27, no 3-4, 1978, p 747-752. 26 refs. In German.

The goals, trends, and results of the past ten years of research at the state concern for pumps and compressors are summarized. Problems worked on included design and measurement techniques for piston compressors, oil and condensate precipitation from pressure gases, and flow in rotary pumps. Some computer-generated velocity fields in a rotary pump are shown. P T H

**A78-49176 #** Aspects of the thermal fatigue strength of gas-turbine engine components (Problemy termotokicheskoi prochnosti detalei GTD) N D Kuznetsov *Problemy Prochnosti*, June 1978, p 3-7. 7 refs. In Russian.

The present review of gas-turbine disk and blade failures points toward a major contribution of thermal cycling to the failure of these and other engine components. The complexity of the action of

thermal cycling loads is demonstrated on the basis of an airliner engine. Methods of evaluating the thermal fatigue strength of gas-turbine engines are examined, and the need for the development of mathematical models that would take into consideration all the factors affecting thermal cyclic fatigue is pointed out. V P

**A78-49238** A systems approach to heliport lighting J R Downing (Downing Electronics, Inc., Northridge, Calif.) *Vertiflite*, vol 24, Sept-Oct 1978, p 8, 9.

A heliport lighting system is described that comprises a surface floodlight-perimeter combination, a visual-approach-slope indicator, a high-intensity strobe locating beacon, a low-level perimeter light, a landing direction arrow floodlight, and a remote radio receiver control. Suggested layouts for the lighting system at a round heliport and at a rectangular one are shown. P T H

**A78-49239** LOGMOD - The fault-isolator W L Andre (U S Army, Research and Technology Laboratories, Moffett Field, Calif.) *Vertiflite*, vol 24, Sept-Oct 1978, p 18, 19.

A portable 20-lb device called LOGMOD (Logic Model) can spot a malfunction in a helicopter system, isolate it, and then tell how to correct it. LOGMOD can fault-isolate helicopter systems such as gun turrets, flight-control systems, and electrical-hydraulic subsystems. The unit can be operated by an untrained technician after 30 minutes of instruction. LOGMOD operates on the actual functional dependency logic of the hardware design of a unit being tested to show where and what test is needed. It stores detail logic of aircraft systems containing thousands of parts. A logic model is put together of an entire aircraft which can fault-isolate to any level of maintenance. No details on design of the instrument are given. P T H

**A78-49285 #** Dynamics of the longitudinal motion of an airplane with a variable-geometry wing Z Dzygadlio and J Maruszkiewicz *Journal of Technical Physics*, vol 19, no 1, 1978, p 125-136. 7 refs.

The longitudinal motion stability of aircraft with fixed and variable sweep wings is analyzed numerically. It is found that an aircraft which is stable for fixed sweep angles undergoes considerable perturbations of the principal flight parameters if the sweepback angle varies during flight. Variable sweep has a significant effect on perturbations of incidence angle, trajectory inclination angle, speed, and altitude. It is concluded that, in order to maintain flight parameters within prescribed limits, it is necessary to operate the controls during change of sweep angle. B J

**A78-49333 #** Use of the U S interim standard microwave landing system in Canada W C Reed (*Canadian Aeronautics and Space Institute, Canadian Symposium on Navigation, 3rd, Ottawa, Canada, Nov 16, 17, 1977*) *Canadian Aeronautics and Space Journal*, vol 24, July-Aug 1978, p 217-227.

A general description of the Tull Microwave ILS serving as the US Interim Standard ILS is given. The system operates at 5.0-5.25 GHz and uses a scanning beam technique for ease of installation and siting. The system uses the ILS signal format of 90 Hz and 150 Hz in order to provide compatibility with aircraft ILS/VOR receivers. Principal ground elements are the localizer and glide-path subsystems. By the principle of beating, the 20 standard ILS frequency pairs can be produced by means of a single converter frequency. MLS airborne equipment interfaces with existing ILS receivers and instrumentation are illustrated. The installation of the system in a first application at the heliports of a helicopter shuttle service is described. P T H

**A78-49334 #** Lateral-aerodynamic characteristics of highly-dihedral wings B Kroeker and J DeLaurier (Toronto, University, Toronto, Canada) *Canadian Aeronautics and Space Journal*, vol 24, July-Aug 1978, p 240-245. 11 refs. Research supported by the National Research Council.

A computer was used to find the solutions for a vortex-lattice model of a V-dihedral wing or tail. The formulations of Hedman (1966) were used, but were extended to take into account noncoplanar vortex elements. The aspect ratios varied from 2.0 to 20.0, the dihedral angles were 10, 20, 30, 40, and 50 deg, and the taper ratios were 0.25, 0.5, and 1. Incompressible, attached, and inviscid flow is assumed. The program calculated the values of  $K$ , defined as the ratio of the lift coefficient on one wing half at given angle of attack with the other half at the negative of this angle to the lift coefficient on one wing with both halves at equal angle of attack. One result is that the  $K$  values varied little with dihedral angle from 10 to 50 deg. Previous NACA values were consistently higher than the present ones. The use of 16 panels in the computation was found to provide sufficient accuracy. P T H

**A78-49336 \*** Gas turbine engine emissions - Problems, progress and future. R E Jones (NASA, Lewis Research Center, Experimental Combustor Section, Cleveland, Ohio). *Progress in Energy and Combustion Science*, vol 4, no 2, 1978, p 73-113. 125 refs.

The current status of the problem of gas turbine engine emissions is reviewed. Presently promulgated EPA standards and their implications for aircraft gas turbines are discussed. The progress and status of emissions reduction technology programs and other efforts which have emphasized advanced combustor technology are reviewed in detail. Also examined are those efforts underway to determine the emissions floor and incorporate those techniques into practical combustors of the future. P T H

**A78-49396** Design and development of a multifunctional helicopter control system. W J Kubbat (Messerschmitt-Bolkow-Blohm GmbH, Munich, West Germany). *European Rotorcraft and Powered Lift Aircraft Forum, 3rd, Aix-en-Provence, France, Sept 7-9, 1977*. *Vertica*, vol 2, no 2, 1978, p 99-109.

The paper describes the design and development of helicopter control system which incorporates the functions of control and stabilization, autopilot, air data computation and strap down computation. All functions mentioned are performed within one dual processor computer. The system controls all four axis of the helicopter (roll, pitch, yaw and collective). This non-redundant system is fail soft, that means that any failure occurring will be detected and indicated to the pilot as well as will cause a disconnection of the system itself. Flight tests with a forerunner of this system (with only a different computer) have been successfully performed. Final flight tests with the end configuration are soon to come. (Author)

**A78-49397** Measurement of vibratory displacements of a rotating blade. D R Gaukroger and C J W Hassal (Royal Aircraft Establishment, Farnborough, Hants, England). *Vertica*, vol 2, no 2, 1978, p 111-120.

An experimental technique for determining the vibratory displacements of a helicopter blade is described. Strain-gauges are used to sense the vibratory behavior of the rotating blade, the strain-gauge output pattern is then converted to a displacement pattern using relationships measured for the non-rotating blade. Some results of the application of the technique to a model blade are given. (Author)

**A78-49398** Stability of a helicopter carrying an under-slung load. A Prabhakar (Royal Military College of Science, Shrivenham, Wilts, England). *European Rotorcraft and Powered Lift Aircraft Forum, 3rd, Aix-en-Provence, France, Sept 7-9, 1977*. *Vertica*, vol 2, no 2, 1978, p 121-143. 23 refs.

A theoretical study is presented of the dynamics of a Sea King helicopter carrying a 2 ton, 20 x 8 x 8 ft standard cargo container, slung by four cables from two longitudinally separated suspension points on the helicopter fuselage. Equations of motion of the helicopter-under-slung load system were derived by representing them as two rigid bodies moving through space, the load being constrained

to the helicopter by the suspension. Aerodynamic reactions of both the helicopter and load were expressed as stability derivatives. The rigid body modes of the helicopter were changed almost completely by the load, the effect being generally destabilizing, the helicopter acted as a load stabilizer, however, by making the yawing motion less divergent. B J

**A78-49399** Helicopter rotor vibration isolation. R A Desjardins and W E Hooper (Boeing Vertol Co., Philadelphia, Pa). *Vertica*, vol 2, no 2, 1978, p 145-159. 14 refs.

An isolation system has been developed for hingeless rotor helicopters which has been demonstrated to be extremely effective in preventing rotor induced vibration from reaching the airframe. Named IRIS (Improved Rotor Isolation System) the system has been in development for 3 years and was first flown and is currently being demonstrated on a BO-105 helicopter. A similar system has been installed in a Company-owned Model 179 helicopter and is presently being developed through flight testing. This paper describes some of the analytical and bench testing background of both IRIS installations and presents latest available flight data. (Author)

**A78-49427 \* #** Volumetric pattern analysis of airborne antennas. C L Yu (U.S. Navy, Naval Weapons Center, China Lake, Calif.), W D Burnside (Ohio State University, Columbus, Ohio), and M C Gilreath (NASA, Langley Research Center, Hampton, Va). *IEEE Transactions on Antennas and Propagation*, vol AP-26, Sept 1978, p 636-641. 8 refs. Grant No. NGL-36-008-138.

By blending together the roll and elevation plane high-frequency solutions, a very efficient technique has been developed for the volumetric pattern analysis of antennas mounted on the fuselage of a generalized aircraft. The fuselage is simulated by an infinitely long, perfectly conducting, elliptic cylinder in cross section and a composite elliptic cylinder in profile. The wings, nose section, stabilizers, and landing-gear doors may be modeled by finite flat or bent plates. Good agreement with accurate scale model measurements has been obtained for a variety of airborne antenna problems. (Author)

**A78-49428** Conformal microstrip phased array for aircraft tests with ATS-6. G G Sanford (Ball Brothers Research Corp., Boulder, Colo). *IEEE Transactions on Antennas and Propagation*, vol AP-26, Sept 1978, p 642-646. 6 refs. US Department of Transportation Contract No. TSC-763.

The development of a novel L-band microstrip phased array for aircraft is described. The array is electronically steerable in elevation, conformal to the surface of an aircraft, 0.14-in thick, low cost in production quantities, installed without cutting large holes in the aircraft, and capable of 12-dB gain relative to right hand circular isotrope. The microstrip radiating element is described, and its operation is explained. The array design is considered in relation to ground plane curvature, grating lobes, sidelobes, beam shape and gain. A technique for obtaining 30 deg phase resolution from 3-bit phase shifters is presented. The design of simple loaded line and switched line phase shifters is reported. (Author)

**A78-49439 #** Fading at 9.6 GHz on an experimentally simulated aircraft-to-ground path. H B Janes and M C Thompson, Jr (NOAA, Institute for Telecommunication Sciences, Boulder, Colo). *IEEE Transactions on Antennas and Propagation*, vol AP-26, Sept 1978, p 715-719. Contract No. F30602-75-F-0256.

This report describes an experimental study of fading at 9.6 GHz on a fixed slanted line-of-sight path simulating aircraft-to-ground propagation conditions. Recordings of signal fading were made over about one year. The data were analyzed to provide a statistical description of the fading, and to compare some of these statistics with those obtained elsewhere under different climatic and terrain conditions. The results include the probabilities of occurrence of fading rates and fade durations at several signal levels below the hourly median level. The extent to which fading behavior depends on

time-of-day and time-of-year was investigated, along with the correlation of hourly average fade duration and hourly fading rate

(Author)

**A78-49447 #** An integrated analysis of the fundamental problems of air transport (Análisis integrado de los problemas fundamentales del transporte aéreo) P González Cristobal *IAA/Ingeniería Aeronáutica y Astronáutica*, vol 30, June-July 1978, p 5-14 In Spanish

An investigation is conducted regarding the various factors involved in the selection of new aircraft by companies engaged in air transport operations. Attention is also given to work and procedures required in connection with the fabrication and the acceptance of a new aircraft, its maintenance, and the preparation of personnel of the company purchasing the aircraft for the various tasks which will have to be performed in connection with the operation and the maintenance of the aircraft. Factors affecting the selection of a particular aircraft by a company engaged in air transport operations can be divided into two categories. One category includes factors related to the requirements of the company. Factors of the second category are related to the aircraft types made available by the aircraft manufacturers, financial aspects, purchasing conditions, and other external matters. Each factor of both categories is examined individually.

G R

**A78-49449 #** Operational regularity in air transport (La regularidad de la operación en el transporte aéreo) L Domínguez Rodríguez *IAA/Ingeniería Aeronáutica y Astronáutica*, vol 30, June-July 1978, p 33-36 In Spanish

Regularity of service is a desirable trait in transport operations. A regularity index is used to obtain a quantitative measure for this trait. A suitable definition for the regularity index is considered and an analysis is conducted regarding the conditions which affect it in one form or another. The procedures employed in the prediction of regularity data are discussed, taking into account predictions made in the case of an aircraft during the design phase and the actual statistical data obtained at a later time. Attention is given to various factors causing operational delays, questions concerning the availability of the aircraft, a review of the delay probabilities for the various systems of the DC-9, data concerning service reliability, flight safety, and maintenance costs.

G R

**A78-49524** Airliner numbers game - Does it add up M Hewish *New Scientist*, vol 79, Aug 31, 1978, p 615-617

Recently the nationalized British Aerospace corporation was authorized by the government to resume development of the 146 jet transport, which will carry 70 to 109 passengers. On the same day as the 146 was relaunched, British Airways were advised to buy 19 Boeing 737s to replace its fleet of Trident. British Airways now wants to go further and order Boeing's new 757. Rolls-Royce supports this application, because the airline would specify British RB 211 engines for the 757 and give Rolls-Royce the advantage of having its powerplant as the initial standard in the new American airliner. France, Germany, Holland, and Spain are now partners in Airbus Industrie, which builds the A300 wide-body airliner. The type has been ordered by Eastern Airlines in the U.S., setting the seal on its acceptability.

G R

**A78-49549** Landing aircraft under poor conditions R J Kelly, H W Redlien, and J L Shagena (Bendix Corp., Towson, Md) *IEEE Spectrum*, vol 15, Sept 1978, p 52-57

The time-reference scanning-beam microwave landing system (TRSB MLS) is the new all-weather landing system designed to replace ILS. TRSB MLS is a systems approach to the landing-guidance problem, it can meet a variety of performance, economic, and safety requirements and still supply a universal airborne receiver-processor able to operate with all ground systems. This paper describes the operating principles of TRSB MLS, discusses the

accuracy requirements, and describes the test and demonstration program

B J

**A78-49550** The U.S. Navy bets on V/STOL R Steele and R Aurora (Grumman Aerospace Corp., Bethpage, N.Y.) *IEEE Spectrum*, vol 15, Sept 1978, p 58-63

The U.S. Navy has begun planning the next generation of sea-based aircraft, encompassing two types of V/STOL: (1) a subsonic aircraft outfitted with ASW or AEW, and (2) a supersonic fighter/interceptor/attack aircraft. This paper reviews the various technologies which will be integrated to produce this new-generation V/STOL. Particular consideration is given to conformal radar, advanced display concepts (e.g., AIDS), avionics, the data processing system, and the flight control system.

B J

**A78-49660** The Omega radionavigation system comes to the Pacific Ocean area D T Haislip and D C Scull (U.S. Coast Guard, Washington, D.C.) In *Oceans '77, Annual Combined Conference*, 3rd, Los Angeles, Calif., October 17-19, 1977, Conference Record Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., Washington, D.C., Marine Technology Society, 1977, p 38A-1 to 38A-9 7 refs

Two Omega transmitting stations have been in operation in the Pacific Ocean area for some time at Tsushima, Japan and Oahu, Hawaii. In addition, the Pacific region receives usable transmissions from Omega stations in Alder, Norway, La Reunion, Indian Ocean, and Golfo Nuevo, Argentina. A final station is planned for siting in the South Pacific area, and probably will be located in Australia. Even without the final station, adequate Omega coverage is now available in large portions of the Pacific Ocean area. The Omega monitoring network, the processing of the collected data, the analysis of predicted and observed signal coverage, and other steps in Omega system validation are necessary to provide the navigating community with a viable radio navigation system for the Pacific Ocean area.

B J

**A78-49661** Twoway - A position and orientation measurement system J Kuipers (Austin Co., Roselle, N.J.) In *Oceans '77, Annual Combined Conference*, 3rd, Los Angeles, Calif., October 17-19, 1977, Conference Record Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., Washington, D.C., Marine Technology Society, 1977, p 38E-1 to 38E-13

Twoway is a full six-degree-of-freedom position measurement system which operates cooperatively between two relatively remote but independent bodies. The system functions symmetrically, using a relatively simple electromagnetic signal which is alternately received from, processed, and transmitted to the other body in a transponding or multiplexed manner. Twoway can provide in each body a measure of the two pointing angles and range which define the direction to and the position of the other body together with the three Euler angles (or direction cosines) which define the relative orientation between the two bodies. The system consists of an antenna which is precisely fixed and oriented to its body, the signals received from and transmitted to the other body are processed by the System Electronics Unit.

B J

**A78-49676 #** Airfield pavement load evaluation - An international overview G D Bell (British Airports Authority, London, England) (*American Society of Civil Engineers, Annual Convention, Exposition and Continuing Education Program, San Francisco, Calif., Oct 17-21, 1977*) *ASCE, Transportation Engineering Journal*, vol 104, Sept 1978, p 531-536

Consideration is given to airfield pavement load evaluations and procedures for reporting the findings of such studies to airfield administration authorities, airline operators, aircraft manufacturers, and airfield licensing authorities. Evaluation programs are discussed.

with reference to determining financial balances between initial costs and subsequent development and maintenance, and assessing load ratings for aircraft and pavements Various testing methods are reviewed including static, moving, and dynamic destructive testing, the application of vibrating loads, ultrasonic testing, and radiographic techniques S C S

**A78-49677 # Proposed load evaluation system for U S Air Force** G T Baird and J P Nielsen (New Mexico, University, Albuquerque, N Mex) (*American Society of Civil Engineers, Annual Convention, Exposition and Continuing Education Program, San Francisco, Calif, Oct 17-21, 1977*) ASCE, *Transportation Engineering Journal*, vol 104, Sept 1978, p 537-543

A nondestructive pavement load evaluation system developed by the U S Air Force is described Particular attention is given to computer codes which calculate stresses caused by single-wheel and multiple-wheel landing gear configurations, soil constitutive models which describe the behavior of paving materials, and the nondestructive pavement-testing equipment Test procedures including load deflection tests, deflection-basin tests, wave propagation tests, and surface seismic refraction surveys are outlined Research aimed at the development of a mobile testing system is noted S C S

**A78-49678 # Transport Canada airfield pavement load evaluation** L B R Hunter, G H Argue, and A C Gamble (Canadian Air Transportation Administration, Airports and Construction Services Directorate, Ottawa, Canada) (*American Society of Civil Engineers, Annual Convention, Exposition and Continuing Education Program, San Francisco, Calif, Oct 17-21, 1977*) ASCE, *Transportation Engineering Journal*, vol 104, Sept 1978, p 545-558 7 refs

The paper discusses the airfield pavement load evaluation system used by Transport Canada The evaluation data base consists of construction histories, strength measurements, and structural condition survey reports The load rating system is based on indexing aircraft loadings and pavement design bearing strengths on a scale of 1-12 Individual written permission is required for overload operations S C S

**A78-49679 # French procedures for airfield pavement load evaluation** D Lacroix (Service Technique des Bases Aeriennes, Paris, France) (*American Society of Civil Engineers, Annual Convention, Exposition and Continuing Education Program, San Francisco, Calif, Oct 17-21, 1977*) ASCE, *Transportation Engineering Journal*, vol 104, Sept 1978, p 559-574

Procedures developed by the French Direction Generale de l'Aviation Civile for evaluating airfield pavement loads are discussed Testing methods for both flexible and rigid pavements are described noting load application systems, vertical displacement measurement, and horizontal strain measurement The delimitation and characterization of homogeneous zones are reviewed along with observations of deteriorations S C S

**A78-49680 # Airfield pavement evaluation - The airline view** C P Weisz (Air Transport Association of America, Washington, D C) (*American Society of Civil Engineers, Annual Convention, Exposition and Continuing Education Program, San Francisco, Calif, Oct 17-21, 1977*) ASCE, *Transportation Engineering Journal*, vol 104, Sept 1978, p 575-579

Procedures for airfield pavement evaluations are considered with reference to growth forecasts in airport capacity It is noted that such evaluations are required to determine the maximum gross load permissible for a specific aircraft, to estimate the number of traffic repetitions allowable for a particular type of aircraft, to forecast pavement design life, and to assess the pavement rehabilitation required for proposed traffic levels Plate bearing tests are described along with various methods of nondestructive testing S C S

**A78-49681 # Airfield pavement evaluation - FAA viewpoint** L E Mudd (FAA, Office of Airports Programs, Washington, D C) (*American Society of Civil Engineers, Annual Convention, Expositi-*

*tion and Continuing Education Program, San Francisco, Calif, Oct 17-21, 1977*) ASCE, *Transportation Engineering Journal*, vol 104, Sept 1978, p 581-585

The current policy of the Federal Aviation Administration concerning airfield pavement evaluations and standards is described Research programs, undertaken in conjunction with the Waterways Experiment Station of the U S Army Corps of Engineers are discussed with reference to the California Bearing Ratio design method Changes in design procedures for rigid pavements are identified although it is noted that no changes have been effected regarding the policy of landing gear design S C S

**A78-49682 # Pavement strength rating methods as viewed by airframe manufacturers** W A Woodcock (Boeing Technology International, Inc, Seattle, Wash) (*American Society of Civil Engineers, Annual Convention, Exposition and Continuing Education Program, San Francisco, Calif, Oct 17-21, 1977*) ASCE, *Transportation Engineering Journal*, vol 104, Sept 1978, p 587-603 5 refs

The role of airframe manufacturers in pavement design and strength ratings is outlined for both the aircraft design phase and during aircraft service life Particular attention is given to flotation techniques specified by the National Aerospace Specification 3601 Objectives for future flotation methods are identified S C S

**A78-49684 \* # Model of aircraft passenger acceptance** I D Jacobson (Virginia, University, Charlottesville, Va) ASCE, *Transportation Engineering Journal*, vol 104, Sept 1978, p 653-663 10 refs Grant No NGR-47-005-181

A technique developed to evaluate the passenger response to a transportation system environment is described Reactions to motion, noise, temperature, seating, ventilation, sudden jolts and descents are modeled Statistics are presented for the age, sex, occupation, and income distributions of the candidates analyzed Values are noted for the relative importance of system variables such as time savings, on-time arrival, convenience, comfort, safety, the ability to read and write, and onboard services S C S

**A78-49693 \* Assessment of relative flammability and thermochemical properties of some thermoplastic materials** D A Kourtidis and J A Parker (NASA, Ames Research Center, Moffett Field, Calif) *Polymer Engineering and Science*, vol 18, Aug 1978, p 855-860 10 refs

The thermochemical and flammability characteristics of some typical thermoplastic materials currently in use and others being considered for use in aircraft interiors are described The properties studied included (1) thermal mechanical properties such as glass transition and melt temperature, (2) changes in polymer enthalpy by differential scanning calorimetry, (3) thermogravimetric analysis in an anaerobic and oxidative environment, (4) oxygen index, (5) smoke evolution, (6) relative toxicity of the volatile products of pyrolysis, and (7) selected physical properties The generic polymers which were evaluated included acrylonitrile-butadiene-styrene, bisphenol A polycarbonate, bisphenol fluorenone carbonate-dimethylsiloxane block polymer, phenolphthalein-bisphenol A polycarbonate, phenolphthalein polycarbonate, polyether sulfone, polyphenylene oxide, polyphenylene sulfide, polyaryl sulfone, chlorinated polyvinyl chloride homopolymer, polyvinyl fluoride, and polyvinylidene fluoride Processing parameters including molding characteristics of some of the advanced polymers are described Test results and relative rankings of some of the flammability, smoke and toxicity properties are presented (Author)

**A78-49708 # Use of ground vibration test equipment to determine unsteady aerodynamic forces (Utilizzazione dell'attrezza-**

**tura di prove di vibrazione al suolo per la determinazione delle forze aerodinamiche instazionarie** L Lecce (Napoli, Università, Naples, Italy) *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 4th, Milan, Italy, Sept 19-23, 1977, Paper 19 p 14 refs* In Italian Consiglio Nazionale delle Ricerche Contract No 115,2648,07,CT-76,00480

The described wind tunnel procedure for studying structural and sinusoidal vibrations of aircraft and their components uses ground vibration test equipment to determine stability parameters required for the calculation of flutter speed. Bidimensional models are used to study the effect of parameters such as the angle of incidence causing surface oscillations, oscillation amplitude, and Reynolds number. Extension of the procedure to three-dimensional models is considered. M L

**A78-49713 Hermite closed splines** L G Napolitano *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 4th, Milan, Italy, Sept 19-23, 1977, Paper 23 p* Grant No AF-AFOSR-76-2889A

Hermite closed splines, constructed to solve interpolation problems related to closed curves, are described. These splines are defined in Hilbert space. Proofs of existence and uniqueness are presented, and their characteristics are developed in connection with the treatment of a minimization problem formulated in a Hilbert space defined by an arbitrary regular and sufficiently smooth contour. M L

**A78-49723 # Choice of cycle for a regenerative bypass turbojet for long-range aircraft (Scelta del ciclo del turboreattore a doppio flusso con rigeneratore per velivoli a lungo raggio).** O Scrofolani (Palermo, Università, Palermo, Italy) *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 4th, Milan, Italy, Sept 19-23, 1977, Paper 25 p 16 refs* In Italian

A thermodynamic and dynamic analysis of a bypass turbojet with heat exchange is presented. Engine components and the dependence of the specific heats of air and combustion products on the temperature and air/fuel ratio are taken into account, and the effect of cycle parameters on specific fuel consumption and specific thrust is examined. These parameters are considered with respect to engine weight and aerodynamic drag, and the performance capabilities of bypass turbojets with and without heat exchange are compared. M L

**A78-49731 # Use of a field bench for testing turbojet engines (Utilizzazione di un banco campale per la prova di turbomotori)** A Russo, A Colantonio (Aeronautica Militare, Rome, Italy), and G Torella (Napoli, Università, Naples, Italy) *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 4th, Milan, Italy, Sept 19-23, 1977, Paper 48 p 7 refs* In Italian

The paper describes the use of a field test bench for taking measurements of the thermodynamic cycle of aircraft turbojet engines. The guiding concept in selecting the instrumentation was to use a minimum of sensors without sacrificing measurement accuracy and reliability. Two attached sensors were used, consisting of two thermocouples, of which one furnished data on the static temperature downstream of the compressor and the second measured the static temperature downstream of the turbine. The test bench, sensor, and other instrumentation are described, and the method of determining the cycle from the measurements is explained. P T H

**A78-49733 # Air traffic control in the terminal area - Use of a simulation technique for the definition of an operative model (La gestione ATC in area terminale - Impiego delle tecniche di simulazione per la definizione di un modello operativo)** L Balis-Crema and C Bottiglieri (Roma, Università, Rome, Italy) *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 4th, Milan, Italy, Sept 19-23, 1977, Paper 13 p 5 refs* In Italian Consiglio Nazionale delle Ricerche Contract No 77,01087,91,115,9694

The purpose of the described simulation study of air traffic in the terminal area is to facilitate the smooth functioning of the terminal when the number of planes seeking entrance to the area exceeds the capacity of the area. The system studied involves  $n$  air routes, with possible nodes of confluence, which lead to a single runway, input-output, sequencing, hierarchy, spacing, and choice of exit gates are considered. A mathematical description of the model is presented, and the associated subroutines are described. M L

**A78-49736 Design of a horizontal tail unit and related adjustments (Dimensionamento di un impennaggio orizzontale e degli impianti relativi)** L Borello (Torino, Politecnico, Turin, Italy) *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 4th, Milan, Italy, Sept 19-23, 1977, Paper 22 p* In Italian

The paper describes a methodology for determining size adjustments of a tail unit and related equipment when these components are to be redesigned for incorporation into a given aircraft. Changes required in avionics and control systems are considered. Procedures for examining the equilibrium, stability, maneuverability, and speed are presented. M L

**A78-49741 # A method for determining the stability characteristics of aircraft in a helicoid flight path (Un metodo per la determinazione delle caratteristiche di stabilità dei velivoli su traiettorie elicoidali)** M Caprili, C Casarosa, and R Lazzeretti (Pisa, Università, Pisa, Italy) *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 4th, Milan, Italy, Sept 19-23, 1977, Paper 33 p 8 refs* In Italian

The stability characteristics of an aircraft in a curvilinear flight path is represented in differential form, and a theorem on the existence and uniqueness of the solution of such a system for physically acceptable initial conditions is presented. The stability of the differential system is considered, a nonlinear system of 12 equations is constructed, and an algorithm which does not require the analytic calculation of the Jacobian is proposed. The necessary and sufficient conditions for stability in a helicoid flight path are investigated, and results pertinent to the control of a typical aircraft are examined. M L

**A78-49744 # Takeoff performance of STOL aircraft (Sulle prestazioni in decollo dei velivoli da trasporto STOL)** C Casarosa (Pisa, Università, Pisa, Italy) *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 4th, Milan, Italy, Sept 19-23, 1977, Paper 23 p 20 refs* In Italian

Takeoff procedures for second generation STOL aircraft are described and compared. Simulation procedures are developed to aid in the evaluation. The recommended procedure involves a critical decision point defined with relation to the rotation velocity or a different velocity parameter. STOL and CTOL takeoff maneuvers are contrasted. M L

**A78-49769 # 'Supermarket' airplanes** R J Linn (American Airlines, Inc., New York, N Y) *American Institute of Aeronautics and Astronautics, Conference on Air Transportation Technical Perspectives and Forecasts, Los Angeles, Calif., Aug 21-24, 1978, Paper 78-1533 6 p*

New fleets will be required to meet the noise, old-age and economic problems facing most of the air transportation industry. American Airlines is in the process of analyzing the numerous new aircraft and engine designs being offered by the manufacturers to meet future fleet requirements. The present paper covers some of the methodology American is using in its analysis for choosing future fleet types. Evaluation objectives (e.g., 707 replacement, 727-100 replacement, and future market requirements) are discussed with reference to operating costs, engines and fuel consumption, and engine rating. B J



**A78-49770 #** Operations and economics of U S air transportation J M Swihart and J I Minnick (Boeing Commercial Airplane Co , Seattle, Wash ) *American Institute of Aeronautics and Astronautics, Conference on Air Transportation Technical Perspectives and Forecasts, Los Angeles, Calif , Aug 21-24, 1978, Paper 78-1545* 9 p

Operational trends indicate that the US air transportation service network is adequate and that the rapid development of the system may be over More efficient equipment, improved fleet mixes, higher seating densities, and higher load factors will be required to hold down increases in airline operating costs caused by inflationary and environmental pressures Higher unit operating costs will require increases in unit revenues to provide operating profit in an era of air transportation which the author calls 'the ear of the bottom line'

(B J)

**A78-49771 #** Piloted flight simulation for active control design development D M Urie (Lockheed-California Co , Burbank, Calif ) *American Institute of Aeronautics and Astronautics, Conference on Air Transportation Technical Perspectives and Forecasts, Los Angeles, Calif , Aug 21-24, 1978, Paper 78-1553* 10 p

This paper reviews experience with piloted flight simulation in current transport development citing the L-1011 yaw SAS and Direct Lift Control Recent simulation studies of a relaxed static stability version of the L-1011 are discussed, as are tests using the vehicle systems simulator with pilot-in-the-loop to verify handling qualities effects of active load alleviation The role of flight simulator data in determining augmentation system reliability criteria are explored Continued utility of piloted simulation for predicting certificability of flying qualities which depend on subjective evaluation are considered Limitations of current equipment for future needs are discussed along with recommendations for simulator planning

(Author)

**A78-49781 \* #** A laser-powered flight transportation system A Hertzberg, K C Sun (Washington, University, Seattle, Wash ), and W S Jones (Lockheed Missiles and Space Co , Inc , Palo Alto, Calif ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1484* 31 p 28 refs Grant No NGL-49-002-044

Laser energy transmitted from a solar power satellite via a set of relay satellites is used to power a cruising air transport, i.e., a laser-powered airplane The result is a nearly fuelless pollution-free flight transportation system which is cost competitive with the fuel-conservative airplane of the future The major components of this flight system include a laser-power satellite, relay satellites, laser powered turbofans, and a conventional airframe The relay satellites are orbiting optical systems which intercept the beam from a power satellite and refocus and redirect the beam to its next target

(Author)

**A78-49782 #** Technology analysis - Candidate advanced tactical fighters R W Bratt and E W Johnston (Northrop Corp , Aircraft Group, Hawthorne, Calif ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1451* 8 p

Technology requirements were evaluated for candidate advanced tactical fighters, with evaluation factors including aircraft buy for fixed life cycle costs, sorties and costs to kill specific targets, and weapons and aircraft unit costs Survivability, effectiveness, and cost were evaluated separately For a representative aircraft weapon system, the advanced high leverage technologies were identified as composite structure, reduced observables, conformal weapons carriage, advanced engines, target acquisition, and detection and recognition systems

(B J)

**A78-49783 #** Design evolution of a supersonic cruise strike-fighter R H Hendrickson, R L Grossman, and A S Sclafani

(Grumman Aerospace Corp , Bethpage, N Y ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1452* 14 p 9 refs

The present paper reviews the preliminary design of an advanced supersonic cruise strike-fighter configuration and compares early wind tunnel data with pre-test predictions and ultimate technology goals The paper goes on to describe how these results and continued configuration studies were factored into the aircraft design evolution for improved performance Specific material covered will include baseline configuration selection, packaging, and supersonic area-ruling, variable twist/variable camber wing design using 2D and 3D transonic computer codes and comparison with wind tunnel force, moment, and pressure data, propulsion-airframe integration effects for several inlet and nozzle configurations, and an appraisal of the maneuvering performance compared to current state-of-the-art capabilities

(Author)

**A78-49784 #** Prospects for commercial commonality in military transports E A Barber, R J Marhefka, and D G Blattner (Boeing Aerospace Co , Seattle, Wash ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1467* 21 p

A description is presented of work conducted in connection with the Innovative Aircraft Design Study (IADS-77) which was concerned with an examination of the prospects for commercial commonality in military transports IADS-77 is an extension of a previous study, Innovative Aircraft Design Study, Task II IADS-Task II was oriented toward studying the size effects of logistic transports The viability of commercial commonality was also investigated with the express purpose of assessing the feasibility of the C-XX concept as proposed by the Military Airlift Command The IADS-77 objectives included evaluating the validity of commercial commonality as related to aircraft design, determining the impact of technology on commercial commonality, evaluating the applicability of transport design to alternative military missions, and evaluating the military use of a minimum-size outside design

(G R)

**A78-49786 #** Wing planforms for large military transports C E Jobe (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), R M Kulfan, and J D Vachal (Boeing Commercial Airplane Co , Seattle, Wash ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1470* 17 p 8 refs

Transport aircraft, designed for long-range military missions with heavy payloads, lead to wings with high aspect ratios and very large spans A wing geometry/cruise speed optimization study was made of a large cantilever wing military transport airplane Preliminary design and performance evaluations were also made of a strut-braced wing airplane Initial results obtained with statistical weights indicated small performance advantages for the cantilever wing design Subsequent results obtained with weights derived from detailed analytical structural analyses reversed the initial conclusions These results indicated that unusual alternative configuration concepts cannot be discarded, based on small differences predicted during conceptual design studies

(Author)

**A78-49787 \* #** A method for localizing wing flow separation at stall to alleviate spin entry tendencies T W Feistel, S B Anderson (NASA, Ames Research Center, Moffett Field, Calif ), and R A Kroeger (Michigan, University, Ann Arbor, Mich ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif , Aug 21-23, 1978, Paper 78-1476* 8 p

A wing leading-edge modification has been developed, applicable at present to single-engine light aircraft, which produces stabilizing vortices at stall and beyond These vortices have the effect of fixing the stall pattern of the wing such that the various portions of the

wing upper surface stall nearly symmetrically. The lift coefficient produced is essentially constant to very high angles of attack above the stall angle of the unmodified wing. It is hypothesized that these characteristics will help prevent inadvertent spin entry after a stall. Results are presented from recent large-scale wind-tunnel tests of a complete light aircraft, both with and without the modification.

(Author)

**A78-49788 #** The influence of propulsion and control system concepts on design of a Navy Type A V/STOL airplane. J. M. Zabinsky (Boeing Military Airplane Development, Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1505* 7 p, 14 refs

Airplane designs for Navy Type A V/STOL are constrained by the integration of the aerodynamic and propulsion systems. The propulsion/control system has a major effect on the airplane concept. Airplanes with various arrangements and number of lift and lift cruise fans and several means of providing low speed flight control were examined. Operational systems and requirements added further constraints. The resulting designs are presented and discussed, but selection of a concept is not made.

(Author)

**A78-49789 #** Ground effects testing of two, three, and four jet configurations. H. E. Sherrieb (Vought Corp., Dallas, Tex.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1510* 7 p, 5 refs

Ground effects of V/STOL aircraft are dependent on the number and arrangement of the propulsive flows. Extensive tests of a generalized powered model have parametrically measured suckdown, buoyant fountain effects, and reingestion as a function of height above the ground. The number and location of the propulsion simulators were varied to represent two-, three-, and four-fan configurations. Two nacelle-mounted ejectors at the aircraft CG represented the two-fan arrangement, a nose fan and two nacelle-mounted fans gave the three-poster arrangement, and two ejectors ganged in tandem in nacelles represented the four-fan configuration. Comparisons of the test results show that the four-poster configuration is buoyant near the ground. The effects of thrust magnitude and direction, differential thrust, aircraft attitude with respect to the ground, and fountain control devices on the underside of the fuselage are identified. Several means of reducing reingestion, such as nozzle position, wing location, canting the thrust direction, and inlet shielding, are compared.

(Author)

**A78-49790 \* #** V/STOL aircraft simulation - Requirements and capabilities at Ames Research Center. D. E. Wilcox and H. C. Quigley (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Los Angeles, Calif., Aug 21-23, 1978, Paper 78-1515* 12 p

Ground-based flight simulation contributes greatly to the development of new aircraft and flight management systems and will be especially important in improving the performance, safety, and environmental characteristics of future civil and military V/STOL aircraft. This paper describes existing simulation facilities at Ames Research Center and discusses their capabilities and limitations for V/STOL aircraft investigations. Simulation requirements for NASA research and support of DOD programs are also discussed, including technology development for advanced rotorcraft and civil and military V/STOL aircraft. Current efforts and future plans are described for the upgrading of Ames simulation facilities to meet those requirements. Recent advances in equipment technology and operational methodology are shown to provide significantly improved simulation fidelity through better motion and visual cues and faster system response to pilot inputs.

(Author)

**A78-49792 #** Unsteady hypersonic gas flow past a thin wing of finite span (Nestatsionarnoe obtekanie tonkogo kryla konechnogo razmaka giperzvukovym potokom gaza). V. T. Bogatko, A. A. Grib, and G. A. Kolton (Leningradskii Gosudarstvennyi Universitet, Leningrad, USSR) *Akademiia Nauk SSSR, Doklady*, vol. 240, June 11, 1978, p. 1040, 1041. In Russian.

The problem of the unsteady uniform hypersonic flow of an ideal gas past the windward side of a finite-span thin wing at constant angle of attack is examined. It is assumed that the shape of the wing surface depends on time. The thin-shock-layer method is used to find a solution.

B J

**A78-49837** Minimum weight design of stiffened panels with fracture constraints. M. W. Dobbs and R. B. Nelson (California, University, Los Angeles, Calif.) *Computers and Structures*, vol. 8, June 1978, p. 753-759. 22 refs. Grant No. AF-AFOSR-74-2460A.

An efficient optimality criteria method is presented for the automated minimum-weight design of structural components for which analytical solutions for developed stress intensity factors are not available. The inclusion of fracture constraints in the automated design process is a logical extension of present structural optimization methods which include stress, displacement, buckling, frequency and aeroelastic flutter constraints. The finite element method is used for stress analysis, while the strain energy release method (the compliance method) is employed to calculate developed opening mode stress intensity factors. Only two structural analyses are needed at each design iteration to calculate the necessary response gradient information and the developed stress intensity factor. The structure is iteratively resized to satisfy the Kuhn-Tucker necessary conditions for a local optimum design. The design of a flat stiffened panel approximating an aircraft fuselage panel is presented.

S D

**A78-49850 #** Aviation control system devices (Aviatsionnye pribory upravliaushchikh sistem). V. G. Vorob'ev and I. K. Kadyshev (Moscow, Izdatel'stvo Transport, 1978) 160 p, 17 refs. In Russian.

The principles of operation, design, and error analysis of the main types of control systems used in aircraft navigation and piloting are studied. On the basis of an analysis of the complex of parameters characterizing the position of the aircraft in space at all stages of flight, a classification of the onboard control equipment ensuring automatic piloting is given. The functional blocks are analyzed for gyroscopic devices, navigational equipment of the membrane-aneroid group, angular sensors of velocity and acceleration, roll and pitch sensors, course sensors and systems, altitude sensors, flight speed sensors, angle-of-attack sensors, angle-of-slip sensors, and air signal systems.

P T H

**A78-49851** NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978. Volumes 1, 2 & 3. Conference sponsored by the Institute of Electrical and Electronics Engineers. New York, Institute of Electrical and Electronics Engineers, Inc., 1978. Vol. 1, 492 p., vol. 2, 501 p., vol. 3, 419 p. Price of three volumes, members, \$22.50, nonmembers, \$30.

The topics considered are related to navigation systems design, Navstar GPS-1, flight control, advanced digital system architectures, improved electronic reliability through packaging and interconnections, fire control technology, software engineering technology, software support and performance monitoring tools, the management of engineering, Navstar GPS-II, sensor and signal processing, communication techniques for jamming resistance, technology in medicine, tactical guided weapon systems, avionics software support systems, system design and integration, laser gyro technology, microcomputer technology, electrical insulation in airborne equipment, lightning and EMP considerations in airborne equipment,

airborne laser systems, and tactical guided weapon technology. Attention is also given to the software executive, aerospace power system developments, inertial technology, aerospace computer families, data communication systems, energy conservation technology, pointing and tracking, higher order language status, power conditioning electronics, navigation, cost estimating methodology, communication system components, airborne radar, software standardization, automatic test equipment software, airborne infrared receiver systems, Kalman filtering applications, avionics design for testability, strategic guided weapons, topics in software acquisition management, and environmental factors on airborne electronic design. G R

**A78-49852** **Modular Missionization Systems /MMS/, an adaptive system interface concept** E L Cloud and K C Leonard, Jr (Westinghouse Electric Corp., Systems Development Div., Baltimore, Md) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 2-12 5 refs Contract No N00140-77-C-0105

Operationally, the Modular Missionized Systems (MMS) concept promises avionics reconfiguration on a sortie-to-sortie basis. A description is presented of a laboratory experiment which had the objective to demonstrate the flexibility of the MMS concept. Three representative sensors were integrated. Each unit could be connected alternatively or in any combination to the cockpit station. This was accomplished through a distributed digital architecture, using standard hardware interfaces, with software that detected which sensors were connected, then automatically executed those instructions appropriate to their integration. The primary findings from the investigation are that sensor technology advances can be accommodated easily in MMS configured vehicles. The concept will allow off-line development of sensors, subsystems, or fully integrated vehicle weapons systems. Attention is given to hardware considerations, communications between main and micro computers, software, questions of practicality, and potential application. G R

**A78-49855** **Pattern recognition as an aid to radar navigation** A M Savol and A J Witsmeier (Boeing Aerospace Co., Seattle, Wash) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 26-32 11 refs Research supported by the Boeing Aerospace Co

Problems of radar navigation in connection with weather conditions, the unpredictability of radar reflections, high aircraft speeds, and low altitude penetration procedures make it very difficult for radar navigators in strategic bombers to perform their assigned tasks. Research has, therefore, been conducted with the objective to develop computer-based techniques which assist the navigator with his landmark navigation task. Preliminary algorithms considered have the dual goals of enhancing the image and extracting information useful for machine processing. The reported investigation establishes the viability of pattern recognition as a research area with the potential for aiding the navigator in landmark recognition. Aspects of computerized pattern recognition are discussed, taking into account images, local edge detection, line growing, and feature extraction and classification. G R

**A78-49856 #** **Navstar GPS field test results** D A Lorenzini and R P Denaro (USAF, Space and Missile Systems Organization, Los Angeles, Calif) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 34-38

The Navstar Global Positioning System (GPS) is a space-based radio navigation system that will provide highly accurate position, velocity, and time to suitably equipped users located anywhere on or near the earth. The GPS is composed of three major segments,

including the Space System Segment, the Control System Segment, and the User System Segment. The operational GPS will deploy twenty-four equally spaced satellites in three planes with near circular 10,890 nautical-mile orbits inclined at approximately 63 degrees and having a twelve hour period. A description is presented of field tests of GPS user equipment which are currently being conducted. Attention is given to the field test concept, the history of the GPS test program, navigational errors, pseudorange errors, and aspects of system applications. G R

**A78-49857** **Comparisons of high anti-jam design techniques for GPS receivers** H L Jones and T J Macdonald (Analytic Sciences Corp., Reading, Mass) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 39-46 7 refs

The spread spectrum Global Positioning System (GPS) signal structure provides inherent jammer tolerance for potential GPS users. Nevertheless potential jamming by CW or broadband noise jammers is still an important design issue for GPS receivers because of the low power of the received GPS signal. A description is presented of techniques for improving the tolerance of GPS receivers to such jammers by using advanced baseband processing techniques. Attention is given to basic receiver structures, inertial navigation system (INS) velocity aiding, adaptive bandwidth designs, and external data aiding. When used in conjunction with INS velocity aiding, the adaptive frequency tracker outperforms the adaptive phase tracker but suffers in certain applications from its inability to decode the data. G R

**A78-49858 \*** **A Costas loop with tangent error signal for use in Navstar GPS avionics.** J H Painter, D A McClung, and R C Reiminger (Texas A & M University, College Station, Tex) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 47-54 5 refs Grant No NsG-1374

This paper describes an augmented Costas loop for use in low-cost avionics for the Navstar Global Positioning System. A standard loop has been augmented with supplementing feed-back to give a tracking error voltage proportional to the tangent of the phase error, rather than to the sine. The augmented loop yields increased performance in the presence of input phase acceleration and jerk, as caused by maneuvers of the GPS user vehicle. Many Monte Carlo simulation results are given. (Author)

**A78-49859** **A compensation technique for acceleration-induced frequency changes in crystal oscillators** J M Przyjemski (Charles Stark Draper Laboratory, Inc., Cambridge, Mass) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 55-60 Contract No F33615-75-C-1149 AF Project 6095

The tracking performance of Global Positioning System (GPS) navigation receivers aboard tactical aircraft is limited by frequency variations in crystal reference oscillators, resulting from resonator sensitivity to acceleration. A requirement exists in this connection for a crystal reference oscillator that is less sensitive to acceleration. The requirements and characteristics of the g-sensitivity of a crystal oscillator are discussed and a description is provided of a compensation technique which is based on a simple model of g-sensitivity. It is shown that a relatively low-cost single-axis accelerometer in conjunction with the considered model can be employed to decrease the effects of acceleration by one, and possibly two, orders of magnitude. G R

**A78-49860** **In-line monitoring of digital flight control computers** T F Westmeier (McDonnell Aircraft Co., St Louis, Mo) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1  
New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 62-69 8 refs

The ability of a digital fly-by-wire (FBW) system to maintain undegraded performance when a failure occurs in either of two channels depends on the efficacy of in-line monitoring techniques applied to the various systems elements. Especially, the ability depends on computer self-test, since the computer is frequently the weakest link in the reliability chain, and also because the computer is used to in-line monitor other system elements. The subject of computer self-test is introduced by reviewing certain fundamentals relating to redundancy management and showing the significant system benefits that accrue through a reduced redundancy level. Quantitative data is introduced to show the in-line monitoring coverage needed to achieve acceptable system reliability. The relationship between in-line monitoring coverage and computer self-test coverage is presented. G R

**A78-49861** **Laboratory testing of lightning and EMP susceptibility of avionic systems** G L Graves (Honeywell, Inc., Avionics Div., Minneapolis, Minn) and L Andersson (Saab-Scania AB, Aerospace Div., Linkoping, Sweden) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1  
New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 70-73

In connection with the flight criticality of fly-by-wire (FBW) flight control systems in aircraft, attention is now focused on the immunity of these systems to electrical hazards such as lightning strikes. A demonstrated total immunity is an absolute necessity regardless of the redundancy level of the system. An investigation has in this connection been conducted including the collection and review of all published data and literature on aircraft lightning strike effects and test programs involving flight control systems. Two major airframe test programs directed toward flight control hardware were also reviewed. On the basis of the investigation it was concluded that a system or device should be subjected to an environmental condition equivalent to that seen within an airframe when struck by lightning. This environmental condition must be duplicated in a laboratory test facility under controlled conditions and should be performed as a follow-on to EMI qualification testing. Approaches used for implementing these requirements are discussed and the obtained test results are considered. G R

**A78-49862 #** **The terrain following task for the advanced tactical fighter using discrete optimal control** R L Simmons, M J Breza, and J E Funk (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1  
New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 74-82

Through the use of state space, continuous optimal control, and discrete optimal control, a digital flight control system was designed for the terrain following task. A sample rate of five hertz was shown to be high enough to adequately form the desired controls. The aircraft was shown to track the desired path in a highly acceptable manner through the use of a hybrid simulation. The design method utilized is recommended for consideration in designing the digital control laws for other flight control tasks. (Author)

**A78-49863 #** **A qualitative analysis of redundant asynchronous operation** T W Johnson (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1  
New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 108-120

York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 83-90 9 refs

The AFFDL/DAIS program is developing a flight engineering facility to simulate aircraft flight control systems and avionics interfaces, using DAIS core elements and MIL-STD-1553A data buses. Because of practical problems in synchronizing redundant systems, the four redundant flight control channels, which consist of computers and interface hardware (as typical of a system that might be required for a digital fly-by-wire aircraft) are asynchronous. This paper analyzes a few selected problems encountered in integrating such an asynchronous system performance corruption due to asynchronous command updates and effect on failure detection, time delays involved in data exchange and mode engagement logic, possibly as large as 3/8 of a second, and difficulties in avoiding potential single point failures with interdependent asynchronous channels. (Author)

**A78-49864** **Synthesis of digital flight control systems by the method of entire eigenstructure assignment** J J D'Azzo (USAF, Institute of Technology, Wright-Patterson AFB, Ohio) and B Porter (Salford, University, Salford, England) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1  
New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 91-99 21 refs Grant No AF-AFOSR-76-3005A

For a full utilization of the capability of digital controllers, it is essential that a powerful method be available for the design of regulators for controllable and observable linear multivariable sampled-data systems governed by state and output equations of appropriate forms. The method of entire eigenstructure assignment reported by Moore (1976) and Porter and D'Azzo (1977) constitutes such a method for the design of regulators governed by state-feedback control laws of the form  $u(kT) = Kx(kT)$  which assigns both the eigenvalues and eigenvectors to the plant matrix of the resulting closed-loop system governed by the considered equations. The method of entire eigenstructure assignment is illustrated by designing a range of digital regulators for the lateral dynamics of the F-4 aircraft such that the controlled system exhibits fast settling characteristics while requiring only acceptably small control surface deflections. G R

**A78-49865** **Comparison monitoring in redundant digital flight control systems** C Slivinsky and W Shoemaker (Missouri-Columbia, University, Columbia, Mo) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1  
New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 100-106 8 refs Grant No AF-AFOSR-76-2968

The presented results are applicable to the analysis of tri- and quad-redundant signals that change one at a time, but in random order. Particular attention is given to results applicable to the monitoring process. The set of binary relationships among the signals is characterized by using seven keys that are useful for showing the evolution of signal patterns as the signal states change. A monitoring algorithm based on the above characterization is developed and its implementation in software is given. Simulation studies verify the capabilities of the algorithm. A description is presented of a means for characterizing all possible relationships among quad- or tri-redundant signals subjected to a monitoring scheme that uses a binary test for deciding whether two signals are within tolerance of each other. G R

**A78-49866** **MIL-STD-1553B proposed** W A Crossgrove (Boeing Aerospace Co., Seattle, Wash) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1  
New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 108-120

The Air Force military standard, MIL-STD-1553, was developed in August 1973. With the production of the F-16, MIL-STD-1553

found its first full aircraft application. During late 1974 and early 1975 the DOD directed the military to develop a single position and made the necessary revisions to the present standard. From this effort MIL-STD-1553A was released in April 1975. Since that time, industry and the military have continued to coordinate on the standard through symposia, studies, and military development programs. As applications became extensive, certain difficulties were recognized in the standard. In connection with these difficulties an SAE task group, MIL-STD-1553 Update was formed in October 1976. The task group's assignment was to develop suggested changes to the present MIL-STD-1553A. In October 1977, after review and changes, the SAE-A2K approved the proposed MIL-STD-1553B. The proposed improvements are examined. G R

**A78-49867**      **Application of the General Purpose Multiplex System to the A-7E avionics** J L Jones, J R Perkins (Vought Corp, Dallas, Tex), H Brown, and E Kee (US Naval Material Command, Naval Air Development Center, Warminster, Pa) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1, New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 122-128

A summary is presented of the results of a study conducted for the Navy which encompassed three primary areas of investigations, development of a signal data base, establishing a General Purpose Multiplex System (GPMS) architecture for fulfilling the A-7E requirements, and determining the impact of applying the GPMS to advanced avionics systems. The data base study defined the A-7E aircraft and avionics subsystem information required to establish the GPMS architecture. Attention is given to the A-7E general purpose multiplex system, the avionics equipment with integral data terminals, multiplexed signals, and advanced aircraft applications. The conclusions from the study are discussed, taking into account protocol, data bus, data rate, the integral data terminal, area multiplex terminals, and control group terminals. G R

**A78-49868**      **A hierarchical network for avionics systems** J A Edwards and F Hubans, Jr (General Dynamics Corp, Fort Worth, Tex) In NAECON '78 Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1, New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 129-136 11 refs

A hierarchical network considered in connection with a study of advanced avionics system concepts can provide a means of easily tailoring the system hardware to the system requirements, i.e., performance, reliability, growth, and cost. A description is presented of the evolution of the hierarchical system from early avionics, the benefits obtained from employing such a system, the requirements this system places upon system partitioning and system control, and a network implementation philosophy. It is pointed out that the main issue in a distributed network is controllability. The hierarchical architecture has evolved from previous avionics configurations to provide a structure which improves both the system controllability and the system extensibility. Additional improvements, however, are needed in the areas of communication protocol and the interconnect methodology. G R

**A78-49869**      **Multiprocessing for electronic warfare avionics** C Wise, R Koppelman, R Higginbotham, and D Wiles (Westinghouse Electric Corp, Baltimore, Md) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1, New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 137-141

A key question arising in connection with the employment of microprocessor technology is related to the type of processing architecture which will evolve. Multiprocessing provides an architecture which offers many advantages. Key technical problems confronting it are related to additional considerations concerning interprocessor communications and decisions regarding the allocation of tasks to an individual processor. A description is presented of an

investigation in which multiprocessing is developed around bus interfacing because of its relative simplicity and flexibility. Problems of task management are discussed, taking into account tasks with the largest input buffer, tasks nearest the system input, and tasks nearest the system output. Attention is also given to problems of task partitioning and an electronic warfare processing model. G R

**A78-49872**      **Non-volatile memory system for severe environment flight recorders** J H Trageser (Technology, Inc, Dayton, Ohio) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1, New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 158-163

An intensive in-house study was undertaken to select the most cost-effective state-of-the-art technology to implement a high-performance nonvolatile memory system for use in microprocessor-controlled military flight recorders. Emphasis was placed on minimum size and weight with proven ability to function reliably under the environmental requirements for Class 2 equipment as defined by MIL-E-5400. Candidate technologies included Magnetic Core, Bubble, MNOS, NMOS and CMOS. To provide nonvolatility for semiconductor memories the study included a review of current battery technology applicable to the subject requirement. CMOS RAMs combined with lithium solid-state batteries are shown to be a reliable, cost effective alternate to core memory with an order of magnitude reduction in weight and size. (Author)

**A78-49874**      **Interface design considerations for F-16 sensors and weapons** J D Watts and T G Cheatum (General Dynamics Corp, Fort Worth, Tex) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1, New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 172-176

The F-16 avionics system examined in the present paper has been designed for flexibility and growth. New systems, sensors, and weapons can be accommodated without the normal proliferation of black boxes. The system is partitioned into logical functional groups with standard interfaces. The fire control computer is the integrating element that ties the subsystems together. Sensor computations relating to sensor control and data processing are accomplished within each sensor subsystem. The result is a design which will guarantee the F-16 as a highly effective air-to-air and air-to-surface weapon system. V P

**A78-49875**      **Software structured weapon delivery** L L Crews (Intermetrics, Inc, Cambridge, Mass) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1, New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 177-182

This paper deals with the air-to-ground weapon delivery OFF for an attack aircraft. The program uses top-down structured programming and has been block-structured for ease in adding new weapons or new sensors for ranging. This program will be used in the Air Force DAIS system and will be used in the AN/AYK-15 with the Mil Std 1553-A Bus. Using top-down structured programming techniques allows the user to add and eliminate blocks very easily and to also transfer select routines that are already debugged from one system to another. The program is currently programmed in JOVIAL J73/1. (Author)

**A78-49876**      **Peace Rhine - A digital Weapon Control System for the F-4 aircraft** E H Thompson and E W Beaver (Westinghouse Electric Corp, Baltimore, Md) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference,

Dayton, Ohio, May 16-18, 1978 Volume 1 , New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 183-191 10 refs Contract No F33657-77-C-0189

The Peace Rhine Weapon Control System (WCS), currently being developed for the F-4F Aircraft, is described with emphasis on fire control methodology and performance. Unique mechanizations are described for the employment of present-day missiles and fixed, forward-firing guns against maneuverable A/A threats. The computed launch envelopes of both Sparrow and Sidewinder Missiles are enclosed by both the permissible lead/lag angle boundaries and the permissible range separation from the target. Performance design goals of less than 20% missed opportunities and 15% out-of-boundary launches have been achieved using the AIM-7F Missile. Flight test results also established a 10 mrad CEP in aided visual delivery of conventional A/G ordnances and an aiming accuracy of 8 mrad (CEP) utilizing the director gunnery mechanization. (Author)

**A78-49897** Scan-limited near field testing for directive airborne antennas. K R Grimm (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio) and B Schmidt (Dayton, University, Dayton, Ohio). In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 360-367 7 refs

Methods are introduced for estimating the nonsampled near field (NF) in antenna test applications when the physical size of the antenna is larger than the available planar scanner. With the aid of a polynomial perturbation approach it is attempted to match a least-mean-square fit for a complete NF data set at selected match points of a scan-limited set. The forced match is achieved by random perturbations of the unique recursion coefficients of the complete set fit, and is guided by imposing tolerances on the match and the number of match points. Attention is given to planar near field probing, scan-limited testing, the processing of scan-limited data, power extrapolation, extrapolation by endpoint constraint, and extrapolation by polynomial perturbation. G R

**A78-49900** Approach for identifying avionics flight software operational support requirements - PAVE TACK an example. H A Montgomery (TRW Defense and Space Systems Group, Redondo Beach, Calif ) and R L Turk (USAF, Warner Robins Air Logistics Center, Robins AFB, Ga ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 418-425 5 refs

An approach is presented for identifying the types of tools required by the Air Force Logistics Command (AFLC) to support an avionics flight program over its operational life. This approach involves an analysis of the avionics system with respect to the phases of the software life cycle. Characteristics of avionics systems are identified which contribute to an active operational life and have implications for support methods. Operational support requirements are then established from the activity phases of the software life cycle and AFLC operational support objectives. Tool requirements can then be selected from a hierarchy of tools which support the software life cycle. (Author)

**A78-49901** Subsystem verification of an AFLC organically developed F-15 simulation. J B Sharp and O P Cerny (USAF, Warner Robins Air Logistics Center, Robins AFB, Ga ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 426-433 6 refs

This paper describes techniques used to verify subsystems of an F-15 simulation which is under development at the Warner Robins

(Ga ) Air Logistics Center (WR ALC). This simulation is an element of the overall F-15 Avionics Integrated Support Facility being developed as a depot capability in support of the F-15 Subsystems verification is addressed by this paper since verification of the simulation system as a whole will be minimally contingent on acceptance of the component subsystems. (Author)

**A78-49902** The role of system performance analysis in the independent assessment of B-1 navigation software. T E Shirley, W F Stabenau (Logicon, Inc , Dayton, Ohio), and M M Freed (USAF, Aeronautical Systems Div , Wright-Patterson AFB, Ohio). In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 434-440 Contract No F33657 77-C 0004

The role of systems performance analysis during the independent assessment of B-1 navigation software is described. Two flexible analysis techniques, functional system/software simulation and covariance analysis, are shown to be useful in independent software evaluations. Concrete examples of their use to support Air Force management during B-1 development are given. These examples include baseline performance evaluations, the evaluation of the impact upon system performance due to changes in avionics equipment, and the diagnosis of problems encountered during flight test. These examples provide evidence that system performance analysis is an integral part of independent software assessment and increases Air Force management effectiveness. (Author)

**A78-49903** # Digital avionics support - A retrospective view of the future. M van den Broek and N J Babiak (USAF, Logistics Command, Wright-Patterson AFB, Ohio). In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 442-448

The introduction and increasing utilization of digital technology in Air Force weapons systems has considerably enhanced operational capability, system flexibility, and hardware reliability. There have, however, been difficulties related to the way in which digital technology was approached. What appears to be lacking is a single focal point which will blend the efforts of academia, research, development, user, and supporter into a unified whole. The reported investigation has the objective to demonstrate that such a focal point would result in significant support improvements while simultaneously enhancing operational capabilities. It is shown that the first stages of such a capability are now developing in the form of Avionics Integration Support Facilities throughout the Air Force Logistics Command. G R

**A78-49904** Comparison study of MLS airborne signal processing techniques. R J Kelly and E F C LaBerge (Bendix Corp, Communications Div , Baltimore, Md ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 502-510 9 refs

The Time Reference Scanning Beam (TRSB) Microwave Landing System (MLS) is being developed by FAA. Early in the prototype hardware phase of the development, the Dwell Gate Processor (DGP) which operates on the received beam envelope, was selected as the economic airborne receiver signal processing design for the accurate estimation of the aircraft's angular position in the presence of strong specular multipath and receiver noise. The study discussed in this paper was undertaken to review the selection of the DGP in the light of work done on other processor mechanizations in the interim. The study included the definition of an optimum phase and amplitude processor against which all of the techniques were compared. The comparison was based on both computer and receiver bench tests. It was concluded that the DGP is the appropriate choice for general TRSB processing requirements. B J

**A78-49905** Digital simulation and flight verification of the F-5E/F Flight Director Computer R Emerson (USAF, Aeronautical Systems Div, Wright-Patterson AFB, Ohio), R E Weaver, and R A Weeks (Northrop Corp, Hawthorne, Calif) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2 New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 511-518 USAF-supported research

A digital real-time flight simulation was performed to determine the modifications required to an analog Flight Director Computing System to adapt it to the F-5E/F Aircraft The investigation assumed that all gains would be of constant value and that the input/output of the existing Flight Director Computer (FDC) would be unaltered The simulation program was carried out to permit pilot in the loop evaluations Analog FDC aircraft hardware, from which the baseline Digital FDC model was derived, was interfaced to the simulation to allow parallel comparisons and validation with existing analog computing avionics Flight tests were conducted in a F-5F to validate that the gain changes made in the FDC as a result of the digital simulation were compatible with the operational aircraft (Author)

**A78-49906** Fiber optic development for tactical fighter applications R W Uhlhorn and R G Autry (McDonnell Aircraft Co, St Louis, Mo) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2 New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 519-527 5 refs Navy-supported research

Fiber-optic material evaluations were conducted in four areas (1) terminations for bundle type cables, (2) extruded cable jacket resistance to heat and moisture, (3) hydrolytic stability of encapsulating epoxies, and (4) adhesion promoters between fibers and ferrules Harness assemblies were also evaluated in the following tests thermal aging, humidity, thermal cycling, and vibration and flexure An EM immunity and flight test program is described in which digital fiber-optic data transfer systems will be installed in two YAV-8B Harrier test aircraft, the fiber-optic instrumentation for this program is described Results of cost/benefit studies on airborne fiber-optic systems are discussed along with future activities in the field B J

**A78-49920** Electromagnetic coupling analysis of a Learjet aircraft in a lightning environment J C Corbin, Jr (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and D F Strawe (Boeing Aerospace Co, Seattle, Wash) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2 New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 644-648 20 refs

A joint AFFDL/NASA lightning research program was conducted at Kennedy Space Center in July and August of 1977 as part of Project Thunderstorm (TRIP-77) A NASA Learjet aircraft was instrumented with E and H field antennas, field mills, and skin current sensors to obtain near field lightning data Special cable runs were installed to record induced voltages and currents within the aircraft As part of the program, an electromagnetic coupling analysis of the aircraft was developed and applied to predict and interpret magnitudes and waveforms of induced voltage and current transients on selected cables and circuits This paper describes the modeling techniques used to calculate the external induced skin current density for arbitrary lightning sources, the penetration fields that produce voltage sources on interior cables and circuits, and the circuit responses to these sources (Author)

**A78-49927** Bank-to-turn /BIT/ autopilot technology R M McGehee (USAF, Armament Laboratory, Eglin AFB, Fla) and R I Emmert (Rockwell International Corp, Missile Systems Div, Columbus, Ohio) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18,

1978 Volume 2 New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 688-696

A bank-to-turn (BIT) steering mechanization has been developed and evaluated for a tactical missile concept, resulting in exceptional short range performance, by employing the maximum maneuvering capability of an unsymmetrical airframe The control system employs BIT steering, an adaptive autopilot, and proportional navigation (with closing velocity) The BIT steering mechanization allows the large 'g' capability of the airframe pitch axis to be applied in a direction to reduce the total line-of-sight rate The adaptive autopilot assures adequate performance throughout a large flight envelope, without exceeding critical values of angle-of-attack and side-slip A small amount of skid-to-turn maneuvering in conjunction with proportional navigation with closing velocity provides high accuracy against maneuvering targets from all aspects G R

**A78-49928** Strapdown seeker guidance for tactical weapons T R Callen (USAF, Armament Laboratory, Eglin AFB, Fla), and R D Ehrich (Rockwell International Corp, Columbus, Ohio) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2 New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 697-704

A description is presented of the work accomplished thus far in connection with a study which is to determine the best combination of guidance law structure, signal processing techniques, and achievable seeker and sensor accuracy requirements for the effective use of strapdown seekers with tactical guided weapons An evaluation is provided of proportional navigation utilized as the guidance scheme for air-to-surface weapons with strapdown seekers Attention is given to mathematical models of air-to-surface weapons, methods of generating line-of-sight rates, seeker models and error sources, and simulation results The results of the study thus far indicate, as expected, that proportional navigation with reasonable navigation gain is sufficiently sensitive to seeker and scale factor errors to make implementation extremely difficult G R

**A78-49929** In-flight alignment/calibration techniques for unaided tactical guidance J W Kraemer, N J Roessler, and D M Brandin (McDonnell Douglas Astronautics Co, St Louis, Mo) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2 New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 705-711 Contract No F08635-77-C 0210

An evaluation is conducted of various alignment/calibration procedures which permit the use of low-cost sensors in unaided navigation satisfying tactical mission requirements The missile navigation system and its interface with the reference launch aircraft navigation system are illustrated in a figure Strapdown gyros and accelerometers are included in the missile's inertial sensor subsystem To provide the optimum cost-effective utilization of these sensors for their navigation role, in-flight estimation of critical sensor error terms is achieved by processing launch aircraft navigation data through a Kalman integration filter A description is presented of the development of realistic launch aircraft alignment maneuvers and reduced-state Kalman filter mechanizations which optimize navigation performance of the strapdown Low Cost Inertial Guidance System G R

**A78-49932** The DAIS Executive - An introduction W H Vandever, Jr (Intermetrics, Inc, Dayton, Ohio) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2 New York, Institute of Electrical and Electronics Engineers, Inc, 1978, p 733-740 8 refs

Ninety-five percent of the DAIS Executive was written in J73/I, thus aiding in its own portability. The current implementation was designed to handle a federated computer network and was implemented in such a fashion as to isolate the network characteristics from the Applications Software. This has allowed the Applications Software to be developed with assurance on a virtual single processor and then transferred to a federated system without modification. In addition, the DAIS executive tables are optimized by having a pre runtime tool (PALEFAC) create static tables to minimize the dynamic characteristics of execution and to minimize on memory requirements. Several associated results occur when a standardized executive interface is used in conjunction with a Higher Order Language. These include the ability to develop a powerful and cost effective simulator on various host computer systems, the Application Software has become truly portable, and a Higher Order Language implementation of the executive itself will add legacy to the executive and thus the corresponding reduction in errors and cost.

(Author)

**A78-49933** An interface management approach to software development. L. C. Klos (General Dynamics Corp., Fort Worth, Tex.) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 741-748.

The method described was developed for managing interfaces between software modules through the use of data flow graphs, computerized interface lists, and automated generation of common data declarations. The tools used to accomplish this are Directed Flowgraphs and a System Development Interface Manager. These tools and the rationale for using an interface management approach are examined. Interface management is important to real-time software development, because interfaces are the critical links between program modules and between avionic subsystems. The management of these interfaces and their time relationships in a controlled and standardized manner requires the clarification of thought processes and leads to a thorough well-documented design with better software partitioning and fewer problems.

(Author)

**A78-49934** Dynamic analysis of electrical systems. P. J. Leong and I. S. Mehdi (Boeing Aerospace Co., Seattle, Wash.) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 752-756.

A technique is presented for modeling the dynamics of an aircraft three-phase ac electrical power system. The analysis is accomplished using the EASY model generation and analysis program, which can determine steady-state operating points, simulate nonlinear components, generate linearized models, and perform transient and stability analyses. Mathematical models of the major components of the electrical system, such as the generator, exciter, voltage regulator, feeders, and load, are derived and implemented into the standard EASY component representation. The program user can then analyze a system by specifying the topology of a network of these predefined component models. Some sample simulation results are included.

(Author)

**A78-49935 #** Application of rare earth/transition metal permanent magnets to 400 Hz aircraft systems. An AF overview. W. U. Berger (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 757-764. 9 refs.

This paper describes, in overview fashion, the USAF programs

involving the utilization of rare-earth permanent magnets in generating 400-Hz aircraft power. All of the programs discussed employ the variable speed constant frequency (VSCF) approach, and all are formulated to consider power generation as well as gas-turbine engine starting. Three specific programs are described: (1) 150 kVA samarium cobalt VSCF starter generator electrical system, (2) SmCo generator/engine integration study, and (3) permanent magnet variable speed constant frequency power generation system (flight test on A-10 aircraft). Additional comments pertaining to permanent magnet generator (PMG) VSCF systems in general are provided.

(Author)

**A78-49936** A standard programmable I/O for the advanced aircraft electrical system power control set. J. R. Perkins, W. T. Turnage (Vought Corp., Dallas, Tex.), H. Brown, and J. Davidson (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 765-771.

A description is provided of a method whereby the I/O channels of the multiplex terminal can be universally used for either multiplexing input signals or demultiplexing output signals. The terminals can be wired directly to either signal source or power controller devices without having to reconfigure the terminal in terms of signal conditioning or I/O assignments via reprogramming. In presenting the universal terminal concept, a brief overview is given on the Solid State Electric Logic (SOSTEL) and Electrical Multiplex (EMUX) type systems. Attention is also given to the 'switched impedance' signal interface technique developed primarily for the purpose of expanding the built-in-test capability of the SOSTEL system. A universal terminal functional diagram is presented.

G R

**A78-49937 #** Aircraft electrical system testing and data reduction using digital techniques. E. J. Caputo (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 772-776.

The testing and data reduction of aircraft electrical systems and electrical system components using digital and computerized techniques is discussed. The major objective of electrical system testing is to determine actual power quality of the various configurations of conventional (electromechanical) and solid-state electrical system components. These data are then used to provide information for future updates of MIL-STD-704 ('Aircraft Electrical Power Characteristics'). The Digital Testing System used by the Air Force Aero Propulsion Laboratory (AFAPL) is examined. The system consists of five major components. Several modes of operation are described. Digital computation methods used to reduce the data taken are discussed. Test methods for solid-state power controllers, circuit breakers, generators, integrated drive generator units, and VSCF units are outlined. Results from some of the testing done at AFAPL are given. Conclusions are presented on the effectiveness of testing of electrical system components using digital techniques.

(Author)

**A78-49941** Multi-Function Inertial Reference Assembly (MIRA) update. R. C. Burns (McDonnell Aircraft Co., St. Louis, Mo.) and J. M. Perdsock (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 798-807.

This paper presents a summary of the preliminary assessment task studies that showed significant cost savings were potentially possible based upon projected improvements in strapped down technology. Laboratory demonstrations provided added confidence to the preliminary feasibility assessment. Three candidate MIRA configurations chosen for further analysis leading to the selection of



a single MIRA design are described. Design criteria for candidate evaluation are discussed in relation to key study findings in the areas of performance, survivability, reliability, and installation. The three candidate MIRA systems are then discussed in terms of risk estimation versus potential life cycle cost savings. Current design studies and refinements are leading to the definition and selection of a single MIRA design which will be incorporated in the MIRA specification (Author)

**A78-49951**      **Digital area correlation tracker** M G Woolfson (Westinghouse Electric Corp , Baltimore, Md ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2      New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 882-886

The Digital Area Correlation Tracker (DACT) and a system interface were designed and built with the objective to satisfy the requirements of the 'single seat' mission in which the pilot must, among other tasks, fly the aircraft and provide inputs to the E-O sensor system. Additional requirements are imposed on the auto-tracker to minimize pilot attention and command inputs. DACT uses no preprocessor controls to eliminate the need for video gain, threshold, and contrast polarity adjustments. These requirements have been eliminated because the DACT employs direct conversion of the analog video signal into 5-bit digital data rather than threshold circuits which convert the analog video signal to one bit data. Aspects of tracker operation are explained from a concept point of view. G R

**A78-49952 #**      **Prediction of angular disturbances from airframe members to airborne electro-optical packages** P W Whaley and D L Brown (USAF, Flight Dynamics Laboratory, Wright Patterson AFB, Ohio) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2      New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 887-896 9 refs

A description is presented of the general frequency response behavior of aircraft angular vibration relative to linear vibration. For two sets of aircraft data, the angular vibration Power Spectral Density (PSD) falls off less steeply than does the linear vibration PSD at higher frequencies. Comparisons to available data from two aircraft show that these prediction models given good predictions of the angular PSD shape with respect to frequency. Until complete knowledge concerning the characteristics of aircraft angular vibration is available, the designer can use the shape function to predict angular vibration PSD. Aspects of theoretical development are discussed, taking into account the Bernoulli-Euler beam, the Timoshenko beam, cylindrical shell dynamics, and parameter choices. G R

**A78-49954**      **Modular target acquisition and designation systems.** M W Iverson (Honeywell Inc , Avionics Div , St Louis Park, Minn ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2      New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 905-909

It has been found in recent conflicts that the effectiveness of weapons has been limited by a failure to hit the target. Missiles and projectiles can be sent much beyond the limit of the area for which an accurate detection, location, identification, and tracking of targets is possible. The more uncertain the target location, the larger the number of volleys required to destroy a target. The significance of the anti-aircraft threat in Central Europe is examined and alternatives are discussed to extend the effective range of the weapons in this hostile environment. It is found that there are really no alternatives as such. Instead combinations of different systems are needed in a mix which will yield the highest probability of success with the lowest losses. A description is presented of two of the systems needed in the future system mix, taking into account the Target Acquisition RPV and the Mast Mount Helicopter. In particular,

attention is given to a modular Target Acquisition System which has been designed for these applications. G R

**A78-49956**      **The versatility of Jovial J73 in avionics systems.** T E Matysek (Westinghouse Electric Corp , Pittsburgh, Pa ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2      New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 928-933

A complete Avionics Systems Operational Software Package must be able to handle logic functions, equation writing, and I/O block packing for I/O to peripheral devices. A description is presented of Jovial J73 which has the capability to handle all of these needed functions. The compiler is written in machine independent FORTRAN and produces assembly language for use on the currently used computer. An intermediate language is generated and the target machine instructions are easily substituted in the compiler's working tables. To provide a different assembly language, the compiler code generation tables would need to be changed. Attention is given to the logical functions in Jovial, equation writing in Jovial, aspects of I/O block packing, and questions of compiler verification. G R

**A78-49957**      **A flight simulation high order language study** C L Braun (SofTech, Inc , Waltham, Mass ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2      New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 934-940 7 refs Contract No F33615-76-R-0029

This paper describes a study, conducted for the Air Force Human Resources Laboratory (Contract No F33615-76-R-0029), to determine the requirements for a Higher Order Language (HOL) for programming modern flight training simulators. The objective of this study was to determine the suitability of existing HOLs to the flight training simulator area, not to define a new HOL. The approach taken in this study for HOL evaluation and selection is applicable in other areas, especially those areas where assembly languages are in wide use because of the presumed inadequacy of existing HOLs. (Author)

**A78-49959**      **Higher order languages for avionics software - A survey, summary and critique** R J Rubey (SofTech, Inc , Waltham, Mass ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 2      New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 945-951 28 refs

This paper surveys the activities of the last ten years with regard to avionics Higher Order Languages (HOLs). It presents reasons why HOLs were late arriving in the avionics arena and why they have not been more widely used today. In particular, the published experiences with existing HOLs in avionics applications are summarized. Descriptions of important HOL evaluation criteria, such as 'efficiency' and 'programmer productivity' are presented and the reported measurements with respect to these criteria are discussed. The problems and deficiencies of past reporting with respect to these criteria are highlighted. In addition to this summary of the quantitative information regarding avionics HOL use, the need for improvements are discussed. This includes the relationship of the HOL to the total software development process, the improved software tools that can be employed, and the level of HOL documentation available. (Author)

**A78-49961**      **Modeling refinements for the rectified superconducting alternator** T A Stuart (Toledo, University, Toledo, Ohio) and M W Tripp (Detroit Edison Co , Detroit, Mich ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3      New York, Institute of Electrical and Electronics

Engineers, Inc., 1978, p 1002-1009 10 refs Grants No AF-AFOSR-76-2997, No AF-AFOSR 77-3413

Certain characteristics of an earlier steady state model developed by Stuart and Tripp (1977) for the rectified superconducting alternator are examined. The earlier approach involved the derivation of a set of five nonlinear equations, these equations were then solved via a standard Newton-Raphson algorithm, and the solution was used to evaluate several other variables. The present paper carries out an analysis which shows that the earlier model can be improved by eliminating an ambiguity associated with the ac field current and by reducing the number of system equations from five to two. Data are included to show that the modified equations are consistent with the earlier model. B J

**A78-49962** **Impact of aircraft electrical power quality on utilization equipment** A W Schmidt and E T Reiquam (Boeing Commercial Airplane Co., Seattle, Wash.) In *NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978* Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1010-1014 5 refs

Aircraft electric power characteristics impose significant penalties - associated with voltage surges, voltage spikes, frequency transients, long power interruptions, unbalanced phase voltages, and waveform distortion - on avionics systems. This paper presents a qualitative assessment of penalties imposed on avionics systems and discusses some methods for improving power quality characteristics. In support of the penalty assessment, technical and cost data are presented for a large number of self-contained power supplies of avionics equipment. B J

**A78-49965** **Station deselection procedures to support automatic Omega receiver operation** R D Healy (Analytic Sciences Corp., Reading, Mass.) In *NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978* Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1026-1030 9 refs Contract No F19628-77-C-0033

The paper discusses four types of propagation modeling errors which can lead to navigationally significant errors in indicated Omega position: (1) wrong-way path, (2) westerly signal traverse of magnetic equator, (3) sudden ionospheric disturbances, and (4) polar cap anomalies. It is shown that position errors can be minimized by using the manual deselection feature of the receiver. An Omega station selection chart is presented containing specific recommendations for station deselection in a number of worldwide locations. B J

**A78-49966** **Performance of a differential Omega-ring laser strapdown aircraft navigator** C San Giovanni, Jr (Sperry Rand Corp., Sperry Gyroscope, Great Neck, NY) In *NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978* Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1031-1043 15 refs

The accuracy performance of an aircraft differential Omega ring laser strapdown system is evaluated on the basis of a time history of rms position, velocity, and attitude errors. Simulation results are presented for a vehicle trajectory generally corresponding to a close air support mission. A ground align period is included. For the assumed nominal error models, it is shown that horizontal velocity error can be bounded to a steady state value of approximately 1 m/sec rms. A complete three-axis mathematical model was used in the analysis to represent the error propagation characteristics of the strapdown system. B J

**A78-49967** **Real-time simulators for augmented inertial navigation systems** S C Bose (Litton Industries, Guidance and Control Systems Div., Woodland Hills, Calif.) In *NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978* Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1044-1053

The design, implementation, and operation of real-time simulators for augmented inertial navigation systems are described. Detailed mathematical models of the inertial platform, the Doppler radar sensor, and the aircraft flight profile generation are presented. The actual software design of the simulator is not discussed. B J

**A78-49968** **Reliability of inertial navigation systems** A J Brann (Litton Industries, Guidance and Control Systems Div., Woodland Hills, Calif.) In *NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978* Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1054-1060

An analysis of several major military and commercial INS programs over the last 20 years is performed. The results of the analysis show that the older analog INS have low predicted MTBFs using today's prediction techniques. More modern technology INS (the last 10 years) used in both military and commercial application show comparable predicted MTBFs using identical environmental factors. When an attempt is made to account for the differences between military and commercial application with respect to temperature, vibration, and on/off cycling, it is noted that the principal reason for higher MTBF of commercial INS is environmental. Present-day design and test techniques for assuring high field reliability of INS are described. B J

**A78-49971** **The AN/APX-100(V) transponder** J T Skudrna and G L Vogt (Bendix Corp., Communications Div., Baltimore, Md.) In *NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978* Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1086-1093

The AN/APX 100(V), an integrated panel-mounted transponder has been developed for military aircraft through the use of microminiaturization in both digital and RF circuitry. This paper describes the system design and system integration of the transponder and gives attention to considerations of reliability, maintainability, and human factors. Performance improvements incorporated in the transponder are discussed in detail with attention given to such features as diversity, automatic overload control, built in test, solid state transmitter, and alternate remote configuration. B J

**A78-49972** **Dual band airborne SATCOM terminal** E M Perdue and G K H Tsao (Raytheon Co., Equipment Div., Sudbury, Mass.) In *NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978* Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1094-1096 5 refs Contract No F33615-73-C-4036

An experimental airborne low level terminal is developed for command and control communications via either the DSCS satellites in the SHF band or the LES-8/LES-9 satellites in the EHF band. The terminal utilizes a agile frequency synthesizer system to generate carrier frequencies with exceptionally low phase noise, wide carrier tuning range and short switching settling time. The dual band SATCOM terminal system interfaces at a 70 MHz IF with a pseudo-noise spread spectrum MODEM, USC-28 and at a 700 MHz IF with a frequency-hopping MODEM, OM-53. (Author)

**A78-49973** **Digital system architecture for a 1980's jammer** E M Drogin (Cutler-Hammer, Inc., AIL Div., Deer Park, N.Y.) In *NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978* Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1097-1103 6 refs

The AN/AIQ-161, initially designed for the B-1 bomber, is an automatic, fully power-managed jamming system. The network which sends commands and receives status data from the jamming hardware may be characterized as a nonhomogeneous federated multicomputer. This paper describes the jamming logic organization, the data bus structure, and the rationale behind the data rate requirements imposed on the network components. The jamming

system employs advanced concepts which will have general applications in the command and control field for many military aircraft and ships deployed in the 1980s  
B J

**A78-49975**      **Constant false alarm rate detector for a pulse radar in a maritime environment** L G Cole (Westinghouse Electric Corp., Pittsburgh, Pa) and P-W Chen (Boeing Aerospace Co., Seattle, Wash) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3      New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1110-1113 Contract No F19628-70-C-0218

A new doubly adaptive detector with target discrimination circuitry is proposed, based on the use of an auxiliary parallel adaptive detector in addition to the conventional main adaptive detector. The target discrimination circuitry is a simple logic circuit inserted between the detection cell and the clutter average cells. This logic circuitry prevents the target from entering the succeeding clutter average cells by replacing the target report with the clutter average established previously. Therefore, the overall clutter average will not be raised significantly. No detection degradation for the adjacent cell will result, which minimizes target-to-target interference  
B J

**A78-49976**      **A high duty factor chirp radar** M B Ringel (Westinghouse Electric Corp., Baltimore, Md) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3      New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1114-1119

A system description and simulation results are presented for a high-duty-factor gated chirp radar. Appropriate gating and processing of a suitable chirp signal completely eliminates the degradation suffered by a partially eclipsed chirp signal and allows the transmission of a signal of 50% duty cycle. In addition, the matched filter for a gated chirp signal can be obtained as a straightforward modification of that for a standard chirp signal. The advantages and disadvantages of gated chirp are reviewed  
B J

**A78-49977**      **Air-to-air designate/track with time sharing** J L Farrell, M Tom, and C Nemecek (Westinghouse Electric Corp., Systems Development Div., Baltimore, Md) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3      New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1121-1127

The paper describes a system of selective designation which provides high data rates for all targets under consideration, thus enabling multitarget tracking under severe dynamic conditions. A digital program simulates flight paths for the interceptor and up to 10 maneuverable targets, while verifying the application of modern estimation techniques to all track files. Both optimal and suboptimal estimation are used to maximize computational efficiency. The optimal algorithm tracks an accelerating vehicle (acquired at sonic speed) having a 20-g thrust maintained for 1.5 sec after acquisition. Suboptimal estimation at varying data rates is used for supersonic and subsonic aircraft. Processing is organized in such a way that only the highest-priority target warrants high-precision tracking, while the suboptimal algorithm is designed for maximally efficient time sharing  
B J

**A78-49984**      **Autothreshold autoscreener/FLIR system** D Serreyn, M Geokezas, R Larson, and K Fant (Honeywell, Inc., Minneapolis, Minn) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3      New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1180-1185

The target screener/FLIR system was designed to operate on imagery data from an AAS-27 sensor. It detected man-made objects (MMO's) and cued the operator by displaying a symbol at each sector area containing MMO's. In the present paper, a modification of the system is discussed in which the thresholds for manual extraction of candidate MMO's were eliminated by autothreshold, which is an automated technique to extract edges and bright signals. With this technique, it proved possible to detect MMO's with a detection probability of 91.2 percent at a 4.3 percent false alarm probability  
V P

**A78-49985** #      **Infrared receiver performance** S J Dunning (USAF, Data Systems Div., Sunnyvale Air Force Station, Calif) and S R Robinson (USAF, Institute of Technology, Wright-Patterson AFB, Ohio) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3      New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1186-1193 9 refs

The performance of an optical receiver which uses the target's spectral signature to detect the target is discussed. The receiver processes the signal in several narrow frequency bands. It is based on a statistical model in which the field in each band is represented in the form of a Gaussian random process whose moments depend upon the target and background characteristics. The signal is detected by an array of power detectors whose outputs are modeled as random variables characterized by noncentral chi-square probability density functions  
V P

**A78-49987**      **Assessment of dynamic coordinate alignment for elastic aircraft** C Wakefield (Charles Stark Draper Laboratory, Inc., Cambridge, Mass) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3      New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1199-1204 Contract No F33615-77-C-1121 AF Project 7629

A description is presented of some results for Kalman type filter algorithms that ignore the colored nature of the noise. This implies that the noise is treated as if it were mutually uncorrelated white noise. The data used to drive the filter is synthetically generated angular rates and accelerations that contain appropriate aeroelastic characteristics of a B-52 type aircraft. The effects of various classes of instruments used to sense linear and angular motion are also described. The results presented illustrate the effect of some unmodeled error sources and improvements that can be achieved by simple modeling of specific error terms. As a consequence, certain classes of inertial measurement systems can be eliminated as possible candidate systems regardless of the type of filter employed, adaptive or otherwise  
G R

**A78-49988**      **High-accuracy three-dimensional image reconstruction for an airborne line-scanning system** C J Vahlberg and C C Ormsby (Analytic Sciences Corp., Reading, Mass) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3      New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p 1205-1211

A data processing system has been developed to accurately analyze data produced by an airborne line-scanning system. The objective is the creation of a three-dimensional sensor data base which will be used in the evaluation of correlation guidance systems. To accurately form this data base, the aircraft track and a variety of instrumentation parameters must be estimated to an accuracy beyond that normally possible using the available instrumentation (LTN-51 inertial measurement unit, laser ranging system, and metric camera). This paper presents the data analysis methodology and resulting computer program structure created to achieve these objectives, along with a sample of the results      (Author)

**A78-49989**      **Accuracy requirement and cost effectiveness of GPS-aided INS for tactical fighters** P P Chen (Northrop Corp.,

Electro-Mechanical Div , Anaheim, Calif ) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 1212-1218

A method of deriving the Inertial Navigation System (INS) accuracy requirement in a Global Positioning System (GPS)-aided INS configuration for tactical fighters and an assessment of its cost effectiveness are presented. Scenario and avionic performance parameters essential to this configuration are identified and their tradeoffs are established. Kalman covariance analysis is applied to determine the overall navigation performance in an environment with and without jamming and for various INS qualities. The analysis results show that an INS with an accuracy of 4 to 8 nmi/hr Circular Error Probable (CEP) will be sufficient when aided by GPS for tactical fighters. A 30 to 60 percent cost saving over current fighter navigation systems is predicted by employing the configuration with a strapdown INS. (Author)

**A78-49991 # F-15 avionics Built-in-Test** L E Lang (USAF, Aeronautical Systems Div , Wright-Patterson AFB, Ohio) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 1225-1230

In the present paper, the avionics Built-in-Test (BIT) design and development for the F-15 aircraft is discussed. The basic weapon-system maintenance concept and BIT design philosophy are reviewed, and some problems encountered during integration of the various BIT-capable avionic systems are discussed. Field experience with BIT has shown that allowing BIT to detect one time or short duration faults may cause problems in maintenance under an F-15 type concept. Time delaying or filtering of BIT signals has proven to enhance user confidence in BIT by restricting LRU latches to indicating only hard failures which can be confirmed and repaired in the shop. Some examples of these techniques in F-15 avionics are presented. V P

**A78-49997 A parametric analysis of TERCOM false fix probability** E H Conrow (General Dynamics Corp , Convair Aerospace Div , San Diego, Calif) In NAECON '78 Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 1271-1277

Terrain contour matching (TERCOM) is a map-matching technique that uses elevation data of the earth's surface for position location and navigation updating in some systems. The accuracy of TERCOM, like other map-matching methods, is affected by temporal (environmental) and geometric variations and noise between computer-stored reference and sensor (altimeter)-generated test scenes. In this study a Monte Carlo simulation using the MAD algorithm, was developed to investigate the sensitivity of various reference and sensor scenes, and vehicle parameters on the TERCOM false fix probability. From this, an estimate was made of the level of each parameter necessary to significantly impact TERCOM performance (although some scene-to-scene variation should be expected). (Author)

**A78-49998 Advanced pattern matching for navigation and guidance** D H Close and C A McNary (Hughes Research Laboratories, Malibu, Calif) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 1278-1280 Contracts No F30602-76-C-0074, No F30602-77-C-0049, No F33615-77-C-1227

We describe an advanced pattern matching system for providing navigational updates. This system uses syntactic image features, such as straight line segments and segmented regions, to build a semantic model of image content. Matching of reference and sensed models

permits a match point computation that provides the navigational fix. We discuss generic and derived features, feature based image models, and the optimization and evaluation of a baseline pattern matching system. (Author)

**A78-50001 Combinatorially derived limits on the surface return for an air/surface monopulse ranging radar** R E Wilcox (Emerson Electric Co , Electronics and Space Div , St. Louis, Mo) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 1296-1302 11 refs

This paper presents a systematic approach to placing limits upon the simultaneous values of the sum and difference channels in a given range gate for a bounded but large variety of surface topologies with segmented sections of different cross section contributing to the return. Combinatorial generating functions are constructed over a defined antenna gain space which enumerate and define all possible returns. These in turn are examined for particular partitions which yield maximum and minimum electromagnetic returns. The paper is concluded with a specific example to illustrate some of the principles that are involved. (Author)

**A78-50002 A frequency-selective YIG limiter for airborne FM/CW X-band radar** S N Stitzer and H Goldie (Westinghouse Defense and Electronic Systems Center, Baltimore, Md) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 1303-1308 8 refs Contract No F33615-76-C-1036

This paper describes a multistage frequency-selective power limiter in which the limiting takes place in three tandem connected stages. The diameters of the YIG sphere power-limiting elements used in each stage are optimized for sharpest selectivity, lowest threshold, and widest dynamic range. The passive YIG limiter provides 28 dB of dynamic range, will handle up to 3 watts CW, has a 1 percent bandwidth in X-band, and has a below-threshold loss of 1.7 dB. Limited output power is under 5 milliwatts, third order intermodulation products at the output are better than 20 dB down from a 0 dBm in-band signal beating with a second in-band signal of +33 dBm. The device has application to high power FM/CW monostatic radars when simultaneous transmission and reception is required, also to RF signal leveling, long term RF memory loops for ECM, ordinary limiting, and protection of communications receivers from strong RF signals without causing loss of reception during the overload period. (Author)

**A78-50007 A flight qualified graphics generator** R C Landgraf (Boeing Wichita Co , Seattle, Wash) In NAECON '78, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978 Volume 3 New York, Institute of Electrical and Electronics Engineers, Inc , 1978, p 1357-1363

A flight qualified Graphics Generator (GG) which has been developed for use on the B-1 Defensive Avionics System will be described in this paper. The GG generates the symbol and graphic displays which provide information to the defensive operator to enable him to defend the B-1 aircraft. The information is displayed on two cathode-ray tube (CRT) Electronic Display Units (EDU). The GG features interchangeable circuit cards which require no recalibration when cards are substituted. The refresh rate is automatically adjusted based on quantity of imagery, thereby avoiding loss of displayed information. The factors considered in choosing dot writing instead of stroke or television techniques will be discussed, some of these factors are positioning control, line closure, circuit complexity, and adjustments required during circuit card manufacturing tests. A block diagram will be presented and the operation of the GG will be described. (Author)

**A78-50125 # Operating characteristics of bypass turbojet engines (Eksploatatsionnye kharakteristiki dvukhkonturnykh turbo-reaktivnykh dvigateli)** A L Khachkin Moscow, Izdatel'stvo Transport, 1978, 128 p 36 refs In Russian

The bypass engines of commercial aviation are the subject of this book which investigates the effects of operating conditions on engine parameters and indices and also the cost aspects of engine operation The results of numerous studies on the effect of bypass ratio on engine characteristics are summarized The principal paths for increasing the efficiency of bypass engines are explored P T H

**A78-50160 # Flight controls of Army/Hughes YAH-64 advanced attack helicopter** R E Lane (Hughes Helicopters, Culver City, Calif) In Guidance and Control Conference, Palo Alto, Calif, August 7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1978, p 1-8 (AIAA 78-1237)

The flight controls of the YAH-64 have been designed to meet strict requirements in performance, maintainability, survivability, weight, human factors and cost To achieve these requirements a blend of mechanical, hydraulic and electronic flight controls has been used which provides the necessary handling qualities to perform day or night missions in the critical NOE environment (Author)

**A78-50161 # An investigation of potential control-display configurations for V/STOL aircraft** B J Eulrich and J V Lebacqz (Calspan Corp, Buffalo, NY) In Guidance and Control Conference Palo Alto, Calif, August 7-9, 1978, Technical Papers

New York, American Institute of Aeronautics and Astronautics, Inc, 1978, p 9-11 8 refs Contract No N62269-77-C 0561 (AIAA 78-1238)

A literature review and analytic study was conducted to define potential combinations of control system and display presentation characteristics that will permit VTOL instrument decelerating approaches to small ship platforms under adverse weather conditions The study consisted of a review of operational and experimental VTOL results since 1973, the development of procedures to relate these results to the pilot-centered control-display requirements as a function of approach trajectory and environmental factors such as wind/turbulence, and finally to combinations that may be hypothesized to provide an all-weather VTOL capability (Author)

**A78-50162 # Performance of a ring laser strapdown attitude and heading reference for aircraft** C San Giovanni, Jr (Sperry Rand Corp, Sperry Gyroscope, Great Neck, NY) In Guidance and Control Conference, Palo Alto, Calif, August 7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1978, p 12-19 16 refs (AIAA 78-1240)

This paper describes an accuracy performance analysis of a generic ring laser strapdown attitude and heading reference system (AHRS) operating in an aircraft environment The system configuration involves the use of magnetic heading and airspeed sensors to provide the required heading and velocity reference information The analysis is based on the assumed use of an optimal (Kalman) fifteen-state filter to process the available measurement data Covariance analysis results are presented to indicate the relationship of system accuracy performance to gyro drift and to wind model characteristics Results show that, under straight and level flight conditions, a pitch/roll accuracy of approximately 4 arc-min (rms) can be provided using ring laser gyros with 0.15 deg/sq root hr 'white noise' drift Selection of gyros with white noise drift of 0.05 deg/sq root hr will reduce these errors to approximately 2.5 arc-min (rms) per axis These gyro drift characteristics are well within the range of current ring laser gyro designs The study also showed that the magnitude of wind variations in the 4-5-7 rad/hr frequency region is an important characteristic of this error source (Author)

**A78-50163 # Optimal terrain-aided navigation systems** L D Hostetler (Sandia Laboratories, Albuquerque, N Mex) In Guidance and Control Conference, Palo Alto, Calif, August 7-9, 1978, Technical Papers New York, American

Institute of Aeronautics and Astronautics, Inc, 1978, p 20-30 25 refs Research supported by the US Department of Energy (AIAA 78-1243)

The basic framework for applying Kalman filtering techniques to radar terrain-clearance data is investigated By recursively Kalman processing each individual radar measurement separately, a whole new class of terrain-aided navigation schemes becomes available which in the past could not be developed by using simple correlation algorithms To diminish the effect of terrain nonlinearities, adaptive stochastic linearization techniques are utilized in a second-order filter formulation As an application example, results are presented indicating the performance improvements available through continuous terrain-aiding of an inertial, an air-data, and a velocity-sensing navigation system (Author)

**A78-50179 # Shipboard launch and recovery of RPV helicopters in high sea states** G Gevaert and E Schulze (Lear Siegler, Inc, Santa Monica, Calif) In Guidance and Control Conference, Palo Alto, Calif, August 7-9, 1978, Technical Papers

New York, American Institute of Aeronautics and Astronautics, Inc, 1978, p 175-182 7 refs (AIAA 78-1269)

We have recently completed an analytical design of a fully automatic helicopter shipboard recovery system Two simulated vehicles were used in the study, the Gyrodyne QH-50 drone helicopter and a Development Sciences, Inc (DSI) rotary-wing research RPV Guidance and control algorithms were developed to successfully land the aircraft on board a nonaviation ship in high seas The study employed six DOF helicopter models and recorded ship motion data in both fully automatic and remote pilot-in-the-loop simulations which were used to establish statistical performance The simulation, developed system and the tradeoffs that led to the final design are described in this paper The expected performance as a function of recovery conditions and recommended criteria for successful recovery are presented The study indicates that safe launch and recovery in sea state 5 are possible (Author)

**A78-50181 # RPV flying qualities design criteria** T L Neighbor (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and C D Wiler (Rockwell International Corp, Los Angeles, Calif) In Guidance and Control Conference, Palo Alto, Calif, August 7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1978, p 192-201 5 refs (AIAA 78-1271)

In January 1976, a contract with an American aerospace company was initiated by the Air Force with the objective to establish a framework for remotely piloted vehicle (RPV) flying qualities criteria Later phases of the program were to provide data for that framework One of the essential aspects of RPV flying qualities criteria is that they must consider the total RPV system This includes not only vehicle stability and control, but must also encompass automatic and manual control, command and data link, and man-machine interfaces The general organization of the scope and classification section is considered, taking into account vehicle classes, flight phases, and the level of RPV flying qualities The system requirements examined are related to automatic control, manual control, stability margins, operation and interface, and atmospheric disturbances G R

**A78-50182 # Guidance and control problems in semiautomatic recovery of the Aquila RPV** T R Beal (Lockheed Missiles and Space Co, Inc, Sunnyvale, Calif) In Guidance and Control Conference, Palo Alto, Calif, August 7-9, 1978, Technical Papers

New York, American Institute of Aeronautics and Astronautics, Inc, 1978, p 202-207 (AIAA 78-1272)

This paper describes the recovery system for the Aquila RPV developed by Lockheed Missiles & Space Company, Inc (LMSC), for the US Army The approach flight control concept is presented, as are the guidance command algorithms that control the flight to a fixed glide slope boresighted to a TV camera The camera is located on the ground behind a vertical net and is adjusted to define a 4-deg glide slope leading into the net To recover the RPV, an operator controls the motion of a cursor on a TV screen to follow the RPV

image as closely as possible. The coordinates of the cursor provide the basis for the guidance command algorithms. Also, in this paper the predominant sources of error in the recovery system are identified and analyzed, computer modeling of the human operator transfer function is discussed, and the effects of sharp-edged gusts on recovery performance are presented (Author)

**A78-50183 #** The evolution of a remotely piloted vehicle microprocessor flight control system. M. Woolley (Teledyne Ryan Aeronautical, San Diego, Calif.) In Guidance and Control Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers

New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 208-225. 10 refs. (AIAA 78-1273)

The development of a microprocessor flight control system (MFCS) for RPVs is traced through the evolution of the control concepts to the flight testing of the MFCS. RPV control law concepts were applied in the digital system and provided a natural division for multirate computations, significantly alleviating computational requirements. Analytical aspects of the design process, such as z-transform analyses, sample rate determination, computational constraints and simulation analyses are discussed. Data obtained from the MFCS flight tests are presented and compared with simulation results and with the test data for a current analog system. B. J.

**A78-50184 #** Guaranteed cost control of linear systems with uncertain parameters - Application to remotely piloted vehicle flight control systems. A. Vinkler (California Institute of Technology, Pasadena, Calif.) and L. J. Wood. In Guidance and Control Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers

New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 226-234. 22 refs. Research supported by the Teledyne Ryan Aeronautical (AIAA 78-1274)

In many physical systems, an accurate knowledge of certain parameters is very difficult or very expensive to obtain. The designer of an RPV flight control system, for example, frequently has available little data regarding aerodynamic coefficients, due to a lack of wind tunnel tests. Based on the concept of guaranteed cost control, an algorithm has been developed to analyze the effect of parameter uncertainties on closed-loop system stability. An extension of this algorithm results in a technique for choosing constant feedback gains which result in stable closed-loop behavior for a range of parameter values. This technique has been applied to the design of a lateral autopilot for a rudderless RPV with uncertain aerodynamic coefficients (Author)

**A78-50185 #** Software development for fly-by-wire flight control systems. J. A. Bosch and P. Briggs (General Electric Co., Binghamton, N.Y.) In Guidance and Control Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 235-250. 8 refs. (AIAA 78-1276)

A rigorous computer program documentation and configuration control procedure is being applied successfully to the development of the Operational Program for the F-18 Flight Control System. Approximately 50% of this program implements and supports the flight critical foreground tasks, and the remainder implements built-in tests in the background. The traditional software development concept has been modified to incorporate 'incremental progress' and 'manage the feedback' approaches, which are described in this paper. Fundamentally, the software development process described provides an effective and rapid method to identify and correct errors while assuring successful development within a compressed time schedule (Author)

**A78-50186 #** Improved combat survivability for fly-by-wire sensor systems. H. Berman and J. Boudreau (Grumman Aerospace Corp., Bethpage, N.Y.) In Guidance and Control Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 251-263. 7 refs. Contract No. F33615-77-C-3041 (AIAA 78-1277)

Recent developments in Digital Fly-By-Wire flight control technology can offer improved survivability for combat aircraft. Redundancy, which is used to achieve the desired levels of reliability and failure tolerance, can also lead to decreased vulnerability. Results are presented that show that sensor dispersion, in combination with analytic redundancy techniques, enhances flight control system survivability. However, dispersion of flight control sensors, e.g., gyros and accelerometers, can cause problems in sensor redundancy management and in control law dynamic performance. It is shown that these problems, which are due to like sensors measuring different elastic motions and rigid body kinematic effects, can be eliminated by using state estimators to remove these effects from the sensor data (Author)

**A78-50187 #** Triplex digital fly-by-wire redundancy management techniques. T. F. Westermeier (McDonnell Aircraft Co., St. Louis, Mo.) In Guidance and Control Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 264-271. 7 refs. (AIAA 78-1279)

Operational fly-by-wire (FBW) systems, whether analog or digital, are today mostly quadruplex. The introduction of digital computers into FBW systems presents the possibility of reducing the redundancy level from quadruplex to triplex (even, in some cases, duplex) with attendant system benefits: reduction in maintainability, size, weight, power, and cost. Quantitative data is introduced to show the failure coverage needed to achieve acceptable system reliability. Redundancy management techniques are presented, their failure coverage determined, and an analytical link established between these techniques and system reliability. The conclusion is that a triplex system is both desirable and achievable (Author)

**A78-50193 #** Optimal flight control synthesis via pilot modeling. D. K. Schmidt (Purdue University, West Lafayette, Ind.) In Guidance and Control Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 309-313. 10 refs. (AIAA 78-1286)

The paper deals with the development of a synthesis approach usable in the absence of quantitative aircraft handling qualities specifications, and includes explicitly design objectives based on pilot-rating concepts by means of an optimal-control pilot model. The methodology uses the pilot's objective function (from which the pilot model evolves) to design the stability augmentation. The procedure involves simultaneously solving for the stability augmentation system gains and pilot model via optimal control techniques. Simultaneous solution is required in this case since the pilot model (gains, etc.) depends upon the augmented plant dynamics, and the augmentation is obviously not a priori known (Author)

**A78-50194 #** Flight investigation and theory of direct side-force control. W. B. Binnie (U.S. Naval Air Training Command, Washington, D.C.) and R. F. Stengel (Princeton University, Princeton, N.J.) In Guidance and Control Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 314-324. 11 refs. Office National d'Etudes et de Recherches Aérospatiales Contract No. 18,884/SAT,2/LL (AIAA 78-1287)

Several side-force command modes were implemented for flight test in Princeton's 6-DOF Variable-Response Research Aircraft (VRA), and pilot opinions of these modes were assessed, emphasizing the requirements of crosswind landing. Command modes included proportional and rate thumb-switch, lateral stick, and rudder pedal commands, together with various blending ratios of side-force panel deflection with ailerons and rudder. Pilot preferences were shaped by their primary flying experience (general aviation or military), although there was consensus on the desirability of side force commands which are uncoupled from conventional inputs. Analytical foundations of the study are presented, and future research directions are suggested (Author)

**A78-50195 \* #** A learning flight control system for the F8-DFBW aircraft R C Montgomery (NASA, Langley Research Center, Hampton, Va ), R Mekei, and S Nachmias (NASA, Langley Research Center, Hampton, Va , New York, City University, New York, N Y ) In Guidance and Control Conference, Palo Alto, Calif , August 7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc , 1978, p 325-331 8 refs (AIAA 78-1288)

This report contains a complete description of a learning control system designed for the F8-DFBW aircraft The system is parameter-adaptive with the additional feature that it 'learns' the variation of the control system gains needed over the flight envelope It, thus, generates and modifies its gain schedule when suitable data are available The report emphasizes the novel learning features of the system the forms of representation of the flight envelope and the process by which identified parameters are used to modify the gain schedule It contains data taken during piloted real-time 6 degree-of-freedom simulations that were used to develop and evaluate the system (Author)

**A78-50196 #** Close encounters of the aeroservoelastic kind L R Felt, L J Huttsett, T E Noll, and D E Cooley (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) In Guidance and Control Conference, Palo Alto, Calif , August 7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc , 1978, p 332-341 23 refs (AIAA 78-1289)

Aeroservoelasticity involves the interaction between aerodynamics, structural dynamics, and automatic flight control systems It is an increasingly important design and test consideration in the synthesis and evaluation of airborne high-gain automatic control systems In the present paper, recent Air Force experience is reviewed which emphasizes the need for aeroservoelastic considerations on a variety of research, prototype, and production aircraft V P

**A78-50200 \* #** Navigation performance of the Triscan concept for shipboard VTOL aircraft operations L A McGee (NASA, Ames Research Center, Moffett Field, Calif ), S F Schmidt (Analytical Mechanics Associates, Inc , Mountain View, Calif ), and S K Miyashiro (U S Naval Ocean Systems Center, San Diego, Calif ) In Guidance and Control Conference, Palo Alto, Calif , August 7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc , 1978, p 363-373 (AIAA 78-1293)

The paper deals with the Triscan concept a dual-antenna microwave landing guidance system, using triangulation for close-in accuracy - developed to facilitate the landing of VTOL aircraft on ships in all-weather conditions Analysis of the navigation performance of an onboard system receiving data from Triscan and data-linked information regarding the motion of the ship showed that the approach navigation performance depends on the approach path profile flown, the magnitude of the measurement bias error, and the navigation system's knowledge of the shipboard landing pad motion, which was implemented through the concept of a landing pad deviation vector V P

**A78-50202 \* #** Approach guidance logic for a tilt-rotor aircraft J Beser (Intermetrics, Inc , Long Beach, Calif ) In Guidance and Control Conference, Palo Alto, Calif , August 7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc , 1978, p 381-392 6 refs Grant No NGL-05-020-007 (AIAA 78-1295)

The distinctive feature of a tilt-rotor aircraft is that the pilot can change the rotor mast angles to go from a helicopter configuration for take-off and landing to an airplane configuration for high cruise speeds and vice-versa An approach path for such an aircraft is proposed and the logic required to fly along this path in the presence of wind is determined The main contribution of this work is an efficient and, to my knowledge, new method for generating the nominal state and control histories taking into account an estimate of the mean wind velocity and direction The method requires the

solution of algebraic (mostly linear) equations to generate a 'universal nominal', and feedforward and feedback gains Then, in flight the additional state and control corrections due to deviation in descent rate, deceleration, and flight in a steady wind are obtained by multiplying simple precalculated functions of time by descent rate, deceleration or sine and cosine components of the mean wind vector Simulations of approach flights for different wind conditions, assuming perfect state information in the feedback signal, indicated satisfactory performance (Author)

**A78-50203 \* #** Guidance and navigation for automatic landing, rollout, and turnoff using MLS and magnetic cable sensors S Pines (Analytical Mechanics Associates, Inc , Jericho, N Y ) and R M Hueschen (NASA, Langley Research Center, Hampton, Va ) In Guidance and Control Conference, Palo Alto, Calif , August 7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc , 1978, p 393-406 5 refs Contract No NAS1-14311 (AIAA 78-1296)

This paper describes the navigation and guidance system developed for the TCV B-737, a Langley Field NASA research aircraft, and presents the results of an evaluation during final approach, landing, rollout and turnoff obtained through a nonlinear digital simulation A Kalman filter (implemented in square root form) and a third order complementary filter were developed and compared for navigation The Microwave Landing Systems (MLS) is used for all phases of the flight for navigation and guidance In addition, for rollout and turnoff, a three coil sensor which detects the magnetic field induced by a buried wire in the runway (magnetic leader cable) is used The outputs of the sensor are processed into measurements of position and heading deviation from the wire The results show the concept to be both feasible and practical for commercial type aircraft terminal area control (Author)

**A78-50209 \* #** The effect of prefilter design on sample rate selection in digital flight control systems U Peled and J D Powell (Stanford University, Stanford, Calif ) In Guidance and Control Conference, Palo Alto, Calif , August 7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc , 1978, p 449-454 9 refs Grant No NsG-4002 (AIAA 78-1308)

The effect of prefilters on sample rate selection is examined and design procedures are determined for obtaining the best combination of prefilter breakpoint and sample rate The employed approach involves a quantitative comparison of the output noise response of systems originating from the same basic plant and designed over a wide range of prefilters and sample rates Each system design was carefully tailored so that it exhibited approximately identical responses to commands The results presented augment the criteria for sample rate selection which have been discussed by Powell and Katz (1975) Attention is given to system characteristics, an integrator as a plant, and the short period motion of the F-8 aircraft G R

## STAR ENTRIES

**N78-30039\*#** National Aeronautics and Space Administration  
Langley Research Center Langley Station Va  
**AERODYNAMIC CHARACTERISTICS INDUCED ON A SUPERCRITICAL WING DUE TO VECTORING TWIN NOZZLES AT MACH NUMBERS FROM 0.40 TO 0.95**  
Francis J Capone Aug 1978 115 p refs  
(NASA-CR-78746) Avail NTIS HC A06/MF A01 CSCL 01A

The induced lift characteristics are studied for a vectored-thrust concept in which jet-exhaust nozzles were located in the fuselage at the wing trailing edge. The wing had a supercritical airfoil section. The investigation was conducted at Mach numbers from 0.4 to 0.95 angles of attack up to 14 deg and thrust coefficients up to 0.35 and nozzle deflection angles of 0 deg and 30 deg. Separate force balances were used to determine both total aerodynamic and thrust forces alone which allowed for a direct measurement of jet turning angle at forward speeds. The Reynolds number per meter varied from  $8.20 \times 10^6$  to  $12.80 \times 10^6$ . The results show that the configuration with the supercritical wing generally had a better performance with respect to both lift augmentation and drag reduction than the same configuration with a 64 series airfoil. G G

**N78-30040\*#** National Aeronautics and Space Administration  
Langley Research Center Langley Station Va  
**WIND-TUNNEL TESTING OF VTOL AND STOL AIRCRAFT**  
Harry H Heyson Jul 1978 81 p refs Presented at the Seminar on Aerodyn of V/STOL Aircraft and Helicopters University Park Pa 31 Jul - 4 Aug 1978  
(NASA-TM-78750) Avail NTIS HC A05/MF A01 CSCL 01A

The basic concepts of wind-tunnel boundary interference are discussed and the development of the theory for VTOL-STOL aircraft is described. Features affecting the wall interference such as wake roll-up configuration differences, recirculation limits and interference nonuniformity are discussed. The effects of the level of correction on allowable model size are shown to be amenable to generalized presentation. Finally experimental confirmation of wind-tunnel interference theory is presented for jet-flap rotor and fan-in-wing models. Author

**N78-30041\*#** National Aeronautics and Space Administration  
Langley Research Center Langley Station Va  
**STATUS OF AERIAL APPLICATIONS RESEARCH IN THE LANGLEY VORTEX RESEARCH FACILITY AND THE LANGLEY FULL-SCALE WIND TUNNEL**  
Frank L Jordan H Clyde McLemore and Michael B Bragg (Illinois Univ) Aug 1978 12 p refs  
(NASA-TM-78760) Avail NTIS HC A02/MF A01 CSCL 01A

Small scale models of agricultural airplanes were tested and numerical methods were utilized to study interactions between the airplane wake and the dispersed spray and granular materials. Methods were developed to measure and predict dispersal transport and wake characteristics and dispersal techniques to obtain interactions more favorable to wide uniform deposition patterns and reduced drift. In the full scale wind tunnel full scale agricultural airplanes and dispersal systems for both liquid and solid applications were evaluated to improve aircraft aerodynamics and dispersal systems efficiency. The program status in these two facilities is reported with emphasis on wake interactions and dispersal systems research. G G

**N78-30042\*#** Lockheed-California Co Burbank  
**REXOR 2 ROTORCRAFT SIMULATION MODEL VOLUME 1 ENGINEERING DOCUMENTATION Final Technical Report**

J S Reaser and P H Kretsinger Jun 1978 272 p refs  
Sponsored in part by AVRADCOM 3 Vol  
(Contract NAS1-14570)  
(NASA-CR-145331 LR-28435-Vol-1) Avail NTIS  
HC A12/MF A01 CSCL 01A

A rotorcraft nonlinear simulation called REXOR II divided into three volumes is described. The first volume is a development of rotorcraft mechanics and aerodynamics. The second is a development and explanation of the computer code required to implement the equations of motion. The third volume is a user's manual and contains a description of code input/output as well as operating instructions. G Y

**N78-30043\*#** Lockheed-California Co Burbank  
**REXOR 2 ROTORCRAFT SIMULATION MODEL VOLUME 2 COMPUTER IMPLEMENTATION Final Technical Report**

J S Reaser and P H Kretsinger Jun 1978 177 p ref  
Sponsored in part by Avradcom 3 Vol  
(Contract NAS1-14570)  
(NASA-CR-145332 LR-28435-Vol-2) Avail NTIS  
HC A09/MF A01 CSCL 01A  
For abstract see N78-30042

**N78-30044\*#** Lockheed-California Co Burbank  
**REXOR 2 ROTORCRAFT SIMULATION MODEL VOLUME 3 USER'S MANUAL Final Technical Report**

J S Reaser and P H Kretsinger Jun 1978 247 p ref  
Sponsored in part by AVRADCOM 3 Vol  
(Contract NAS1-14570)  
(NASA-CR-145333 LR-28435-Vol-3) Avail NTIS  
HC A11/MF A01 CSCL 01A  
For abstract see N78-30042

**N78-30045\*#** Vought Corp Hampton Va  
**DESIGN OF A LARGE SPAN-DISTRIBUTED LOAD FLYING-WING CARGO AIRPLANE WITH LAMINAR FLOW CONTROL**

W A Lovell J E Price C B Quartero R V Turriziani and G F Washburn Jun 1978 45 p refs  
(Contract NAS1-13500)  
(NASA-CR-145376) Avail NTIS HC A03/MF A01 CSCL 01A

A design study was conducted to add laminar flow control to a previously design span-distributed load airplane while maintaining constant range and payload. With laminar flow control applied to 100 percent of the wing and vertical tail chords the empty weight increased by 4.2 percent the drag decreased by 27.4 percent the required engine thrust decreased by 14.8 percent, and the fuel consumption decreased by 21.8 percent. When laminar flow control was applied to a lesser extent of the chord (approximately 80 percent) the empty weight increased by 3.4 percent the drag decreased by 20.0 percent the required engine thrust decreased by 13.0 percent and the fuel consumption decreased by 16.2 percent. In both cases the required take-off gross weight of the aircraft was less than the original turbulent aircraft. Author

**N78-30046\*#** National Aeronautics and Space Administration  
Langley Research Center Langley Station Va  
**SHOCKLESS AIRFOILS WITH THICKNESSES OF 20.6 AND 20.7 PERCENT CHORD ANALYTICALLY DESIGNED FOR A MACH NUMBER OF 0.68 AND A LIFT COEFFICIENT OF 0.40**

Dennis O Allison May 1976 38 p refs  
(NASA-TM-X-73917) Avail NTIS HC A03/MF A01 CSCL 01A

A 20.8 percent-thick airfoil shape was designed to have shockless inviscid flow at a Mach number of 0.68 and a lift coefficient of 0.40. In order to determine the actual airfoils which would yield this same shockless flow when viscous effects are included boundary layer displacement thicknesses were subtracted from the inviscid shape for Reynolds numbers of 100 and 35 million. This process yielded airfoils with thicknesses of 20.7 and 20.6 percent respectively. Subtraction of boundary layer displacement thicknesses for Reynolds numbers below 35 million



yielded nonphysical airfoils that is airfoils with negative thicknesses near the trailing edge. The pitching moment about the quarter-chord point at the design condition was -0.082 for the inviscid shape and consequently for both airfoils. Off-design calculations for the two airfoils were made using a computer program which provides for the interaction of the inviscid flow and boundary layer solutions. The pressure distributions of the airfoils were shockless for conditions from the design point to lower Mach numbers and lift coefficients. No boundary layer separation was predicted except in the last 3 percent chord on the upper surface. Author

**N78-30048\*#** Bihle Applied Research Inc Jericho N Y  
**STATIC AERODYNAMIC CHARACTERISTICS OF A TYPICAL SINGLE-ENGINE LOW-WING GENERAL AVIATION DESIGN FOR AN ANGLE-OF-ATTACK RANGE OF -8 DEG TO 90 DEG**

William Bihle Jr Billy Barnhart and Paul Pantason Jul 1978 466 p refs

(Contract NAS1-14849)

(NASA-CR-2971) Avail NTIS HC A20/MF A01 CSCL 01A

Static force data obtained at the NASA Ames Research Center 12 foot Pressure Tunnel are presented in plotted form for a 1/7 scale, single-engine low-wing general aviation airplane model. The configurations tested included the basic airplane, various airfoil shapes tail designs fuselage strakes and fuselage modifications as well as airplane components. The test conditions included an angle-of-attack and sideslip range of -8 to 90 and -10 to 30 degrees, respectively at a Mach number of 0.2 for Reynolds numbers of 288 000 and 3 450 000. The data are presented without analysis. Author

**N78-30049\*#** Bihle Applied Research Inc Jericho N Y  
**ROTARY BALANCE DATA FOR A TYPICAL SINGLE-ENGINE LOW-WING GENERAL AVIATION DESIGN FOR AN ANGLE-OF-ATTACK RANGE OF 30 DEG TO 90 DEG**

William Bihle Jr Randy S Hultberg and William Mulcay Jul 1978 446 p refs

(Contract NAS1-14849)

(NASA-CR-2972) Avail NTIS HC A19/MF A01 CSCL 01A

Aerodynamic characteristics obtained in a spinning flow environment utilizing a rotary balance located spin tunnel are presented in plotted form for a 1/5 scale single-engine low-wing general aviation airplane model. The configurations tested include the basic airplane various airfoil shapes tail designs, fuselage strakes and modifications as well as airplane components. Data are presented for pitch and roll angle ranges of 30 to 90 degrees and 10 to -10 degrees respectively and clockwise and counter-clockwise rotations covering an Omega b/2V range from 0 to 9. The data are presented without analysis. Author

**N78-30050\*#** Neilsen Engineering and Research Inc Mountain View Calif

**CALCULATION OF THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF UPPER-SURFACE-BLOWN WING-FLAP CONFIGURATIONS** Final Report

Michael R Mendenhall and Selden B Spangler Aug 1978 83 p refs

(Contract NAS1-14086)

(NASA-CR-3004 NEAR-TR-157) Avail NTIS HC A05/MF A01 CSCL 01A

An engineering method for predicting the longitudinal aerodynamic characteristics of wing-flap configurations with upper surface blowing (USB) was developed. Potential flow models were incorporated into the prediction method a wing and flap lifting surface model and a jet wake model. The wing-flap model used a vortex-lattice to represent the wing and flaps. The wing had an arbitrary planform and camber and twist and the flap system was made up of a Coanda flap and other flap segments of arbitrary size. The jet wake model consisted of a series of closely spaced rectangular vortex rings. The wake was positioned such that it was tangent to the upper surface of the wing and flap between the exhaust nozzle and the flap trailing edge. It was specified such that the mass momentum and spreading rates were similar to actual USB jet wakes. Comparisons of measured and predicted pressure distributions span load

distributions and total lift and pitching-moment coefficients on swept and unswept USB configurations are included. A wide range of thrust coefficients and flap deflection angles were considered at angles of attack up to the onset of stall. S B S

**N78-30051\*#** McDonnell-Douglas Corp St Louis Mo  
**MODIFICATION OF THE DOUGLAS NEUMANN PROGRAM TO IMPROVE THE EFFICIENCY OF PREDICTING COMPONENT INTERFERENCE AND HIGH LIFT CHARACTERISTICS**

Final Report

D R Bristow and G G Grose Aug 1978 126 p refs

(Contract NAS1-14756)

(NASA-CR-3020) Avail NTIS HC A07/MF A01 CSCL 01A

The Douglas Neumann method for low-speed potential flow on arbitrary three-dimensional lifting bodies was modified by substituting the combined source and doublet surface paneling based on Green's identity for the original source panels. Numerical studies show improved accuracy and stability for thin lifting surfaces permitting reduced panel number for high-lift devices and supercritical airfoil sections. The accuracy of flow in concave corners is improved. A method of airfoil section design for a given pressure distribution, based on Green's identity was demonstrated. The program uses panels on the body surface with constant source strength and parabolic distribution of doublet strength and a doublet sheet on the wake. The program is written for the CDC CYBER 175 computer. Results of calculations are presented for isolated bodies wings, wing-body combinations and internal flow. Author

**N78-30053\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**STATIC AERODYNAMIC CHARACTERISTICS OF A WINGED SINGLE-STAGE-TO-ORBIT VEHICLE AT MACH NUMBERS FROM 0.3 TO 4.63**

Delma C Freeman and Roger H Fournier Aug 1978 119 p refs

(NASA-TP-1233, L-12200) Avail NTIS HC A06/MF A01 CSCL 01A

The Langley 8 foot transonic pressure tunnel and the Langley Unitary Plan wind tunnel used to determine the longitudinal and lateral-directional aerodynamic characteristics of a winged single-stage-to-orbit vehicle was investigated. The model was tested over a Mach number range from 0.3 to 4.63 for an angle-of-attack range from 4 to 30 D at both 0 and 5 D sideslip. S E S

**N78-30054\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**APPROXIMATE INDICIAL LIFT FUNCTION FOR TAPERED, SWEEP WINGS IN INCOMPRESSIBLE FLOW**

M J Queijo, William R Wells (Wright State Univ Dayton, Ohio), and Dinesh A Keskar (Cincinnati Univ, Ohio) Aug 1978 32 p refs

(NASA-TP-1241 L-12110) Avail NTIS HC A03/MF A01 CSCL 01A

An approximate indicial lift function associated with circulation was developed for tapered, swept wings in incompressible flow. The function is derived by representing the wings with a simple vortex system. The results from the derived equations compare well with the limited available results from more rigorous and complex methods. The equations, as derived are not very convenient for calculating the dynamic response of aircraft, parameter extraction or for determining frequency-response curves for wings. Therefore, an expression is developed to convert the indicial response function to an exponential form which is more convenient for these purposes. Author

**N78-30056\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**THEORETICAL ESTIMATION OF THE TRANSONIC AERODYNAMIC CHARACTERISTICS OF A SUPERCRITICAL-WING TRANSPORT MODEL WITH TRAILING-EDGE CONTROLS**

James M Luckring and Michael J Mann Aug 1978 34 p refs  
(NASA-TP-1253 L-11257) Avail NTIS HC A03/MF A01 CSCL 01A

A method for rapidly estimating the overall forces and moments at supercritical speeds below drag divergence of transport configurations with supercritical wings is presented. The method was also used for estimating the rolling moments due to the deflection of wing trailing-edge controls. This analysis was based on a vortex-lattice technique modified to approximate the effects of wing thickness and boundary-layer induced camber. Comparisons between the results of this method and experiment indicate reasonably good correlation of the lift pitching moment and rolling moment. The method required much less storage and run time to compute solutions over an angle-of-attack range than presently available transonic nonlinear methods require for a single angle-of-attack solution. SES

**N78-30057\*#** National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio  
**PERFORMANCE WITH AND WITHOUT INLET RADIAL DISTORTION OF A TRANSONIC FAN STAGE DESIGNED FOR REDUCED LOADING IN THE TIP REGION**

James F Schmidt and Robert S Ruggeri Aug 1978 84 p refs  
(NASA-TP-1294 E-9246) Avail NTIS HC A05/MF A01 CSCL 01A

A transonic compressor stage designed for a reduced loading in the tip region of the rotor blades was tested with and without inlet radial distortion. The rotor was 50 cm in diameter and designed for an operating tip speed of 420 m/sec. Although the rotor blade loading in the tip region was reduced to provide additional operating range, analysis of the data indicates that the flow around the damper appears to be critical and limited the stable operating range of this stage. For all levels of tip and hub radial distortion there was a large reduction in the rotor stall margin. Author

**N78-30058#** Air Force Flight Dynamics Lab Wright-Patterson AFB, Ohio

**A CALCULATOR PROGRAM FOR ANALYZING AIRLOADS ON A WING OF ARBITRARY PLANFORM AND CAMBER IN SUBSONIC FLOW Final Report, 1 Apr - 31 Aug 1976**

John C Sparks Jan 1978 53 p refs  
(AD-A054180 AFFDL-TR-77-136) Avail NTIS HC A04/MF A01 CSCL 20/4

A subsonic airloads program for small (8-K) calculators is presented. Features include good man-machine interaction and quick turn-around which speed preliminary design. The program is written in BASIC for the HP9830 or HP9831 calculator systems equipped with Matrix ROM and 9862A plotter. Programming techniques illustrated may be applied to any small system having special function keys or an equivalent capability. Author (GRA)

**N78-30064#** Liverpool Univ (England)

**CALCULATIONS OF THE EFFECTS OF BLOWING FROM THE LEADING EDGES OF A CAMBERED DELTA WING**

J E Barsby London Aeron Res Council 1978 53 p refs  
Supersedes ARC-36252 Sponsored in part by Sci Res Council and Univ of East Anglia, Engl  
(ARC-R/M-3800 ARC-36252 BR61584) Avail NTIS HC A03/MF A01 HMSO £5 26, PHI \$20 20

The thin jet model applied to the study of the jet flap is combined with the vortex sheet model applied to the study of leading-edge separation to study the effect of blowing from the leading-edges of a cambered wing. The numerical techniques used to solve problems of leading-edge separation were improved, and in the present investigation solutions were generated for various values of the lift, camber and blowing strength of the jet whose direction is restricted to lie in a plane normal to the free stream. Regions existed in the parameter space within which solutions could not be obtained and there were regions within which solutions were not unique. The downward deflection of

the jet which is associated with the camber does not produce a lift increment due to blowing which is significantly larger than the increment produced by the same blowing momentum on a plane wing. However the drag for a given lift when blowing is introduced is greatly reduced and in some cases a negative drag is predicted. Author (ESA)

**N78-30065#** Cambridge Univ (England) Engineering Dept  
**LINEARIZED SUPERSONIC UNSTEADY FLOW IN CASCADES**

T Nagashima and D S Whitehead London Aeron Res Council 1978 39 p refs  
Supersedes ARC-37198  
(ARC-R/M-3811 ARC-37198 BR61587) Avail NTIS HC A03/MF A01 HMSO £4, PHI \$15 30

A linearized theory is presented for the calculation of force and moment coefficients for two-dimensional cascades of blades in supersonic flow. The cases of both supersonic and subsonic axial velocity are treated. The perturbations are due to bending vibration, torsional vibration and wakes shed from moving obstructions upstream. The method leads to analytical results in the quasi-steady case and to a fast computer program for the general unsteady case. Results are in good agreement with previous work. The method can be used to predict forced vibration and flutter in transonic fan blades. Author (ESA)

**N78-30066#** Queen Mary Coll London (England)  
**A MEAN CAMBERLINE SINGULARITY METHOD FOR TWO-DIMENSIONAL STEADY AND OSCILLATORY AEROFOILS AND CONTROL SURFACES IN INVISCID INCOMPRESSIBLE FLOW**

B C Basu Aeron Res Council 1978 54 p refs  
Supersedes QMC-EP-1019 ARC-37207  
(ARC-CP-1391 QMC-EP-1019 ARC-37207) Avail NTIS HC A04/MF A01 HMSO £2 50 PHI \$9 70

A numerical method has been developed to calculate the pressure distribution on the surface of steady and oscillating airfoils in incompressible inviscid flow. In this method singularities are placed on the mean camber line of the airfoil and the boundary condition of tangency of flow is satisfied on the surface of the airfoil. Problems considered include steady single airfoils with and without control surfaces, a cascade of airfoils, airfoils oscillating in pitch, airfoils oscillating in heave, airfoils in harmonic travelling gusts and control surface oscillations. Comparison with analytic solutions and other numerical methods where available are good. The main advantages of this method are the relatively fast computing times and the fact that the method converges satisfactorily in the limit of zero airfoil thickness. Author (ESA)

**N78-30068#** Queen Mary Coll London (England) Dept of Aeronautical Engineering

**TWO-DIMENSIONAL AEROFOILS AND CONTROL SURFACES IN SIMPLE HARMONIC MOTION IN INCOMPRESSIBLE INVISCID FLOW**

B C Basu and G J Hancock Aeron Res Council 1978 62 p refs  
Supersedes ARC-37204  
(ARC-CP-1392 ARC-37204) Avail NTIS HC A04/MF A01 HMSO £3 PHI \$11 55

A numerical method developed for the calculation of the two-dimensional potential flow about an airfoil of arbitrary shape undergoing small amplitude simple harmonic motions is described. Problems considered include airfoils oscillating in pitch, airfoils oscillating in heave, airfoils in harmonic travelling gusts and control surface oscillations. Comparison with analytic solutions where available, is good. Significant differences between linear and non-linear theory are shown especially for the in-phase hinge moment coefficients. Author (ESA)

**N78-30069\*#** Virginia Univ Charlottesville Research Labs for the Engineering Sciences

**DEMAND MODELLING OF PASSENGER AIR TRAVEL AN ANALYSIS AND EXTENSION, VOLUME 2 Final Report**

I D Jacobson Aug 1978 151 p refs  
(Grant NsG-7266)  
(NASA-CR-157402 UVA/528148/MAE78/101) Avail NTIS  
HC A08/MF A01 CSCL 01C

Previous intercity travel demand models in terms of their ability to predict air travel in a useful way and the need for disaggregation in the approach to demand modelling are evaluated. The viability of incorporating non-conventional factors (i.e. non-econometric such as time and cost) in travel demand forecasting models are determined. The investigation of existing models is carried out in order to provide insight into their strong points and shortcomings. The model is characterized as a market segmentation model. This is a consequence of the strengths of disaggregation and its natural evolution to a usable aggregate formulation. The need for this approach both pedagogically and mathematically is discussed. In addition this volume contains two appendices which should prove useful to the non-specialist in the area. G Y

**N78-30070\*#** Aeronautical Research Foundation Cambridge Mass

**REQUIREMENTS FOR REGIONAL SHORT-HAUL AIR SERVICE AND THE DEFINITION OF A FLIGHT PROGRAM TO DETERMINE NEIGHBORHOOD REACTIONS TO SMALL TRANSPORT AIRCRAFT**

Kornel Feher Lynn Bollinger Jeffrey V Bowles and Mark H Waters Aug 1978 153 p refs Prepared in cooperation with NASA AMES Res Center Moffett Field Calif  
(Contract NAS2-9050)  
(NASA-CR-152151) Avail NTIS HC A08/MF A01 CSCL 05C

An evaluation of the current status and future requirements of an intraregional short haul air service is given. A brief definition of the different types of short haul air service is given. This is followed by a historical review of previous attempts to develop short haul air service in high density urban areas and an assessment of the current status. The requirements for intraregional air service, the need for economic and environmental viability and the need for a flight research program are defined. A detailed outline of a research program that would determine urban community reaction to frequent operations of small transport aircraft is also given. Both the operation of such an experiment in a specific region (San Francisco Bay area) and the necessary design modifications of an existing fixed wing aircraft which could be used in the experiment are established. An estimate is made of overall program costs. G Y

**N78-30071#** Federal Aviation Administration Washington D C Wind Shear/WVAS Branch

**ENGINEERING AND DEVELOPMENT PROGRAM PLAN WAKE VORTEX**

Dec 1977 6 p refs  
(AD-A051143, FAA-ED-21-1A) Avail NTIS  
HC A02/MF A01 CSCL 01/5

The design, development, testing and prototyping of a system to increase runway capacity by minimizing wake vortex effects as an impediment to efficient and effective traffic management in the terminal environment are discussed. Major work areas were vortex advisory system, wake vortex avoidance system, and vortex alleviation research. S B S

**N78-30072\*#** National Aeronautics and Space Administration Ames Research Center Moffett Field Calif  
**CHARACTERISTICS OF CONSTRAINED OPTIMUM TRAJECTORIES WITH SPECIFIED RANGE**

Heinz Erzberger and Homer Lee Sep 1978 39 p refs  
(NASA-TM-78519 A-7592) Avail NTIS HC A03/MF A01 CSCL 17G

Necessary conditions of optimality are derived for trajectories whose structure is limited to climb, steady cruise, and descent segments. 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 (500 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. Computer calculations of typical short-range trajectories obtained about a 1% cost penalty for constraining the thrust. Author

**N78-30073\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va

**DESCRIPTION AND PERFORMANCE OF THE LANGLEY VISUAL LANDING DISPLAY SYSTEM**

John D Rollins Aug 1978 74 p refs  
(NASA-TM-78742) Avail NTIS HC A04/MF A01 CSCL 17G

A television/model board system is described which provides a means of generating a six-degree-of-freedom visual out-the-window scene for the pilot of a simulated aircraft. The hardware and its performance of capability for meeting the visual requirements for a wide range of simulation studies are detailed. Also included is a description of the computer software required for the system. An example of software implementation in a real-time computer program is provided. G G

**N78-30074\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va

**FLIGHT DEMONSTRATIONS OF CURVED, DESCENDING APPROACHES AND AUTOMATIC LANDINGS USING TIME REFERENCED SCANNING BEAM GUIDANCE**

William F White comp May 1978 269 p refs  
(NASA-TM-78745) Avail NTIS HC A12/MF A01 CSCL 17G

The Terminal Configured Vehicle (TCV) program operates a Boeing 737 modified to include a second cockpit and a large amount of experimental navigation guidance and control equipment for research on advanced avionics systems. Demonstration flights to include curved approaches and automatic landings were tracked by a phototeodolite system. For 50 approaches during the demonstration flights the following results were obtained: the navigation system using TRSB guidance delivered the aircraft onto the 3 nautical mile final approach leg with an average overshoot of 25 feet past centerline, subject to a 2-sigma dispersion of 90 feet. Lateral tracking data showed a mean error of 4.6 feet left of centerline at the category 1 decision height (200 feet) and 2.7 feet left of centerline at the category 2 decision height (100 feet). These values were subject to a sigma dispersion of about 10 feet. Finally, the glidepath tracking errors were 2.5 feet and 3.0 feet high at the category 1 and 2 decision heights, respectively, with a 2 sigma value of 6 feet. G G

**N78-30075#** National Aviation Facilities Experimental Center Atlantic City N J

**TRSB MICROWAVE LANDING SYSTEM DEMONSTRATION PROGRAM AT BRUSSELS, BELGIUM Final Report, 20 Jan - 6 Feb 1978**

Feb 1978 84 p  
(AD-A054298, FAA-NA-78-18, FAA-RD-78-18) Avail NTIS  
HC A05/MF A01 CSCL 01/5

The sixth in a series of FAA conducted operational demonstrations of several TRSB system configurations at selected airports in the United States and abroad are reported. The basic wide aperture TRSB was installed to service runway 07L which was the longest of three major runways at the airport. Operational demonstrations and data acquisition flights were made using FAA CV-880 and B-727 aircraft. One-third of the landings were autoland. Flight profiles included straight-in and curved approaches, radials, and partial orbits. Results of the operational demonstrations indicate that the performance of the TRSB basic wide system configuration meets the ICAO full capability system requirements. B B

**N78-30078#** Facility Checking Squadron (1866th) (AFCS), Scott AFB Ill

**TRACALS EVALUATION REPORT TACAN, VOR, AND ILS**

**STATION EVALUATION REPORT, ANDERSEN AFB, GUAM**  
**Final Report, 25 Jul - 15 Aug 1977**  
 Paul W Nix 12 Apr 1978 253 p  
 (AD-A054244 Rept-77/66N-107) Avail NTIS  
 HC A12/MF A01 CSCL 17/7

This evaluation report presents data collected and analyzes capabilities and limitations of the Andersen AFB TACAN (AN/GRN-19A) VOR (AN/FRN-38) ILS (AN/MRN-7A/8A) and their associated power systems. The evaluation was conducted from 25 July to 15 August 1977. The results of the evaluation indicate that all the facilities are capable of providing satisfactory service. The data presented in this report can be used as a valid guide to anticipated performance until there is a significant change in ground equipment siting or screening. Author (GRA)

**N78-30079#** Arinc Research Corp Annapolis Md  
**EVALUATION OF METHODS FOR CALCULATING SYSTEM OPERATING TIME IN ACCORDANCE WITH RELIABILITY IMPROVEMENT WARRANTY (RIW) CONTRACTUAL TERMS**  
**Final Report, 15 Aug 1977 - 15 Feb 1978**  
 A A Bilodeau and P M Dallosta Mar 1978 192 p refs  
 (Contract F09603-77-A-3104)  
 (AD-A054822 Rept-1928-01-1-1704) Avail NTIS  
 HC A09/MF A01 CSCL 17/7

Arinc Research Corporation conducted a six-month study to investigate the validity of contractual techniques for calculating warranty statistics for the AN/ ARN-118 V TACAN. TACAN field data were collected from eleven US Air Force Bases by Arinc Research. Additional TACAN data submitted by the Air Force were used in support of this study. Average Operating Time AOT Total Operating Hours TOH and Mean Time Between Failures MTBF based on these field data were compared with the values of these parameters calculated by contractual methods. No significant differences between field data estimates and the contractual-methods of calculation were identified. Author (GRA)

**N78-30080#** Arinc Research Corp Annapolis Md  
**AVIONICS COST DEVELOPMENT FOR ALTERNATIVES OF SELECTED AIR TRAFFIC CONTROL SYSTEMS**  
**Final Report**  
 S H Kowalski Oct 1977 71 p refs  
 (Contract DOT-FA76WA-3788)  
 (AD-A054823 Rept-1326-01-3-1758) Avail NTIS  
 HC A04/MF A01 CSCL 17/7

This report presents the results of the cost analysis of avionics required in support of the Upgraded Third Generation Air Traffic Control developments. The systems considered were recommended for evaluation by the Office of Systems Engineering Management of the FAA. The costs of avionics were developed with the aid of a pricing model to provide comparative evaluations based on uniform parametric data varying only in system-peculiar descriptors. Author (GRA)

**N78-30087\*#** National Aeronautics and Space Administration  
 Langley Research Center Langley Station Va  
**STABILITY AND PERFORMANCE CHARACTERISTICS OF A FIXED ARROW WING SUPERSONIC TRANSPORT CONFIGURATION (SCAT 15F-9898) AT MACH NUMBERS FROM 0.60 TO 1.20**

John P Decker and Peter F Jacobs Jun 1978 354 p refs  
 (NASA-TM-78726) Avail NTIS HC A16/MF A01 CSCL 01C

Tests on a 0.015 scale model of a supersonic transport were conducted at Mach numbers from 0.60 to 1.20. Tests of the complete model with three wing planforms, two different leading-edge radii, and various combinations of component parts, including both leading- and trailing-edge flaps, were made over an angle-of-attack range from about -6 deg to 13 deg and at sideslip angles of 0 deg and 2 deg. Author

**N78-30088#** National Aviation Facilities Experimental Center  
 Atlantic City, N J  
**A PRELIMINARY COMPARISON OF THERMAL DECOMPOSITION PRODUCTS OF AIRCRAFT INTERIOR MATERIALS USING THE NATIONAL BUREAU OF STANDARDS SMOKE CHAMBER AND THE COMBUSTION TUBE FURNACE**

Louise C Spertel Ray E Feher and Joe C Spurgeon Mar 1978 34 p refs  
 (AD-A054811 FAA-NA-77-22) Avail NTIS  
 HC A03/MF A01 CSCL 01/3

Twelve aircraft interior materials were burned under standard flaming combustion conditions in a smoke chamber. Each material was also exposed to 600 Celsius in a combustion tube furnace under conditions of oxidative pyrolysis. The combustion products were collected in liquid-filled impingers and the contents were analyzed for hydrogen cyanide, hydrogen sulfide, hydrogen chloride, hydrogen bromide, and formaldehyde by differential pulse polarography; nitrogen dioxide and sulfur dioxide by visible spectrophotometry; and hydrogen fluoride by ion-selective electrode. Carbon monoxide was measured directly by a nondispersive infrared analyzer. The yields of the nine gases are reported in terms of milligrams per gram of material. The toxic gas yields were obtained for each material in the smoke chamber and compared to the yields obtained in the combustion tube furnace. The yields were also compared to those obtained using colorimetric detector tubes. The extent of the correlation of the various procedures is reported. The relative yields of HCl, HCN, and H<sub>2</sub>S were found to be somewhat independent of the exposure conditions. The relative yields of the oxidized gases, CO, HCHO, NO<sub>2</sub>, and SO<sub>2</sub>, are much more dependent on the exposure conditions. G G

**N78-30089\*#** National Aeronautics and Space Administration  
 Langley Research Center Langley Station Va  
**EVALUATION OF SEVERAL SECONDARY TASKS IN THE DETERMINATION OF PERMISSIBLE TIME DELAYS IN SIMULATOR VISUAL AND MOTION CUES**  
 G Kimball Miller Jr and Donald R Riley Aug 1978 68 p refs  
 (NASA-TP-1214 L-12006) Avail NTIS HC A04/MF A01  
 CSCL 05H

The effect of secondary tasks in determining permissible time delays in visual-motion simulation of a pursuit tracking task was examined. A single subject, a single set of aircraft handling qualities, and a single motion condition in tracking a target aircraft that oscillates sinusoidally in altitude were used. In addition to the basic simulator delays, the results indicate that the permissible time delay is about 250 msec for either a tapping task, an adding task, or an audio task, and is approximately 125 msec less than when no secondary task is involved. The magnitudes of the primary task performance measures, however, differ only for the tapping task. A power spectral density analysis basically confirms the result by comparing the root-mean-square performance measures. For all three secondary tasks, the total pilot workload was quite high. S B S

**N78-30090\*#** National Aeronautics and Space Administration  
 Langley Research Center Langley Station Va  
**SIMULATOR STUDY OF THE EFFECT OF VISUAL-MOTION TIME DELAYS ON PILOT TRACKING PERFORMANCE WITH AN AUDIO SIDE TASK**  
 Donald R Riley and G Kimball Miller Jr Aug 1978 74 p refs  
 (NASA-TP-1216 L-11996) Avail NTIS HC A04/MF A01  
 CSCL 05H

The effect of time delay was determined in the visual and motion cues in a flight simulator on pilot performance in tracking a target aircraft that was oscillating sinusoidally in altitude only. An audio side task was used to assure the subject was fully occupied at all times. The results indicate that within the test grid employed, about the same acceptable time delay (250 msec) was obtained for a single aircraft (fighter type) by each of two subjects for both fixed-base and motion-base conditions. Acceptable time delay is defined as the largest amount of delay that can be inserted simultaneously into the visual and motion cues before performance degradation occurs. A statistical analysis of the data was made to establish this value of time delay. Audio side task provided quantitative data that documented the subject's work level. S E S

**N78-30091#** Princeton Univ N J Dept of Aerospace and Mechanical Sciences

**A STUDY OF THE PRECISION HOVER CAPABILITIES OF THE AEROCRANE HYBRID HEAVY LIFT VEHICLES Final Report**

H C Curtiss Jr W F Putnam and R M McKillip Jr Feb 1978 144 p refs  
(Contract N62269-77-C 0074 WF41411000)  
(AD-A054281 AMS-TR-1363 NADC-76341-30) Avail NTIS HC A07/MF A01 CSCL 01/3

An analytical study of the precision hover capabilities of the AEROCRANE based on equations of motion verified by flight tests of a dynamic model is described Two methods of control (cyclic pitch and winglets) are examined A real time simulation of the tasks of hovering a proposed large AEROCRANE in gusts and translating from point to point was conducted to evaluate the two control methods and to compare the AEROCRANE with proposed large helicopters The stability and control characteristics of large AEROCRANES are compared with those of proposed large helicopters and the helicopter handling qualities specifications The results of the study indicate that winglets provide a very effective means of hover control With cyclic control the precision hover capabilities of the AEROCRANE are similar to helicopters of equivalent gross weight Extrapolation of helicopter handling qualities specifications to large gross weight characteristic of proposed large AEROCRANES indicates that the configurations studied can meet these specifications Certain aspects of hovering control which are characteristic of any vehicle which derives an appreciable portion of its lift from buoyancy and carries a heavy sling load are examined Author (GRA)

**N78-30092#** North Carolina State Univ Raleigh Dept of Mechanical and Aerospace Engineering

**INVESTIGATION OF A WING-ROTOR INTERACTION SYSTEM FOR HELICOPTERS Final Report, 1 Sep 1973 - 31 Dec 1977**

Fred R DeJarnette Neal T Frink Mohammad A Takallu Steven L Griffith and James J Murray 6 Mar 1978 67 p refs  
(Grants DAHC04-74-G-0007 DAHC04-75-G-0023 DAAG29-76-G-0045 DAAG29-76-G-0318)  
(AD-A054093 ARO-11945 2-E ARO-1357 2-E) Avail NTIS HC A04/MF A01 CSCL 20/4

This research includes experimental and analytical investigations to determine if favorable interference effects could be obtained from a wing-rotor interaction system Lift and drag forces were measured on a wing mounted in a cantilever fashion from the wall and on a propotor positioned above the wing on a shaft which ran through the ceiling of the test section Test results showed significant increases in lift and decreases in drag for both the wing and the propotor due to favorable interference effects The analytical investigation developed a new lifting surface theory for subsonic wings which can also be interpreted as a vortex lattice method Results were found to be more accurate and converge faster than conventional vortex lattice methods The accuracy compared well with other lifting surface theories but with much smaller computational times GRA

**N78-30093#** Douglas Aircraft Co Inc Long Beach Calif  
**DAMPING, STATIC, DYNAMIC, AND IMPACT CHARACTERISTICS OF LAMINATED BEAMS TYPICAL OF WINDSHIELD CONSTRUCTION Final Report, Jul 1975 - Nov 1976**

G F Rhodes Dec 1977 279 p refs  
(Contract F33615-75-C-3105 AF Proj 2202)  
(AD-A054463 MDC-J6944 AFFDL-TR-76-156) Avail NTIS HC A13/MF A01 CSCL 11/9

This eight section report contains the test plans test results and analyses for a series of monolithic and laminated transparent beams which represent aircraft windshield segments A method of imbedding strain gages mounting strain gages and the application of thermocouples is described The method of data collection was assessed for data reduction that could provide stress-strain relationships These relationships were used for the determination of energy transfer, dynamic response and displacements due to applied loads Selected portions of the test data were correlated with data output in a math model representation of test specimens noted in Section 9 of AFFDL-TR-77-1 Eleven cantilevered damping specimens were tested at

various levels in order to study the damping characteristics for each ply of the laminate utilizing strain recordings The strain responses were checked for accuracy with respect to theoretical strains calculated as a function of the applied loads GRA

**N78-30094#** Air Force Flight Dynamics Lab Wright-Patterson AFB, Ohio

**COMPUTER PROGRAM FOR VIBRATION PREDICTION OF FIGHTER AIRCRAFT EQUIPMENTS Final Report, 21 Mar 1976 - 15 Apr 1977**

Robert W Sevy and Mark N Haller Nov 1977 218 p refs  
(AF Proj 6146)  
(AD-A054598 AFFDL-TR-77-101) Avail NTIS HC A10/MF A01 CSCL 01/3

This study details in-house efforts that culminate in a computer program for the prediction of vibration inputs to equipments mounted in fighter aircraft The computer format is orchestrated about a basic function whose thematic variations are invoked to describe boundary layer excitations and to synthesize a sequence of transfer functions whose operations in turn, define the resultant vibration spectrum beginning at the aircraft surface and proceeding inward to the designated equipment Program inputs specify flight conditions aircraft structural classes equipment weight equipment locational coordinates and mounting categories in order to characterize vibration inputs of fighter aircraft equipments during flight attitudes ranging from straight and level states to a variety of significant flight maneuvers and phases Program outputs digital and graphical are designed to provide the direct spectral information necessary to assemble sequential vibration histories corresponding to fighter aircraft mission profiles Author (GRA)

**N78-30095#** Boeing Vertol Co Philadelphia Pa  
**HELICOPTER TRANSMISSION VIBRATION AND NOISE REDUCTION PROGRAM VOLUME 2 USER'S MANUAL Final Report, Jun 1974 - Oct 1977**

John J Sciarra Robert W Howells Joseph W Lenski Jr and Raymond J Drago Mar 1978 430 p refs  
(Contract DAAJ02-74-C-0040, DA Proj 1G2-62207-AH-8902)  
(AD-A054827 D210-11236-2-Vol-2, USARTL-TR-78-2B) Avail NTIS HC A19/MF A01 CSCL 01/3

The objective of the Helicopter Transmission Vibration/Noise Reduction Program was to generate analytical tools for the prediction and reduction of helicopter transmission vibration/noise that provide the capability to perform trade studies during the design stage of a program Application of this optimization capability yields drive train components that are dynamically quiet with reduced vibration/noise levels and inherently longer life The work conducted under this program is highly computer-oriented and makes extensive use of several computer programs as indicated in the technical report (Volume I) This User's Manual describes these computer programs, presents rationale for their use and discusses their application Author (GRA)

**N78-30097#** Royal Aircraft Establishment Farnborough (England)

**DIVERSE FORMS AND DERIVATIONS OF THE EQUATIONS OF MOTION OF DEFORMABLE AIRCRAFT AND THEIR MUTUAL RELATIONSHIP**

D L Woodcock Jun 1977 123 p refs  
(RAE-TR-77077 BR59543) Avail NTIS HC A06/MF A01

The equations of motion of an aircraft for small perturbations from flight with constant linear and zero angular velocities, are developed in detail using constant-velocity or body-fixed axes encastre or free-free modes displacement or velocity body freedom coordinates The relationship is clearly stated between these various forms, and with other proposed forms, in particular those using mean-body axes Author (ESA)

**N78-30098#** Royal Aircraft Establishment Bedford (England) Structures Dept

**FLIGHT MEASUREMENTS OF THE EFFECTS OF SIMULATED LEADING-EDGE EROSION ON HELICOPTER BLADE STALL, TORSIONAL LOADS AND PERFORMANCE**

P Brotherhood and D W Brown London Aeron Res Council

1978 31 p refs Supersedes RAE-TR-76039 ARC-37053  
(ARC-R/M-3809 RAE-TR-76039 ARC-37053) Avail NTIS  
HC A03/MF A01 HMSO £3 50 PHI \$13 45

The leading edges of the main rotor blades of a Wessex helicopter were artificially roughened to simulate light to moderate erosion of unprotected light alloy blades Pitch link loads were measured in forward flight for various spanwise extents of leading-edge roughness and the values of forward speed at which a pre-set limit of oscillatory pitch link load was reached were determined This limit was set so as to avoid excessive fatigue damage to the modified control linkage With a representative length of roughness the speed at which the limit load occurred was reduced by 24 kn This marked reduction was associated with premature blade stall, detected by trailing edge pressure measurements and subsequent stall flutter with an increased power requirement Author (ESA)

**N78-30099#** Advisory Group for Aerospace Research and Development, Paris (France)

**FIGHTER AIRCRAFT DESIGN**

Jun 1978 292 p refs Partly in ENGLISH and FRENCH Presented at the Multi-Panel Symp on Fighter Aircraft Design, Florence, 3-6 Oct 1977 (AGARD-CP-241, ISBN-92-835-0215-9) Avail NTIS HC A13/MF A01

The state of technology as related to future fighter aircraft design is assessed in terms of military requirements for the 80s System design approach, aerodynamics and aircraft configurations propulsion structures design avionics/guidance and human factors are among to topics covered

**N78-30104#** Dornier-Werke G m b H, Friedrichshafen (West Germany)

**ADVANCED CONTROL CONCEPTS FOR FUTURE FIGHTER AIRCRAFT**

Horst Wunnenberg and Wolfgang J Kubbat (Messerschmitt-Boelkow-Blohm G m b H Ottobrunn West Ger) In AGARD Fighter Aircraft Design Jun 1978 15 p refs

Avail NTIS HC A13/MF A01

In detail the possibilities and limits of new control concepts such as active control technology and reduced static stability and the criteria for the corresponding control surface layout are discussed Requirements and the technical realization methods for a modern fly by wire digital control technology are presented Comments on current research programs and future prospects are given JMS

**N78-30105#** McDonnell Aircraft Co St Louis Mo

**FIGHTER SUPERIORITY BY DESIGN**

W P Murden H D Alts, and M L Ramey In AGARD Fighter Aircraft Design Jun 1978 16 p

Avail NTIS HC A13/MF A01

Aspects of the F-18 program are discussed in terms of increasing combat effectiveness and decreasing combat costs Combat performance firepower and weapon system capability multimission versatility increased reliability and maintainability and combat survivability are among the factors considered JMS

**N78-30106#** Avions Marcel Dassault-Breguet Aviation Saint-Cloud (France) Div des Etudes Avancees

**AERODYNAMICS OF THE NEW GENERATION OF COMBAT AIRCRAFT WITH DELTA WINGS [AERODYNAMIQUE DE LA NOUVELLE GENERATION D'AVIONS DE COMBAT A AILE DELTA]**

M Pierre Bohn In AGARD Fighter Aircraft Design Jun 1978 13 p In FRENCH

Avail NTIS HC A13/MF A01

Utilization of various aerodynamic configurations for modern delta wing combat aircraft is discussed in relation to approach speeds and reducing impact damage at Supersonic speeds Mission requirements such as maneuverability were examined in detail

and principle reasons for the discontinuation of fixed winged aircraft for combat were illustrated Transl by B B

**N78-30107#** Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio

**SUPERCRAUISER FIGHTER DAHLEM**

L Earl Miller and Valentine Dahlem III In AGARD Fighter Aircraft Design Jun 1978 16 p

Avail NTIS HC A13/MF A01

A fighter aircraft that cruises efficiently at supersonic speeds and is effective in air to air combat is considered Supersonic cruise performance and transonic maneuvering requirements are emphasized Speed advantage ability to engage or disengage at will maintaining control over the combat arena and target acquisition are among the factors analyzed From differential game technology, supercruiser maneuvering requirements are determined as a function of the threats maneuvering capability Wind tunnel results indicate that a small single aircraft can be configured to produce the level of efficiency necessary for supersonic cruise JMS

**N78-30108#** Naval Air Systems Command Washington D C  
**ANALYSIS OF ADVANCED VARIABLE CAMBER CONCEPTS**

R F Siewert and R E Whitehead (ONR Arlington Va) In AGARD Fighter Aircraft Design Jun 1978 21 p refs

Avail NTIS HC A13/MF A01

A survey of variable camber devices used on contemporary fighter aircraft to improve maneuverability in the air combat flight regime is presented Variable camber concepts which offer potential for even greater benefits on future fighter aircraft designs are discussed Finally some analysis is presented which provides insight into the advantages that are achieved in various off design conditions with the use of these variable camber concepts JMS

**N78-30109#** Motoren- und Turbinen-Union Muenchen G m b H (West Germany)

**VARIABLE-CYCLE ENGINE FIGHTER AIRCRAFT ADVANCE IN PERFORMANCE AND DEVELOPMENT PROBLEMS**

H Grieb W Weiler, and G Weist In AGARD Fighter Aircraft Design Jun 1978 16 p refs Sponsored by Min of Defence of Federal Rep of Ger

Avail NTIS HC A13/MF A01

The requirements on engines for civil and military supersonic aircraft and the interest in variable cycle engines are explained In addition the variable cycle engine concepts and their function are described briefly For two concepts of variable cycle engines for fighter aircraft the operating characteristics performance data and leading design features are discussed These examples are used to contrast the advances offered by such engines against the problems to be overcome It is shown that whereas the desired flexibility in operating characteristic and performance is feasible the extra engine weight and complexity compared with conventional engines is very substantial For a fighter aircraft a simplified comparison of effectivity is made between the installation of variable cycle engine concepts and two types of conventional engines with different bypass ratio It is shown that the extra weight to be expected with variable cycle engines investigated so far does not justify their future application JMS

**N78-30110#** National Gas Turbine Establishment Farnborough (England)

**INTAKE DESIGN FOR FIGHTER AIRCRAFT**

J Dunham In AGARD Fighter Aircraft Design Jun 1978 15 p refs Sponsored in part by RAE

Avail NTIS HC A13/MF A01

An outline is given of the requirements placed upon the intake designer Low external drag high intake pressure recovery, and low distortion of the engine face flow are demanded over

a wide range of aircraft maneuvers at subsonic speeds as well as through the transonic and supersonic speed ranges. All this is to be accomplished at minimum cost, weight, and complexity. Some of the factors involved in the design are discussed. These include intake location, blunt cowl lips, and their influence on incidence, range, matching of engine flow demand with intake capacity, dynamic distortion measurement, and the control system for a variable intake. An assessment of the state of the art, research requirements, and possible technological advances is given. J M S

**N78-30111#** Air Force Aero Propulsion Lab, Wright-Patterson AFB, Ohio, Turbine Engine Div  
**ADVANCE NOZZLE TECHNOLOGY**  
Lawrence D Wolfe and Arthur E Fanning / In AGARD Fighter Aircraft Design Jun 1978 31 p

Avail NTIS HC A13/MF A01

The exhaust concepts developed as design options for use on turbine engines which are to power advanced fighter aircraft are discussed with emphasis on nonaxisymmetric nozzle configurations. Nozzle performance, cooling effectiveness, and structural integrity at minimum weight are among the topics studied. Variations in thrust vector schedule, aircraft wing loading, and thrust loading are included. An example is used to illustrate the point that certain nonaxisymmetric nozzle and thrust vectoring schemes introduce an additional degree of complexity into the procedures necessary to properly account for the applied forces. J M S

**N78-30113#** Messerschmitt-Boelkow-Blohm G m b H, Munich (West Germany)  
**IMPACT OF ACTIVE CONTROL ON STRUCTURES DESIGN**  
O Sensburg and H Zimmermann (Vereingte Flugtechn Werke-Fokker G m b H Bremen West Ger) / In AGARD Fighter Aircraft Design Jun 1978 26 p refs

Avail NTIS HC A13/MF A01

A review of active control technologies is given with emphasis on fighter aircraft structures design. Artificial lateral stability, longitudinal stability, maneuver load control, and gust load alleviation are considered along with fatigue reduction, ride quality improvement, and active flutter suppression. J M S

**N78-30114#** Departement Structures B E Aerospatiale, Toulouse (France)  
**NEW STRUCTURES MADE OF COMPOSITE MATERIALS FOR HIGH PERFORMANCE COMBAT AIRCRAFT [STRUCTURES NOUVELLES EN MATERIAUX COMPOSITES A HAUTES PERFORMANCES POUR AVIONS DE COMBAT]**  
Gilbert Correge / In AGARD Fighter Aircraft Design Jun 1978 18 p In FRENCH  
Avail NTIS HC A13/MF A01

Composite materials utilized in aircraft construction are described. Other areas of study are the following: (1) Types of composite structures utilized, (2) Materials, (3) Principles of local reinforcement, and (4) Protection against lightning strike. Transl by B B

**N78-30115#** Hawker Siddeley Aviation Ltd, Kingston upon Thames (England)  
**METAL TECHNOLOGY FOR FUTURE AIRCRAFT DESIGN**  
Roger S Dabbs / In AGARD Fighter Aircraft Design Jun 1978 16 p  
Avail NTIS HC A13/MF A01

Requirements of a material to be used for aircraft structures are discussed. These include strength and stiffness, service life, vulnerability, reparability, inspectability, and cost effectiveness. Aluminum alloys, titanium alloys, and steels are among the metallic materials considered for application to future aircraft structures. The performance of metallic materials and graphite composites is compared. J M S

**N78-30116#** Messerschmitt-Boelkow-Blohm G m b H, Munich (West Germany), Dept of Human Engineering  
**DISPLAY SYSTEMS AND COCKPIT DESIGN**  
Ruediger Seifert and Hans Denkscherz / In AGARD Fighter Aircraft Design Jun 1978 11 p

Avail NTIS HC A13/MF A01

A concept for a new cockpit design technology is presented. The need for a technology is dictated by the technical requirement for saving cockpit weight and space, resulting from the high g operations requirements, and from the operational requirement for limiting the quantitative personnel requirements. The basis for the technology is given by the present knowledge concerning the information processing capabilities of man, and by the empirical results of measurements of the time budget of man in man machine operations. From this the display and control modalities are derived, which ensure better utilization of the pilot's capabilities in the future fighter aircraft. This concept is considered to increase the system capacity of manned fighter aircraft, compared with the equipment overloaded aircraft of today. The principle allocation of the display and control function to the equipment and an example for the required characteristics for the functions in accordance to the time budget considerations are given. J M S

**N78-30117#** Boeing Co, Seattle, Wash  
**APPLICATION TECHNIQUES FOR DIGITAL FLIGHT CONTROL SYSTEMS**  
Donald L Martin / In AGARD Fighter Aircraft Design Jun 1978 12 p refs

Avail NTIS HC A13/MF A01

System design and implementation considerations in application of digital processing and signal transmission techniques to flight control systems are discussed. The digital flight control design cycle and both the overall similarity with analog implementation and the differences associated with software requirements specification are covered. Design problems that result from the digital processing are reviewed along with software development and testing at both the software and system development levels. The three channel redundant flight control computer used on the Boeing YC-14 advanced medium STOL transport is described along with advantages of digital applications. J M S

**N78-30118#** British Aircraft Corp, Warton (England), Military Aircraft Div  
**THE DESIGN OF A HIGH g COCKPIT**  
A G Barnes / In AGARD Fighter Aircraft Design Jun 1978 12 p refs

Avail NTIS HC A13/MF A01

The physiological factors of operating under high g are discussed. The geometric aspects of reclining the pilot's seat, in order to achieve a measure of g alleviation, are illustrated. The implications of such a change with respect to displays and controls are considered along with techniques which offer solutions to the problems associated with displays and controls. Radical changes in cockpit layout are implied. J M S

**N78-30119#** Institute for Defense Analyses, Arlington Va, Cost Analysis Group  
**THE FEASIBILITY OF ESTIMATING AVIONICS SUPPORT COSTS EARLY IN THE ACQUISITION CYCLE VOLUME 1 THE BASIC REPORT Final Report, 17 Jan - Sep 1977**  
John D Morgan and Aaron B Fuller Sep 1977 248 p  
(Contract DAHC15-73-C-0200)  
(AD-A054016 AD-E500025 P-1292-Vol-1) Avail NTIS HC A11/MF A01 CSCL 15/5

This paper reports on research to determine the feasibility of developing methods to estimate early in the system acquisition cycle the potential support cost inputs of alternative avionics components envisioned for Air Force and Navy fighter aircraft. Support costs are defined as those costs incurred at the organizational, intermediate, and depot levels to maintain avionics equipment and the costs of avionics spares and repair parts support. The results of the study are presented in two volumes.

Volume I reviews and evaluates current methods used in industry and in the Air Force and Navy to estimate these avionics support costs. Finally the paper concludes that it is feasible and desirable to prepare these estimates for avionics support costs. The specific method to be adopted depends on the amount of resources OSD wishes to devote to this effort. Volume II is a compilation of appendixes containing additional material to support the basic report including summary evaluations of forty-eight key documents encountered in the literature search. GRA

**N78-30120#** RCA Government and Commercial Systems Burlington, Mass. Automated Systems Div  
**HMSD DEMONSTRATION MODEL DEVELOPMENT Final Report, Sep 1976 - Dec 1977**  
G T Burton and B R Clay Dec 1977 63 p  
(Contract N62269-76-C-0390)  
(AD-A054437) Avail NTIS HC A04/MF A01 CSCL 01/4

This Final Report summarizes the status of the Holographic Horizontal Situation Display effort. This program's objective was the development and optimization of the techniques and hardware required to demonstrate a bright high contrast annotatable multicolor display. Display hardware with a CRT tape transport and source tapes were developed that demonstrate the characteristics of the focussed image holographic storage technique as applied to the annotated moving map display requirement of the HMSD application of the AIDS program. Author (GRA)

**N78-30121\*#** Pratt and Whitney Aircraft Group East Hartford Conn Commercial Products Div  
**SHORT-TERM PERFORMANCE DETERIORATION IN JT9D-7A(SP) ENGINE 695743**  
R J Bouchard W R Beyerly and G P Sallee 30 Jun 1978 236 p  
(Contract NAS3-20632)  
(NASA-CR-135431 PWA-5512-17) Avail NTIS HC A11/MF A01 CSCL 21E

The level of performance deterioration that occurred during early service was studied and also the contribution of each engine module to the overall level of engine performance deterioration. To assist in the distribution of the performance losses to the module level, testing with expanded experimental instrumentation was accomplished to permit direct measurement of module performance. An analytical teardown of the engine was accomplished to permit assignment of module performance losses to individual mechanical damage mechanisms including blade and seal wear, roughness and thermal distortion of turbine parts. The results of the testing show that the engine deteriorated 1.5 percent in thrust specific fuel consumption from its performance when new. Initial testing which included water washing showed that 0.2 percent in performance deterioration was due to surface contamination (dirt) and 0.1 percent was due to drift of the engine vane control system leaving 1.2 percent in basic TSFC deterioration. This 1.2 percent TSFC loss was distributed among the engine modules with 0.6 percent caused by clearance changes, 0.4 percent loss due to thermal distortion and 0.2 percent loss due to increased roughness of the fan and low-pressure compressor airfoils. G G

**N78-30122\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**COMPUTER PROGRAM FOR THE DESIGN AND OFF-DESIGN PERFORMANCE OF TURBOJET AND TURBOFAN ENGINE CYCLES**

Shelby J Morris Jun 1978 76 p refs  
(NASA-TM-78653) Avail NTIS HC A05/MF A01 CSCL 21E  
The rapid computer program is designed to be run in a stand-alone mode or operated within a larger program. The computation is based on a simplified one-dimensional gas turbine cycle. Each component in the engine is modeled thermodynamically. The component efficiencies used in the thermodynamic modeling are scaled for the off-design conditions from input design point values using empirical trends which are included in the computer code. The engine cycle program is capable of producing reasonable engine performance prediction with a minimum of computer execute time. The current computer execute

time on the IBM 360/67 for one Mach number one altitude, and one power setting is about 0.1 seconds. The principal assumption used in the calculation is that the compressor is operated along a line of maximum adiabatic efficiency on the compressor map. The fluid properties are computed for the combustion mixture but dissociation is not included. The procedure included in the program is only for the combustion of JP-4, methane or hydrogen. G G

**N78-30123\*#** McDonnell Aircraft Co St Louis Mo  
**F-15 INLET/ENGINE TEST TECHNIQUES AND DISTORTION METHODOLOGIES STUDIES VOLUME 1 TECHNICAL DISCUSSION Final Report**  
C H Stevens E D Spong and M S Hammock Jun 1978 248 p refs 9 Vol  
(Contract NAS4-2364)  
(NASA-CR-144866) Avail NTIS HC A11/MF A01 CSCL 21E

Peak distortion data taken from a subscale inlet model were studied to determine if the data can be used to predict peak distortion levels for a full scale flight test vehicle and to provide a better understanding of the time variant total pressure distortion and the attendant effects of Reynolds number/scale and frequency content. The data base used to accomplish this goal covered a range from Mach 0.4 to 2.5 and an angle of attack range from -10 degrees to +12 degrees. Data are presented which show that (1) increasing the Reynolds number increases total pressure recovery, decreases peak distortion and decreases turbulence; (2) increasing the filter cutoff frequency increases both peak distortion and turbulence; and (3) the effect of engine presence on total pressure recovery, peak distortion and turbulence is small but favorable. B B

**N78-30124\*#** McDonnell Aircraft Co St Louis Mo  
**F-15 INLET/ENGINE TEST TECHNIQUES AND DISTORTION METHODOLOGIES STUDIES VOLUME 2 TIME VARIANT DATA QUALITY ANALYSIS PLOTS Final Report**  
C H Stevens E D Spong and M S Hammock Jun 1978 64 p 9 Vol  
(Contract NAS4-2364)  
(NASA-CR-144867) Avail NTIS HC A04/MF A01 CSCL 21E

Time variant data quality analysis plots were used to determine if peak distortion data taken from a subscale inlet model can be used to predict peak distortion levels for a full scale flight test vehicle. For abstract see N78-30123. B B

**N78-30125\*#** McDonnell Aircraft Co St Louis Mo  
**F-15 INLET/ENGINE TEST TECHNIQUES AND DISTORTION METHODOLOGIES STUDIES VOLUME 3 POWER SPECTRAL DENSITY PLOTS Final Report**  
C H Stevens E D Spong and M S Hammock Jun 1978 103 p refs 9 Vol  
(Contract NAS4-2364)  
(NASA-CR-144868) Avail NTIS HC A06/MF A01 CSCL 21E

Power spectral density plots were used to determine if peak distortion data taken from a subscale inlet model can be used to predict peak distortion levels for a full scale flight test vehicle. For abstract see N78-30123. B B

**N78-30126\*#** McDonnell Aircraft Co St Louis Mo  
**F-15 INLET/ENGINE TEST TECHNIQUES AND DISTORTION METHODOLOGIES STUDIES VOLUME 4 AUTOCORRELATION FUNCTIONS Final Report**  
C H Stevens E D Spong and M S Hammock Jun 1978 99 p 9 Vol  
(Contract NAS4-2364)  
(NASA-CR-144869) Avail NTIS HC A05/MF A01 CSCL 21E

Autocorrelation function plots were used to determine if peak distortion data taken from a subscale inlet model can be used to predict peak distortion levels for a full scale flight test vehicle. For abstract see N78-30123. B B



**N78-30127\*#** McDonnell Aircraft Co St Louis Mo  
**F-15 INLET/ENGINE TEST TECHNIQUES AND DISTORTION  
 METHODOLOGIES STUDIES VOLUME 5 EFFECT OF  
 FILTER CUTOFF FREQUENCY ON TURBULENCE PLOTS**  
**Final Report**  
 C H Stevens E D Spong and M S Hammock Jun 1978  
 103 p 9 Vol  
 (Contract NASA-2364)  
 (NASA-CR-144870) Avail NTIS HC A06/MF A01 CSCL  
 21E

The effect of filter cutoff frequency on turbulence plots were used to determine if peak distortion data taken from a subscale inlet model can be used to predict peak distortion levels for a full scale flight test vehicle For abstract see N78-30123 B B

**N78-30128\*#** McDonnell Aircraft Co St Louis Mo  
**F-15 INLET/ENGINE TEST TECHNIQUES AND DISTORTION  
 METHODOLOGIES STUDIES VOLUME 6 DISTORTION  
 ANALYSIS PLOTS Final Report**  
 C H Stevens E D Spong and M S Hammock Jun 1978  
 1056 p 9 Vol  
 (Contract NASA-2364)  
 (NASA-CR-144871) Avail NTIS HC A99/MF A01 CSCL  
 21E

Distortion analysis plots were used to determine if peak distortion data taken from a subscale inlet model can be used to predict peak distortion levels for a full scale flight test vehicle For abstract see N78-30123 B B

**N78-30129\*#** McDonnell Aircraft Co St Louis Mo  
**F-15 INLET/ENGINE TEST TECHNIQUES AND DISTORTION  
 METHODOLOGIES STUDIES VOLUME 7 CROSS  
 CORRELATION FUNCTIONS Final Report**  
 C H Stevens E D Spong and M S Hammock Jun 1978  
 49 p 9 Vol  
 (Contract NASA-2364)  
 (NASA-CR-144872) Avail NTIS HC A03/MF A01 CSCL  
 21E

Cross correlation function plots were used to determine if peak distortion data taken from a subscale inlet model can be used to predict peak distortion levels for a full scale flight test vehicle For abstract see N78-30123 B B

**N78-30130\*#** McDonnell Aircraft Co St Louis Mo  
**F-15 INLET/ENGINE TEST TECHNIQUES AND DISTORTION  
 METHODOLOGIES STUDIES VOLUME 8 CROSS  
 SPECTRAL DENSITY PLOTS Final Report**  
 C H Stevens E D Spong and M S Hammock Jun 1978  
 58 p 9 Vol  
 (Contract NASA-2364)  
 (NASA CR 144873) Avail NTIS HC A04/MF A01 CSCL  
 21E

Cross spectral density plots were used to determine if peak distortion data taken from a subscale inlet model can be used to predict peak distortion levels for a full scale flight test vehicle For abstract see N78-30123 B B

**N78-30131\*#** McDonnell Aircraft Co St Louis Mo  
**F-15 INLET ENGINE TEST TECHNIQUES AND DISTORTION  
 METHODOLOGIES STUDIES VOLUME 9 STABILITY  
 AUDITS Final Report**  
 C H Stevens E D Spong and M S Hammock Jun 1978  
 35 p 9 Vol  
 (Contract NASA-2364)  
 (NASA-CR-144874) Avail NTIS HC A03/MF A01 CSCL  
 21E

Stability audit plots were used to determine if peak distortion data taken from a subscale inlet model can be used to predict peak distortion levels for a full scale flight test vehicle For abstract see N78-30123 B B

**N78-30138\*#** National Aeronautics and Space Administration  
 Langley Research Center Langley Station Va  
**AIRPLANE STABILITY CALCULATIONS WITH A CARD  
 PROGRAMMABLE POCKET CALCULATOR**

Windsor L Sherman Aug 1978 63 p refs  
 (NASA-TM-78678 L-12066) Avail NTIS HC A04/MF A01  
 CSCL 01C

Programs are presented for calculating airplane stability characteristics with a card programmable pocket calculator These calculations include eigenvalues of the characteristic equations of lateral and longitudinal motion as well as stability parameters such as the time to damp to one-half amplitude or the damping ratio The effects of wind shear are included Background information and the equations programmed are given The programs are written for the International System of Units the dimensional form of the stability derivatives and stability axes In addition to programs for stability calculations an unusual and short program is included for the Euler transformation of coordinates used in airplane motions The programs have been written for a Hewlett Packard HP-67 calculator However, the use of this calculator does not constitute an endorsement of the product by the National Aeronautics and Space Administration  
 Author

**N78-30139\*#** Virginia Polytechnic Inst and State Univ  
 Blacksburg  
**STRUCTURAL DYNAMICS, STABILITY, AND CONTROL OF  
 HELICOPTERS**  
 Leonard Meirovitch and Arthur L Hale Jul 1978 55 p refs  
 (Grant NsG-1114)  
 (NASA-CR-158909) Avail NTIS HC A04/MF A01 CSCL  
 01C

The dynamic synthesis of gyroscopic structures consisting of point-connected substructures is investigated The objective is to develop a mathematical model capable of an adequate simulation of the modal characteristics of a helicopter using a minimum number of degrees of freedom The basic approach is to regard the helicopter structure as an assemblage of flexible substructures The variational equations for the perturbed motion about certain equilibrium solutions are derived The discretized variational equations can be conveniently exhibited in matrix form and a great deal of information about the system modal characteristics can be extracted from the coefficient matrices The derivation of the variational equations requires a monumental amount of algebraic operations To automate this task a symbolic manipulation program on a digital computer is developed Author

**N78-30141\*#** National Aeronautics and Space Administration  
 Langley Research Center Langley Station Va  
**SIMULATION STUDY OF THE OSCILLATORY LONGITUDINAL  
 MOTION OF AN AIRPLANE AT THE STALL**  
 William H Phillips Aug 1978 43 p refs  
 (NASA-TP-1242 L-12064) Avail NTIS HC A03/MF A01  
 CSCL 01C

Hybrid simulation of the longitudinal motion of a straight-wing airplane at the stall was studied to investigate the effect of hysteresis in the development of lift and pitching moments on the wing as a function of angle of attack on the occurrence of longitudinal oscillations at the stall Flight data for the simulated airplane and for various other airplanes are shown for the simulated airplane and for comparison The results show that oscillations similar to those measured in flight may be obtained by incorporating hysteresis in the lift and pitching-moment curves S B S

**N78-30142#** Massachusetts Inst of Tech Cambridge Dept  
 of Aeronautics and Astronautics  
**EXPERIMENTAL INVESTIGATION OF GUST RESPONSE OF  
 HINGELESS HELICOPTER ROTORS M S Thesis**  
 Charles A Vehlou Jun 1977 105 p refs  
 (AD-A054752) Avail NTIS HC A06/MF A01 CSCL 01/3

The response to wind gusts of a 1/10-scale hingeless helicopter rotor model in hovering and forward flight is studied experimentally through wind tunnel testing The experimental program involving design construction and testing of a five-foot-diameter rotor utilizing either three NACA 0012 planform blades or one operable blade with two dummy blades is described The rotor design is such that the torsional stiffness of the blade assembly as well as the blade chordwise center-of-gravity location can be varied during the various phases of the test Wind tunnel testing incorporates the variation of wind tunnel speed and the

application of variable frequency, sinusoidal waveform gusts The flap lag and torsional response of the rotor in its various configurations was measured and compared with theoretical predictions  
Author (GRA)

**N78-30143#** Royal Aircraft Establishment Farnborough (England) Flight Systems Dept  
**A PYRAMID SKEWED AXIS SENSOR SET FOR MULTIPLEX FLIGHT CONTROL SYSTEMS**

D Kimberley London Aeron Res Council 1978 35 p refs  
Supersedes RAE-TR-75055 ARC-36355  
(ARC-R/M-3808 BR61586 RAE-TR-75055 ARC-36355)  
Avail NTIS HC A03/MF A01 HMSO £4 PHI \$15 30

In order to meet the two defect survival capability in future full-time flight control systems, one approach is to use four identical sensors in each axis giving a total of twelve for a three-axis system An alternative eight sensor pyramid arrangement has been developed which offers a similar two defect survival capability in all three axes leading to reduced cost and maintenance effort but with slightly larger transients following failure of a sensor The pyramid arrangement can also be used for fail safe systems reducing the number of sensors from six to four or alternatively for a twelve gyro four defect survival configuration  
Author (ESA)

**N78-30182#** California Univ, Livermore Lawrence Livermore Lab

**ROTOR DESIGN IMPLICATIONS FOR COMPOSITE MATERIAL PROPERTIES**

R H Toland 25 Oct 1977 7 p Presented at the Flywheel Technol Symp, San Francisco, 5-7 Oct 1977  
(Contract W-7405-eng-48)  
(UCRL-80117 Conf-771053-8) Avail NTIS HC A02/MF A01

The role and needs of materials research and characterization are defined within the context of the rotor design and analysis process In particular, material/geometry tailoring permits design optimization Composites can be utilized most efficiently when fiber properties govern rotor performance and reliability Time-dependent properties are essential for practical and reliable rotor design  
ERA

**N78-30213#** Battelle Columbus Labs Ohio  
**ENGINEERING DATA ON NEW AEROSPACE MATERIALS STRUCTURAL MATERIALS Final Summary Report, Feb 1975 - Sep 1977**

Omar Deel Wright-Patterson AFB, Ohio AFML Dec 1977 116 p  
(Contract F33615-75-C-5065 AF Proj 7381)  
(AD-A054461, AFML-TR-77-198) Avail NTIS  
HC A06/MF A01 CSCL 11/6

The major objectives of this program were to evaluate newly developed materials of interest to the Air Force for potential airframe structural usage and to provide data sheet-type presentations of engineering data for these materials The materials effort on this program concentrated on MP 159 Multiphase Bar Ti-6Al-2Sn-4Zr-2Mo castings 7175-T73511 and -T76511 extrusions 7050-T73 Extrusions, Ti-6Al-4V PM Product Ti-6Al-4V superplastically formed product Ti-10V-2Fe-3Al Alloy Bar and 4330 M Steel Forgings The properties investigated include tension, compression, shear bearing impact fracture toughness, fatigue creep and stress-rupture and stress corrosion at selected temperatures  
Author (GRA)

**N78-30247#** Air Force Materials Lab Wright-Patterson AFB Ohio Elastomers and Coatings Branch  
**FUNDAMENTALS OF NONCURING SEALANTS FOR AIRCRAFT FUEL TANKS Final Report, Jan. 1975 - Jan 1977**

Warren R Griffin Dec 1977 95 p refs  
(AD-A054627 AFML-TR-77-195) Avail NTIS  
HC A05/MF A01 CSCL 11/1

The need for efficient space utilization in military aircraft has led to the use of wing and fuselage cavities as fuel tanks Of the three methods of sealing these cavities (filleting faying and channel) channel sealants are the least understood and have the most contrast between behavior and requirements Potential failure mechanisms were identified against the thermal, chemical and physical aspects of the fuel tank environment Thermal degradation low temperature embrittlement thermal expansion and viscosity reduction were mechanisms associated with the -54 C to +177 C temperature range Hydrolysis oxidation closed system reversion and crosslinking were associated with the chemical aspect Fuel swelling of the sealant extraction by fuel system pressure vibration shear and adhesion/cohesion were associated with the physical aspect Selected polymers with a wide variety of formulating ingredients were evaluated as channel sealants in laboratory sized test apparatus to confirm the suspected failure mechanisms The results have been digested as engineering principles that govern the behavior of channel sealants Application of these principles resulted in some immediate benefits and a basis for long range sealant development  
GRA

**N78-30259#** Southwest Research Inst San Antonio Tex Army Fuels and Lubricants Research Lab  
**EFFECTS OF HIGH AVAILABILITY FUELS ON COMBUSTOR PROPERTIES Interim Report**

C A Moses and D W Naegeli Jan 1978 100 p refs  
(Contracts DAAG53-76-C-0003 DAAK70-78-C-0001)  
(AD-A054229, AFLRL-101) Avail NTIS HC A05/MF A01 CSCL 21/5

Engines now in production or under development were designed for satisfactory performance and life on current specification fuels many of these engines may not be able to handle the stress implied by a broadened fuel specification Among the fuel properties of greatest concern to turbine engine combustion are the aromatic content, the distillation curve and the viscosity Fuel bound nitrogen is one new property which has emerged from the use of syncrude fuels because of additional NOx found in the exhaust  
GRA

**N78-30271** Aeronautical Research Labs Melbourne (Australia)  
**AIRCRAFT STRUCTURAL FATIGUE**

Apr 1977 504 p refs Proc held in Melbourne 19-20 Oct 1976  
(ARL/Struc-Rept-363 ARL/Mat-Rept-104 AR-000-724)  
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The assessment of structural fatigue is discussed in terms of ensuring safe fatigue lives for aircraft structures and components Fundamentals of fatigue and of fracture mechanics data acquisition and interpretation and structural life prediction are included along with current research and development in structural and materials fatigue

**N78-30272** Aeronautical Research Labs Melbourne (Australia)  
**SAFETY AGAINST FATIGUE IN FLIGHT A PERSPECTIVE OF AUSTRALIAN EXPERIENCE AND RESEARCH**

F H Hooke *In its* Aircraft Structural Fatigue Apr 1974 p 5-22 refs  
Copyright Avail Issuing Activity

Research efforts in aircraft structures and materials to reduce metal fatigue and improve aircraft safety are reviewed Endurance of structures and materials, the loading actions on the structure and inspection methods to maintain structural integrity are among the factors discussed  
J M S

**N78-30273** Aeronautical Research Labs Melbourne (Australia)  
**MECHANISMS OF FATIGUE AND FRACTURE**

S P Lynch *In its* Aircraft Structural Fatigue Apr 1977 p 25-55 refs  
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Overload fracture liquid-metal embrittlement, stress corrosion cracking, fatigue crack initiation fatigue crack growth and corrosion fatigue are discussed and related Observations suggest

that crack growth in many metallic materials generally occurs by plastic flow and that fracture characteristics are determined mainly by the distribution of slip around crack tips This distribution governs ductile versus brittle behavior and is influenced by microstructure stress intensity temperature and environment the effects of environment are attributed mainly to chemisorption at crack tips and are discussed in some detail Changes in microstructure induced by cyclic stress and the association of such changes with initiation and growth of fatigue cracks, are also examined Relationships between crack growth rates and stress intensity factors, and the application of mechanistic understanding are then briefly discussed J M S

**N78-30274** Aeronautical Research Labs, Melbourne (Australia)  
**FRACTURE MECHANICS FUNDAMENTALS WITH REFERENCE TO AIRCRAFT STRUCTURAL APPLICATIONS**

B C Hoskin *In its Aircraft Structural Fatigue* Apr 1977 p 57-89 refs

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Fracture mechanics and its applications to problems associated with cracked or potentially cracked aircraft structures is considered Such applications include assessment of the residual strength of cracked components and also the prediction of fatigue crack growth Limitations of fracture mechanics likely to be of importance in aircraft structural applications are emphasized J M S

**N78-30276** Aeronautical Research Labs, Melbourne (Australia)  
**GUST MEASUREMENTS AND THE N SUB 0 PROBLEM**

Douglas John Sherman *In its Aircraft Structural Fatigue* Apr 1977 p 103-135 refs

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The problem of interpreting level crossing counts superimposed on a lesser number of large fluctuations is considered It is shown that if fluctuations smaller than some specified amount are removed from a time history, the number of level crossings is reduced An empirical formula is given for the amount of the reduction in a time series of atmospheric turbulence velocities J M S

**N78-30277** Aeronautical Research Labs, Melbourne (Australia)  
**DEVELOPMENT OF A LOAD SEQUENCE FOR A STRUCTURAL FATIGUE TEST**

P J Howard *In its Aircraft Structural Fatigue* Apr 1977 p 137-148 refs

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A method for generating a load sequence for a structural fatigue test is described and is illustrated by reference to the Mirage wing fatigue test Flight sequence and load spectra for this test were defined by fatigue meter data and within-flight maneuver load sequences were derived from recorded time histories J M S

**N78-30278** Aeronautical Research Labs, Melbourne (Australia)  
**FATIGUE S/N DATA IN RELATION TO VARIABILITY IN PREDICTED LIFE**

J M Finney and J Y Mann *In its Aircraft Structural Fatigue* Apr 1977 p 149-178 refs

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The variability which may arise from either fitting a mean curve to a given set of fatigue stress and cycles to failure (S/N) data points or from sources affecting the data points themselves was investigated Mean lives to failure were predicted S/N curves for several multi-load-level spectra The range of values of predicted life from the largest to the smallest and averaged over the several spectra was 3:1 for one set of data points and 2x4:1 for the other set Five mathematical methods of curve fitting were applied to one set of data points, with the resultant average range in predicted life being 1x4:1 This variability arises mainly from the subjective choice of a functional form for the S/N curve The added variability due to other arbitrarily-chosen

constraints such as weighting the nonintersection of curves within a family, and the choice of a fatigue limit, is also discussed Many factors associated with the determination of fatigue data influence the resultant S/N relationship and some of the more significant ones are considered Those factors examined include the loading accuracy of the testing machine, specimen manufacturing methods and the number of specimens tested, the definition of fatigue failure variability between batches J M S

**N78-30279** Aeronautical Research Labs, Melbourne (Australia)  
**STRUCTURAL FATIGUE TESTING**

R A Bruton and C A Patching *In its Aircraft Structural Fatigue* Apr 1977 p 179-202 refs

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The various testing techniques available selection of the test article data obtainable from fatigue testing of components, assemblies and complete structures and the conclusions that have been reached based on experience from a large number of fatigue tests on aircraft wings are discussed J M S

**N78-30280** Aeronautical Research Labs, Melbourne (Australia)  
**CURRENT DEVELOPMENTS IN THE LIFE OF AIRCRAFT STRUCTURE**

A O Payne *In its Aircraft Structural Fatigue* Apr 1977 p 205-226 refs

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Procedures for fatigue design and fatigue life estimation substantiation and monitoring of aircraft structures are reviewed Major gaps in the present state of knowledge are identified and further research directed towards filling these gaps is discussed It is shown that the fatigue assessment of modern aircraft structures is a very complex problem for which no general method of solution has yet been established despite the extensive research programs being conducted A trend toward examining various aspects of fatigue behavior to find increasing application is documented J M S

**N78-30281** Aeronautical Research Labs, Melbourne (Australia)  
**AIRCRAFT STRUCTURAL LIFE MONITORING AND THE PROBLEM OF CORROSION**

L M Bland *In its Aircraft Structural Fatigue* Apr 1977 p 227-253 refs

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The principles of fatigue design and related structural maintenance are briefly described for two essentially different philosophies of structural fatigue life In one case it is assumed that no crack is present in any structural component at the beginning of service and that the components should remain crack-free throughout the service life In the other case, it is conservatively assumed that cracks are present in all components which service beings but that these cracks growing slowly can be tolerated for the required service life The relevance of the chemical and physical environment in which the structure exists is discussed for the two cases The role of structural service monitoring in ensuring safe and economic operation of aircraft is considered and the place of environment and corrosion monitoring in the general monitoring scheme is identified The importance of nondestructive inspection in corrosion monitoring is also considered with an assessment of the applicability and adequacy of various inspection methods in the monitoring task Indications are given of the limitations of these methods and of the requirements for improved planning of the corrosion monitoring process J M S

**N78-30282** Aeronautical Research Labs, Melbourne (Australia)  
**NDI AND THE DETECTION OF FATIGUE**

I G Scott *In its Aircraft Structural Fatigue* Apr 1977 p 255-267 refs

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The problems of monitoring fatigue cracks by nondestructive inspection (NDI) are discussed and recent developments in the methods and techniques are reviewed Three aspects are considered in some detail (1) the part played by the operator

in NDI (2) applications of acoustic emission to fatigue studies and (3) future trends in NDI Some new philosophies fatigue testing are also considered J M S

**N78-30283** Aeronautical Research Labs Melbourne (Australia)  
**THE DEVELOPMENT OF THE THEORY OF STRUCTURAL FATIGUE**

D G Ford *In its Aircraft Structural Fatigue* Apr 1977 p 269-298 refs

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The relation of structural fatigue to other branches of fatigue is outlined by a brief historical survey which includes the main ideas of the theory and ends with some of the current problems and possible developments Cumulative damage and reliability are included J M S

**N78-30284** Aeronautical Research Labs Melbourne (Australia)  
**AIRCRAFT STRUCTURAL RELIABILITY AND RISK THEORY A REVIEW**

F H Hooke *In its Aircraft Structural Fatigue* Apr 1977 p 299-344 refs 1

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Evaluation of the structural reliability and probability of failure during the lifetime a statistical exercise based upon load history data and strength decay properties known or attributed to the structures in question are discussed Reliability of reliability estimates is examined and is shown to be usually limited by sampling problems and arbitrary judgments concerning the attribution of properties to the population in question The estimates are compared with those derived by semprobabilistic or limit analysis methods J M S

**N78-30285** Aeronautical Research Labs Melbourne (Australia)  
**LOAD INTERACTION EFFECTS IN FATIGUE CRACK PROPAGATION**

G W Revill, Ningaiah, and J M Finney *In its Aircraft Structural Fatigue* Apr 1977 p 347-372 refs

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Some experiments on the influence of material thickness are described For 2024-T3 aluminum alloy specimens the delay in crack growth caused by a single overload was greater by a factor of about 8.5 for 1.6 mm thick specimens than for 6.4 mm thick specimens The practical importance of this effect is emphasized Various proposed mechanisms of load interaction are described as well as models for quantitative predictions The models all incorporate the extent of crack tip plasticity into the Paris formulation of fatigue crack growth They do not accurately detail the course of crack growth through the interaction period It is concluded that satisfactory prediction of interaction effects will require some materials information obtainable only by test J M S

**N78-30286** Aeronautical Research Labs Melbourne (Australia)  
**A MODEL OF CRACK-TIP BEHAVIOUR FOR FATIGUE LIFE DETERMINATION**

F P Bullen, J A Retchford, C B Rogers, and B J Wicks *In its Aircraft Structural Fatigue* Apr 1977 p 373-391 refs

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The evaluation of fatigue life by simulating the performance of critically stressed areas of a structure using individual tests on small specimens is considered The experiments which are presented have been carried out on polycrystalline copper since the physical basis of crack tip behavior in this simple metal is also applicable to conventional aircraft materials It is shown that in these materials cracks propagate under cyclic loading as a result of irreversible plastic strain and a parameter describing the plastic strain at the crack tip is defined which is shown to be directly related to the rate of crack propagation A simple model of crack tip behavior is proposed in which the elastic and plastic contributions from material around the crack tip can be isolated and recombined in varying proportions This could allow the behavior of a cracked component in a structure to be replicated on small cracked specimens, by superimposing on the specimen load spectrum a stress variation representing the effect

at the crack tip of the elastically deforming structure The model is validated under a wide range of load histories and the implications for practical aircraft materials are discussed J M S

**N78-30288** Aeronautical Research Labs Melbourne (Australia)  
**FIBRE COMPOSITE REINFORCEMENT OF CRACKED AIRCRAFT STRUCTURES**

A A Baker and M M Hutchison *In its Aircraft Structural Fatigue* Apr 1977 p 419-457 refs

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The fatigue performance of a range of commercially available adhesive materials was examined to enable the selection of an adhesive system suitable for bonding of fiber composite reinforcements to cracked aircraft structures Small constant stress cantilever 7075-T6 aluminum alloy fatigue specimens were used to evaluate the characteristics of the adhesives and also to examine the feasibility of using fiber composites to control crack propagation The adhesive selected for the repair application required curing at 130 C which due to the low thermal expansion of the composite induced residual tensile stresses in the aluminum at room temperature Wedge-loaded precracked stress corrosion specimens were used to show that these internal stresses do not significantly limit the practical usefulness of the proposed repair schemes Finally two practical aircraft repairs are described which are currently being evaluated under operating conditions J M S

**N78-30291\*#** National Aeronautics and Space Administration  
Langley Research Center Langley Station Va  
**EXPERIMENTAL DETERMINATION OF THE RATTLE OF SIMPLE MODELS**

Clevenson A Sherman Jul 1978 22 p refs  
(NASA-TM-78756) Avail NTIS HC A02/MF A01 CSCL 20K

The effect of the excitation frequency on the rattle boundaries of simple models was investigated The frequency range investigated was from 40 to 4 000 Hz A 1-inch steel ball was studied to determine the rattle boundary for both vertical motion and for the ball suspended as a pendulum Effects of surface contact and weight were also studied Results indicate that the shape of the rattle boundary depends on the particular configuration being investigated as well as the range of frequency being investigated Although there was considerable scatter in the data the general trend indicates that the level of acceleration required for the onset of rattle was independent of excitation frequency S E S

**N78-30583\*#** Jet Propulsion Lab Calif Inst of Tech Pasadena  
**ANALYSIS OF A SUSPENSION SYSTEM FOR A WHEEL ROLLING ON A FLAT TRACK**

H McGinness 1 Aug 1978 24 p ref  
(Contract NAS7-100)  
(NASA-CR-157563 JPL-Pub-78-43) Avail NTIS  
HC A02/MF A01 CSCL 131

A flexure strut wheel suspension system is described which keeps a wheel flat against the track and maintains a small interface moment Equations are presented for the evaluation of this moment A comparison of the flexure strut system is made with a rigid link design containing pivot bearings Author

**N78-30603#** Industrieanlagen-Betriebsgesellschaft m b H  
Otto-brunn (West Germany)

**THE INFLUENCES OF RESIDUAL STRESSES ON OSCILLATING TENSILE STRENGTH AND THE MEASUREMENT OF RESIDUAL STRESS, WITH EMPHASIS ON AIRCRAFT CONSTRUCTION [UNTERSUCHUNG DES EINFLUSSES VON EIGENSINNUNGEN AUF DIE SCHWINGFESTIGKEIT SOWIE MESSUNG DER EIGENSINNUNGEN, MIT BESONDERER BERUECKSICHTIGUNG DES FLUGZEUGBAUS]**

P Schrader and W Schuetz 1977 105 p refs  
(BMVG-FBWT-77-23) Avail NTIS HC A06/MF A01  
DOKZENTBW 30 DM

Surface rolling and coining of holes in notched specimens shot peening of unnotched flat bars and rolling of fillets of stepped shafts induced compressive residual stresses in aircraft components and increased fatigue life of high strength aluminum titanium and steel alloys Under flight-by-flight loading the fatigue life was increased by coining 6-fold for the notched aluminum specimens, 9-fold for the titanium specimens and 3-fold for the steel specimens Shot peening improved the fatigue life by a factor of 3 for the aluminum, and of more than 10 for the titanium and the steel The life under a random load sequence was increased 3-fold for the rolled stepped shafts The increases in fatigue life cannot be explained in all cases by the effect of the residual stresses alone because they had already been reduced to zero after about 2 per cent of the fatigue life to failure of the shot peened aluminum specimens although the fatigue life increased by a factor of 3 In the shot peened Ti- and steel specimens however the residual stresses had not decreased after 40 percent of the life to failure  
A R H

**N78-30606\***# National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**RECENT DEVELOPMENTS IN ANALYSIS OF CRACK PROPAGATION AND FRACTURE OF PRACTICAL MATERIALS**

H F Hardrath, J C Newman Jr W Elber and C C Poe Jr  
Jun 1978 20 p refs Presented at the Intern Symp of Fracture Mechanics Washington D C 11-13 Sep 1978  
(NASA-TM-78766) Avail NTIS HC A02/MF A01 CSCL 20K

The limitations of linear elastic fracture mechanics in aircraft design and in the study of fatigue crack propagation in aircraft structures are discussed NASA-Langley research to extend the capabilities of fracture mechanics to predict the maximum load that can be carried by a cracked part and to deal with aircraft design problems are reported Achievements include (1) improved stress intensity solutions for laboratory specimens (2) fracture criterion for practical materials (3) crack propagation predictions that account for mean stress and high maximum stress effects (4) crack propagation predictions for variable amplitude loading and (5) the prediction of crack growth and residual stress in built-up structural assemblies These capabilities are incorporated into a first generation computerized analysis that allows for damage tolerance and tradeoffs with other disciplines to produce efficient designs that meet current airworthiness requirements  
A R H

**N78-30620#** National Aerospace Lab, Amsterdam (Netherlands) Structures and Materials Div

**COMPILATION OF TEST DATA FROM AN INVESTIGATION ON THE EFFECT OF ENVIRONMENT ON CRACK GROWTH UNDER FLIGHT-SIMULATION LOADING**

3 Sep 1976 39 p refs Supplement to NLR-TR-76104  
(Contract NIVR-1725)

(NLR-TR-76096-U NLR-TR-76104) Avail NTIS  
HC A03/MF A01

The present report is a supplement to NLR-TR-76104 Numerical test results and several evaluations are given in full detail However the discussion of the results is presented in NLR-TR-76104  
Author (ESA)

**N78-30774\***# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

**AN ASSESSMENT OF THE EFFECT OF SUPERSONIC AIRCRAFT OPERATIONS ON THE STRATOSPHERIC OZONE CONTENT**

I G Poppoff R C Whitten, R P Turco (R and D Associates Marina del Rey, Calif) and L A Capone (San Jose State Univ Calif) Aug 1978 60 p refs  
(NASA-RP-1026 A-7399) Avail NTIS HC A04/MF A01 CSCL 13B

An assessment of the potential effect on stratospheric ozone of an advanced supersonic transport operations is presented This assessment which was undertaken because of NASA's desire for an up-to-date evaluation to guide programs for the development

of supersonic technology and improved aircraft engine designs, uses the most recent chemical reaction rate data From the results of the present assessment it would appear that realistic fleet sizes should not cause concern with regard to the depletion of the total ozone overburden For example the NOx emission of one type designed to cruise at 20 km altitude will cause the ozone overburden to increase by 0.03% to 0.12%, depending upon which vertical transport is used These ozone changes can be compared with the predictions of a 1.74% ozone decrease (for 100 Large SSTs flying at 20 km) made in 1974 by the FAA's Climatic Impact Assessment Program  
Author

**N78-30896\***# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio

**PROCEDURES FOR GENERATION AND REDUCTION OF LINEAR MODELS OF A TURBOFAN ENGINE**

Kurt Seldner and David S Cwynar Aug 1978 45 p refs  
(NASA-TP-1261 E-9460) Avail NTIS HC A03/MF A01 CSCL 12B

A real time hybrid simulation of the Pratt & Whitney F100-PW-F100 turbofan engine was used for linear-model generation The linear models were used to analyze the effect of disturbances about an operating point on the dynamic performance of the engine A procedure that disturbs samples and records the state and control variables was developed For large systems such as the F100 engine the state vector is large and may contain high-frequency information not required for control This reducing the full-state to a reduced-order model may be a practicable approach to simplifying the control design A reduction technique was developed to generate reduced-order models Selected linear and nonlinear output responses to exhaust-nozzle area and main-burner fuel flow disturbances are presented for comparison  
Author

**N78-30909#** European Space Agency, Paris (France)  
**THEORETICAL AND EXPERIMENTAL STUDIES OF ACOUSTIC PROPAGATION IN INHOMOGENEOUS MOVING MEDIA**

Sebastien Candel Jun 1978 315 p refs Transl into ENGLISH of 'Etudes Theoriques et Exptl de la Propagation Acoustique en Milieu Inhomogene et en Mouvement', ONERA Paris Report ONERA-P-1977-1, 1977 Original report in FRENCH previously announced as N78-24905

(ESA-TT-477 ONERA-P-1977-1) Avail NTIS  
HC A14/MF A01

Three problems are treated in particular the propagation of plane and modal pressure waves in nozzles and diffusers, the adiation of the jet noise high-frequency components and the propagation of an acoustic field in the free flow of an open wind tunnel A numerical algorithm based on the geometrical approximation was developed and allows the calculation of the wave field (amplitude and phase) in the case of very general media (inhomogeneous dispersive including reflecting surfaces) A comparison between calculations and experimental results obtained in an open wind tunnel was made to check the proposed numerical method and to demonstrate its practical utility  
Author (ESA)

**N78-30910#** Loughborough Univ of Technology (England) Dept of Transport Technology

**A FURTHER SURVEY OF SOME EFFECTS OF AIRCRAFT NOISE IN RESIDENTIAL COMMUNITIES NEAR LONDON (HEATHROW) AIRPORT**

J B Ollerhead and R M Edwards Jun 1977 148 p refs  
(Contract SN/1170/012)

(TT-7705) Avail NTIS HC A07/MF A01

Six hundred residents of suburban communities near London (Heathrow) airport were interviewed in a pilot survey designed to compare alternative methods of scaling aircraft noise exposure and human reactions to it The various associations between noise variables is discussed It is concluded that no new noise scale is likely to emerge which is a more reliable or convenient predictor of aircraft noise annoyance than Noise and Number Index (NNI)  
ESA

**N78-30911#** Loughborough Univ of Technology (England)  
Dept of Transport Technology

**A COMPARISON OF ANNOYANCE CAUSED BY AIRCRAFT NOISE NEAR LONDON, MANCHESTER AND LIVERPOOL AIRPORTS**

J B Ollerhead Jun 1977 77 p refs  
(Contract SN/1170/012)

(TT-7706) Avail NTIS HC A05/MF A01

In a postal survey designed to investigate the validity of Noise and Number Index (NNI) for scaling aircraft noise impact at airports other than London (Heathrow) questionnaires were sent simultaneously to some 3000 residents near London (Heathrow) Manchester and Liverpool airports. Although the response rate was poor the results indicate that NNI is one of several noise scales which show optimum correlation with annoyance reactions. However the mean reactions differed between airports with Manchester residents being slightly more sensitive and Liverpool residents significantly less sensitive to a given amount of aircraft noise than their Heathrow counterparts. It is recommended that rather than perform more surveys to identify an optimum noise scale a suitable convenient scale be standardized and that the primary objective of future surveys should be to establish the relevant dose-response relations. An important step in this direction would be the development of a general procedure for the measurement of noise annoyance.

Author (ESA)

**N78-31007#** Rohr Industries Inc Chula Vista Calif  
**TEST AND DEMONSTRATION PROTOTYPE TRACKED AIR CUSHION VEHICLE (PTACV) PHASE IIC Final Report, Jan 1976 - Nov 1977**

A K Smith J Dallas R Stott Dynes and L Samusson Nov 1977 330 p refs

(Contract DOT-FR-54089)

(PB-279970/8 FRA/ORD-78/03) Avail NTIS  
HC A15/MF A01 CSCL 13F

A six year multi-phased program for design development and test of a prototype tracked air cushion vehicle was culminated in a six month test and demonstration. Descriptions of the various major sub-systems are presented with design and operational performance data. Technical data covering test objectives, descriptions and results are furnished on a wide variety of functional assemblies, subsystems and performance conditions. Physical characteristics were measured for accelerations, braking, aerodynamic drag, ride comfort, acoustical quality, reliability and maintainability performance. GRA

**N78-31042** Stanford Univ Calif  
**THE TRANSONIC FLOW ON A HELICOPTER ROTOR Ph D Thesis**

Francis Xavier Caradonna 1978 197 p  
Avail Univ Microfilms Order No 7814162

The flow on a hovering helicopter rotor operating at a supercritical tip Mach number is modeled using potential theory. The general potential equation is casted in blade-fixed coordinates and the transonic small disturbance approximation is invoked. The resulting equation only differs from its fixed-wing counterpart in having a spanwise increasing free-stream Mach number. Solutions shown use an arbitrary but not untypical vortex location and the strength is assumed to be the maximum blade circulation. Solutions obtained show the onset of supercritical flow and ultimately drag divergence. The drag divergence Mach number was considerably higher than that at which supercritical flow first occurs. Although there is some good comparison of computed results with fixed-wing-model data, there currently exists no body of hovering wake and load data adequate to test the present code. Dissert Abstr

**N78-31043#** National Aeronautics and Space Administration  
Langley Research Center, Hampton, Va  
**CONTROL-SURFACE HINGE-MOMENT CALCULATIONS**

**FOR A HIGH-ASPECT-RATIO SUPERCRITICAL WING**

Boyd Perry, III Sep 1978 26 p refs  
(NASA-TM-78664 L-12219) Avail NTIS HC A03/MF A01  
CSCL 01A

The hinge moments at selected flight conditions resulting from deflecting two trailing edge control surfaces (one inboard and one midspan) on a high aspect ratio swept, fuel conservative wing with a supercritical airfoil are estimated. Hinge moment results obtained from procedures which employ a recently developed transonic analysis are given. In this procedure a three dimensional inviscid transonic aerodynamics computer program is combined with a two dimensional turbulent boundary layer program in order to obtain an interacted solution. These results indicate that trends of the estimated hinge moment as a function of deflection angle are similar to those from experimental hinge moment measurements made on wind tunnel models with swept supercritical wings tested at similar values of free stream Mach number and angle of attack. JMS

**N78-31044#** National Aeronautics and Space Administration  
Langley Research Center, Hampton Va  
**ANALYSIS OF STABILITY CONTRIBUTIONS OF HIGH DIHEDRAL V-TAILS**

Carl E Freeman (AVRADCOM Res and Technol Labs) and William T Yeager (AVRADCOM Res and Technol Labs) Aug 1978 22 p refs

(DA Proj 1L1-61102-AH-45)

(NASA-TM-78729, AVRADCOM-TR-78-34, L-12277) Avail  
NTIS HC A02/MF A01 CSCL 01A

An investigation was undertaken to determine the effectiveness of four analytical methods (empirical, modified empirical, vortex-lattice, and an inviscid three dimensional, potential flow, wing body program) to estimate the lateral and longitudinal static stability characteristics of an isolated V-tail wind tunnel model. The experimental tests were conducted in the V/STOL tunnel at a Mach number of 0.18. Angle-of-attack data were obtained from -12 deg to 8 deg at 0 deg sideslip. Sideslip sweeps from -5 deg to 10 deg were made at angles of attack of 4 deg, 0 deg and -4 deg. The V-tail dihedral angles were 45 deg, 50 deg, 55 deg and 60 deg. BB

**N78-31045#** National Aeronautics and Space Administration  
Langley Research Center Hampton Va  
**AERODYNAMIC CHARACTERISTICS OF A HYPERSONIC RESEARCH AIRPLANE CONCEPT HAVING A 70 DEG SWEEP DOUBLE-DELTA WING AT MACH NUMBER 0.2**

Jim A Penland Theodore R Creel, Jr., and James L Dillon Sep 1978 83 p refs

(NASA-TP-1252 L-12215) Avail NTIS HC A05/MF A01  
CSCL 01A

A wind-tunnel of the static longitudinal, lateral and directional stability characteristics of a hypersonic research airplane concept having a 70 deg swept double-delta wing was conducted in the Langley low-turbulence pressure tunnel. The configuration variables included wing planform, tip fins, center fin, and scramjet engine modules. A Mach number of 0.2 was investigated over a Reynolds number (based on fuselage length) range of 2,200,000 to 19.75 x 1,000,000 (with a majority of tests at 10.0 x 1,000,000). Tests were conducted through an angle-of-attack range from about -2 deg to 34 deg at angles of sideslip of 0 deg to 5 deg, and at elevon deflection of 0 deg, -5 deg, -10 deg, -15 deg, and -20 deg. The drag coefficient of the integrated scramjet engine appears relatively constant with Reynolds number at the test Mach number of 0.2. Mild pitch-up was exhibited by the models equipped with tip fins. The forward delta a highly swept forward portion of the wing, was destabilizing. The center fin model has a higher trimmed maximum lift-drag ratio and a wider trim lift and angle-of-attack range than the tip fin model. Both the tip fin models and center fin models exhibited positive dihedral effect and positive directional stability. Roll control was positive for the tip fin model but yaw due to roll control was unfavorable. Author

**N78-31046#** Naval Air Test Center Patuxent River Md Strike Aircraft Test Directorate  
**MAXIMUM LIKELIHOOD IDENTIFICATION OF THE**

**LONGITUDINAL AERODYNAMIC COEFFICIENTS OF THE EA-6B AIRPLANE IN THE CATAPULT LAUNCH CONFIGURATION**

David E Bischoff 8 May 1978 34 p refs  
(AD-A054243, NATC-TM-78-2-SA) Avail NTIS  
HC A03/MF A01 CSCL 01/3

The aerodynamic coefficients describing the longitudinal equations of motion of the EA-6B airplane with landing gear and flaps down were determined from flight test data through use of a maximum likelihood identification algorithm. These identified coefficients were accurately determined and were utilized to both (1) predict short and long period time history responses and (2) duplicate the results of conventional flight test specification requirement test procedures. The identified results provide an example of the type of information available through the application of parameter estimation technology in the areas of airplane data base generation. These data can be utilized for ACLS and Operational Flight Trainer simulations as well as for parametric studies of aerodynamic characteristics. Author (GRA)

**N78-31047# Naval Ship Research and Development Center Bethesda Md Aviation and Surface Effects Dept TWO-DIMENSIONAL SUBSONIC WIND TUNNEL EVALUATION OF TWO RELATED CAMBERED 15-PERCENT THICK CIRCULATION CONTROL AIRFOILS Final Report**

Jane Abramson Sep 1977 68 p refs  
(AD-A055140, DTNSRDC/ASED-373) Avail NTIS  
HC A04/MF A01 CSCL 20/4

Two circulation control cambered elliptic airfoil sections with a thickness-to-chord ratio of 0.15 and 1.0 percent circular arc camber were evaluated subsonically to determine their aerodynamic characteristics. The two models designated NCCR 1510-7067N and NCCR 1510-7567S have a common leading edge but different Coanda surfaces. GRA

**N78-31048# Hydronautics Inc Laurel, Md MEASUREMENTS AND ANALYSIS OF THE FORCES ACTING ON A SMALL AIRCRAFT FLYING IN THE UPWASH OF A LARGE AIRCRAFT Final Report, 1 Jan 1976 - 31 Dec 1977**

Clinton E Brown Peter VanDyke and John W Kloetzli Apr 1978 30 p refs  
(Contract F44620-76-C-0073 AF Proj 2307)  
(AD-A055286 TR-7615, AFOSR-78-0903TR) Avail NTIS  
HC A03/MF A01 CSCL 20/4

Preliminary analysis of the expected ranges of forces and moments were made using available theoretical methods and confirming experiments were performed in the Hydronautics Ship Model Basin. The tests used a large model of the Boeing 747 transport aircraft and a smaller model typifying a fighter-type aircraft. The range of positions of the small model relative to the large model extended laterally 30 full-scale feet from the wing tip or from the tip vortex and downstream roughly 80 feet behind the wing tip. Consideration was given to the problem of maintaining steady position at a point that provided a maximum increase in the lift to drag ratio (L/D) of the small aircraft. The model tests have shown that an increase of 50% in L/D can be obtained by a small fighter-type aircraft flying close to the tip trailing vortex of a larger aircraft. Higher increases in L/D for the same relative aircraft positions would result if the smaller aircraft exhibited higher performance (max L/D was 8.9 in free air). Calculations made for the models tested indicate that control power of typical fighters would be sufficient to maintain level flight in the favorable positions close to a tip vortex. GRA

**N78-31052# Grumman Aerospace Corp Bethpage NY AN AUTOMATED PROCEDURE FOR COMPUTING THE THREE-DIMENSIONAL TRANSONIC FLOW OVER WING-BODY COMBINATIONS, INCLUDING VISCOUS EFFECTS VOLUME 1 DESCRIPTION OF ANALYSIS METHODS AND APPLICATIONS Final Report, May 1975 - Oct 1977**

William H Mason Donald Mackenzie Mark Stern William F Ballhaus and Juanita Frick Feb 1978 220 p refs  
(Contract F33615-75-C-3073)  
(AD-A055899 AFFDL-TR-77-122-Vol-1) Avail NTIS

**HC A10/MF A01 CSCL 20/4**

This report describes a numerical method to predict the detailed pressure distribution and force and moment results for wing-body combinations at transonic Mach numbers less than one. The resulting computer code has been developed with the intent of providing the user with an easy to use and reliable tool that produces the most accurate possible engineering predictions. In order to provide accurate surface pressure predictions on the wing several additional features of the typical transonic flow field have been incorporated. These consist of the viscous displacement effect, local strong viscous interaction at the shock wave foot and at the trailing edge (including an approximate treatment of local shallow separations) and finally the interaction effect of the fuselage. GRA

**N78-31061\*# National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio SIMULTANEOUS MEASUREMENTS OF OZONE OUTSIDE AND INSIDE CABINS OF TWO B-747 AIRLINERS AND A GATES LEARJET BUSINESS JET**

Porter J Perkins and Daniel Briel 1978 11 p refs Proposed for presentation at the Conf on Atmospheric Environ of Aerospace Systems and Appl Meteorology New York, 13-16 Nov 1978 sponsored by the Am Meteorol Soc and the AIAA  
(NASA-TM-78983 E-9760) Avail NTIS HC A02/MF A01 CSCL 06T

The average amount of ozone measured in the cabins of two B-747 airliners varied from 40 percent to 80 percent of the atmospheric concentrations without special ozone destruction systems. A charcoal filter in the cabin air inlet system of one B-747 reduced the ozone to about 5 percent of the atmospheric concentration. A Learjet 23 was also instrumented with monitors to measure simultaneously the atmospheric and ozone concentrations. Results indicate that a significant portion of the atmospheric ozone is not destroyed in the pressurization system and remains in the aircraft cabin of the Learjet. For the two cabin configurations tested the ozone retentions were 63 and 41 percent of the atmospheric ozone concentrations. Ozone concentrations measured in the cabin near the conditioned-air outlets were reduced only slightly from atmospheric ozone concentrations. It is concluded that a constant difference between ozone concentrations inside and outside the cabin does not exist. G G

**N78-31064# Rockwell International Corp Los Angeles, Calif HAZARD ASSESSMENT OF AIRCRAFT GUN COMPARTMENTS Final Report, May 1976 - Oct 1977**

William A Pace Dec 1977 240 p refs  
(Contract F33615-76-C-2051)  
(AD-A055026, NA-77-938, AFAPL-TR-77-79) Avail NTIS  
HC A11/MF A01 CSCL 19/6

Aircraft gun compartments provide an inherent fire/explosion risk potential because of the common location of flammable fluids, thermal ignition source and various environmental conditions. This program, while specifically addressing the hazards associated with aircraft gun compartments, investigated other related areas of concern. The areas include gun compartment hazard identification, accident/incident reports, historical data on aircraft gun compartment design and evaluation, development of a hazard assessment methodology, the chemical composition and behavior of typical gun gases and various types of sensors to detect and measure combustible gases. The results of the study were used to prepare technical design guidance for possible inclusion in the Armament Handbook DH2-5. Author (GRA)

**N78-31068\*# Ohio Univ Athens Dept of Electrical Engineering**

**PHASE-LOCKED TRACKING LOOPS FOR LORAN-C**  
R W Burhanz Aug 1978 25 p  
(Grant NGR-36-009-017)  
(NASA-CR-157582 TM-60) Avail NTIS HC A02/MF A01 CSCL 17G

Portable battery operated LORAN-C receivers were fabricated to evaluate simple envelope detector methods with hybrid analog to digital phase locked loop sensor processors. The receivers are used to evaluate LORAN-C in general aviation applications. Complete circuit details are given for the experimental sensor and readout system. Author

**N78-31070#** National Aviation Facilities Experimental Center Atlantic City, N J  
**TRSB MICROWAVE LANDING SYSTEM DEMONSTRATION PROGRAM AT JOHN F KENNEDY INTERNATIONAL AIRPORT, LONG ISLAND, NEW YORK, USA Final Report, Dec. 1977 - Jan. 1978**  
 4 Jan 1978 134 p  
 (AD-A055447 FAA-NA-78-16 FAA-RD-78-16) Avail NTIS HC A07/MF A01 CSCL 17/2

The TRSB (Time Reference Scanning Beam) system was demonstrated at JFK airport in December 1977 and consisted of a 1 degree phased array azimuth subsystem, a 15 degree elevation subsystem with an antenna of the Rotman lens design and a precision L-Band DME. A laser tracker was provided for precise aircraft position data but was considered unusable. However, TRSB airborne recordings are available for several flights and provide useful data output. During the operational demonstrations national and international observers in the NASA B-737 aircraft flew the Canarsie approaches, under fully coupled and manual flight conditions to touchdown and rollout. These demonstrations highlighted the important capability of Microwave Landing Systems to provide precision guidance over complex approach paths to a busy international airport. G Y

**N78-31071#** National Aviation Facilities Experimental Center Atlantic City, N J  
**TRSB MICROWAVE LANDING SYSTEM DEMONSTRATION PROGRAM AT KRISTIANSAND, NORWAY Final Report, 15-17 Jan 1978**  
 Jan 1978 82 p  
 (AD-A055317 FAA-NA-78-17 FAA-RD-78-17) Avail NTIS HC A05/MF A01 CSCL 01/2

A demonstration of Kjevik Airport Kristiansand Norway, was the fifth in a series of operational demonstrations of several TRSB system configurations at selected airports in the United States and abroad. Operational demonstrations and data acquisition flights were made utilizing an FAA Boeing 727 test aircraft. Flight profiles included approaches radials, and partial orbits perpendicular to the runway centerline. Some flight tests were also made by Norwegian and British Civil Aviation Authority personnel using TRSB equipment installed in their respective flight inspection aircraft. Results of the operational demonstrations indicated that the performance of both system configurations was well within their respective U S program design requirements and also met ICAO (AWOP) full capability system requirements. B B

**N78-31072#** National Aviation Facilities Experimental Center, Atlantic City, N J  
**TRSB MICROWAVE LANDING SYSTEM DEMONSTRATION PROGRAM AT CHARLEROI, BELGIUM Final Report, 18 Jan. - 6 Feb 1978**  
 Feb 1978 52 p  
 (AD-A055920, FAA-NA-78-19 FAA-RD-78-19) Avail NTIS HC A04/MF A01 CSCL 01/4

A demonstration was held at Gosselies Airport, Charleroi, Belgium in conjunction with the United States TRSB demonstration program, and was the sixth in a series of operational demonstrations of several TRSB system configurations at selected airports in the United States and abroad. Operational demonstrations were made utilizing FAA Boeing 727 and Convair 880 test aircraft. Flight performance data was acquired with the Boeing 727 test aircraft only. Flight profiles included approaches on centerline and offset plus and minus 1 and 2 degrees at various elevation angles and radials at constant altitude on centerline and offset plus and minus 10 degrees. Results of the operational demonstrations indicated that the performance of the TRSB Small Community azimuth subsystem met ICAO (AWOP) full capability systems requirements. B B

**N78-31073#** Westinghouse Defense and Electronic Systems Center Baltimore Md  
**CAPTURE EFFECT ARRAY GLIDE SLOPE GUIDANCE STUDY Interim Report**  
 J T Godfrey H F Hartley R A Moore and G J Moussally  
 Mar 1978 95 p  
 (Contract DOT-FA74WA-3353)  
 (AD-A055678 FAA-RD-78-41) Avail NTIS HC A05/MF A01 CSCL 17/7

The performance of the capture effect glide slope array as a function of the quality and quantity of required ground planes was examined. Methods of improvement were also investigated. Wherein either a smoothing of the glide path structure or a reduction of the required ground plane was considered an improvement. An extensive computer model was developed and it was used to study the effect on glide path DDM of different position arrangements of elements. It was found that a unique arrangement of elements could be found for any terrain environment which would give a zero DDM along the entire glide path up to threshold. G Y

**N78-31074#** Lincoln Lab Mass Inst of Tech Lexington  
**IPC DESIGN VALIDATION AND FLIGHT TESTING Final Report**  
 J W Andrews, J C Koegler and K D Senne 31 Mar 1978  
 267 p refs  
 (Contracts DOT-FA72WAI-261 F19628-78-C-0002 Proj 034-241-012)  
 (AD-A055529, ATC-85 FAA-RD-77-150) Avail NTIS HC A12/MF A01 CSCL 01/4

A series of flight tests were conducted to evaluate the collision avoidance system known as intermittent positive control (subsequently re-named automatic traffic advisory and resolution service ATARS). These tests involved both professional test pilots and subject pilots selected from the aviation community. Analysis of the collision avoidance algorithm pilot visual acquisition performance and pilot reaction to avoidance instructions are also included. B B

**N78-31075#** Federal Aviation Administration Washington D C  
**IFR AIRCRAFT HANDLED FORECAST BY AIR ROUTE TRAFFIC CONTROL CENTER, FISCAL YEARS 1978-1989**  
 Bernard Hannan Nov 1977 51 p  
 (AD-A049305 FAA-AUP-77-34) Avail NTIS HC A04/MF A01 CSCL 17/7

The forecasts of instrument flight rule aircraft handled by FAA air route traffic control centers are presented. They serve as a base for the FAA planning and budget process in determining future requirements for facilities, equipment and manpower. The forecasts show that total aircraft handled will increase from 25.7 million FY 1977 to 41.5 million in FY 1989. These national total numbers along with those for the intervening years are broken down by FAA region and by each air route traffic control center in this report. G G

**N78-31076#** Committee on Science and Technology (U S House)  
**FUTURE NEEDS AND OPPORTUNITIES IN THE AIR TRAFFIC CONTROL SYSTEM**  
 Washington GPO 1977 716 p refs. Hearings before Subcomm on Transportation, Aviation and Weather of the Comm on Sci and Technol 95th Congr 1st Sess 8-9 14-16 Jun 8 Sep 1977  
 (GPO-98-931) Avail Subcomm on Transportation, Aviation and Weather

Testimony concerning the philosophies and issues related to future or post third generation air traffic control (ATC) systems is presented. Research and development programs, microwave landing systems, wind shear, wake vortex, availability of energy and the economic climate are among the factors considered. Emphasis is placed on the enhancement of system capacity, safety and productivity. Aviation demands of the public are projected through the turn of the century in terms of expansion of ATC services. J M S



**N78-31077#** Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering  
**A DESIGN OF TRAJECTORY ESTIMATOR USING MULTIPLE DME RANGE MEASUREMENTS M S Thesis**  
 Robert Riggins Mar 1978 134 p refs  
 (AD-A055191, AFIT/GGC/EE/78-4) Avail NTIS HC A07/MF A01 CSCL 17/7

This report is directed toward the design of a real-time estimation algorithm, a Kalman filter, that estimates aircraft position and velocity using multiple DME range measurements. The estimator is designed and tested for feasibility as a reference system for examining Inertial Navigational System (INS) low frequency errors. Both a 9 state estimator including jerk states and a 7 state estimator without the jerk states are designed.

GRA

**N78-31078#** Air Force Inst of Tech, Wright-Patterson AFB, Ohio School of Engineering  
**PERFORMANCE IN A JAMMING ENVIRONMENT OF A LOW-COST GPS USER RECEIVER ALGORITHM FOR AIDING A TACTICAL INS M S Thesis**  
 Stephen E Cross Dec 1977 133 p refs  
 (AD-A055239 AFIT/EE/GGC/77-2) Avail NTIS HC A07/MF A01 CSCL 17/4

The design and evaluation of a position and velocity estimation algorithm for a low-cost Global Positioning System (GPS) user receiver is presented. The algorithm is intended as a navigation aid for a tactical aircraft. The algorithm is based on linearized range and range rate equations using the INS indicated position and velocity and the GPS user receiver's measured range and range rate. Hotelling's iterative matrix inversion algorithm is used to invert a (4 x 4) measurement matrix. A feedback and feedforward mechanization is proposed for the estimation algorithm. The performance is based on simulations using a dynamic F-4 flight profile. Comparisons are made with results obtained from a Carlson Square Root Filter and an unaided INS.

Author (GRA)

**N78-31083** Iowa State Univ of Science and Technology, Ames  
**TRAJECTORY OPTIMIZATION FOR SOME SAILPLANE PERFORMANCE PROBLEMS Ph D Thesis**  
 Imao Chen 1978 217 p  
 Avail Univ Microfilms Order No 78-13220

Three specific sailplane performance problems are formulated as optimal control problems and studied: (1) minimum landing-approach distance problem, (2) minimum altitude-loss problems in the presence of sinusoidal vertical winds, and (3) minimum time problems in the presence of sinusoidal vertical winds. Both minimum altitude-loss and minimum time problems have several cases involved: (1) fixed and equal initial and final states, (2) free but equal initial and final states, (3) effects of varying the wind amplitude, (4) effects of varying the fixed range, and (5) wing-loading effects. One more case of effects of varying the prescribed altitude loss for minimum time problems is also studied.

Dissert Abstr

**N78-31084** Purdue Univ Lafayette Ind  
**EFFECTS OF DYNAMIC AEROELASTICITY ON HANDLING QUALITIES AND PILOT RATING Ph D Thesis**  
 Wen-Yo Yen 1977 122 p  
 Avail Univ Microfilms Order No 78-13142

Pilot performance parameters, such as pilot ratings, tracking errors, and pilot comments were determined for a longitudinal pitch tracking task using a large flexible bomber with parametric variations in the undamped natural frequencies of the two lowest frequency symmetric elastic modes. This pitch tracking task was programmed on a fixed base simulator with an electronic attitude-director display of pitch command, pitch angle and pitch error. The results of this study indicate that low-frequency structural flexibility can significantly affect the handling qualities and pilot ratings in the task evaluated.

Dissert Abstr

**N78-31085\*#** Lockheed-California Co, Burbank  
**STUDY OF FUEL SYSTEMS FOR LH2-FUELED SUBSONIC TRANSPORT AIRCRAFT, VOLUME 1 Final Report, Sep 1976 - Dec 1977**

G D Brewer R E Morris G W Davis, E F Versaw G R Cunnington Jr (Lockheed Missiles and Space Co, Inc) J C Riple (AirResearch Mfg Co), C F Baerst (AirResearch Mfg Co), and G Garmong (Rocketdyne) Jul 1978 202 p 2 Vol (Contract NAS1-14614) (NASA-CR-145369-Vol-1 LR-28384-Vol-1) Avail NTIS HC A10/MF A01 CSCL 01C

Several engine concepts examined to determine a preferred design which most effectively exploits the characteristics of hydrogen fuel in aircraft tanks received major emphasis. Many candidate designs of tank structure and cryogenic insulation systems were evaluated. Designs of all major elements of the aircraft fuel system including pumps, lines, valves, regulators, and heat exchangers received attention. Selected designs of boost pumps to be mounted in the LH2 tanks and of a high pressure pump to be mounted on the engine were defined. A final design of LH2-fueled transport aircraft was established which incorporates a preferred design of fuel system. That aircraft was then compared with a conventionally fueled counterpart designed to equivalent technology standards.

Author

**N78-31086\*#** Lockheed-California Co Burbank  
**STUDY OF FUEL SYSTEMS FOR LH2-FUELED SUBSONIC TRANSPORT AIRCRAFT, VOLUME 2 Final Report, Sep 1976 - Dec 1977**

G D Brewer R E Morris, G W Davis E F Versaw G R Cunnington Jr (Lockheed Missiles and Space Co, Inc), J C Riple (AirResearch Mfg Co), C F Baerst (AirResearch Mfg Co) and G Garmong (Rocketdyne) Jul 1978 356 p refs 2 Vol (Contract NAS1-14614) (NASA-CR-145369-Vol-2) Avail NTIS HC A16/MF A01 CSCL 01C

For abstract, see N78-31085

**N78-31087#** Royal Aircraft Establishment Farnborough (England)  
**TECHNICAL EVALUATION OF FLYING WEAPON SYSTEMS**

P Ebeling Mar 1978 28 p refs Transl into ENGLISH of 'Technische Bewertung Fliegender Waffensysteme' Rept BMVg-FBWT-75-29-Pt-2 Fed German Min of Defense West Germany 1975 p 243-272 (RAE-Lib-Trans-1948, BR64083) Avail NTIS HC A03/MF A01

Some details on the evaluation of military aircraft and missile weapon systems are presented. A technical evaluation of the different phases of weapon systems development and procurement is explained and a brief survey is given of the different methods involved. Two digital computer programs are detailed for design and scaling of aircraft and tactical missiles and their possible applications within the technical evaluation of weapon systems.

G G

**N78-31088#** Lockheed-California Co, Burbank  
**GENERAL AVIATION AIRPLANE STRUCTURAL CRASH-WORTHINESS USER'S MANUAL VOLUME 1 PROGRAM KRASH THEORY Final Report, Jun 1976 - Feb 1978**  
 Max A Gamon Feb 1978 278 p refs  
 (Contract DOT-FA75WA-3707) (AD-A055898, LR-28307-Vol-1 FAA-RD-77-189-1-Vol-1) Avail NTIS HC A13/MF A01 CSCL 01/2

A comprehensive description of program KRASH is provided. Included are the following sections: (1) Program KRASH Description and Theory and (2) Program Controls and Listing.

B B

**N78-31089#** Boeing Vertol Co Philadelphia Pa  
**HELICOPTER TRANSMISSION VIBRATION AND NOISE REDUCTION PROGRAM VOLUME 1 TECHNICAL REPORT Final Report, Jun 1974 - Oct 1977**  
 John J Sciarra, Robert W Howells, Joseph W Lenski Jr, Raymond J Drago and Edward G Schaeffer Mar 1978 307 p refs  
 (Contract DAAJ02-74-C-0040 DA Proj 1G2-62207-AH-89) (AD-A055104 D210-11236-1 USARTL-TR-78-2A) Avail NTIS HC A14/MF A01 CSCL 01/3

The objective of the Helicopter Transmission Vibration/Noise Reduction Program was to generate analytical tools for the prediction and reduction of helicopter transmission vibration/noise that provide the capability to perform trade studies during the design stage of a program. Application of this optimization capability yields drive train components that are dynamically quiet with reduced vibration/noise levels and inherently longer life.

Author (GRA)

**N78-31091#** Army Aviation Engineering Flight Activity, Edwards AFB, Calif

**MODIFIED HELICOPTER ICING SPRAY SYSTEM EVALUATION Final Report, 23 Sep - 4 Dec 1976**

Gary L. Bender, Mathew S. Mathews III and John S. Tulloch  
Mar 1977 87 p refs  
(AD-A055039, USAAEFA-75-04) Avail NTIS  
HC A05/MF A01 CSCL 01/3

All tests required 55 flight hours (41 flights). During the first testing period, structural and dynamic tests were conducted throughout the CH-47C flight envelope and the physical properties of the spray cloud generated by the modified icing spray system were measured. Two deficiencies were found: boom stresses greater than the materials endurance limit which severely restricted the maximum airspeed at which the system could be operated (110 knots true airspeed) and an inadequate and unsafe boom extension/retraction system. Additional modification was made to the system and envelope expansion tests were repeated. During the second testing period, the two deficiencies were eliminated. However, flight with the boom retracted (except at very low airspeeds) and flight at a rotor speed of 235 rpm continued to produce excessive boom stresses. These excessive stresses constituted a shortcoming. Additional modification to the HISS was made to correct this shortcoming. The modified HISS with this additional change is airworthy within the unrestricted CH-47C flight envelope.

GRA

**N78-31092#** Army Agency for Aviation Safety, Fort Rucker Ala

**ANTITORQUE TRAINING: EVALUATION OF EFFECTIVENESS IN REDUCING MISHAP LOSSES**

William C. McDaniel, Feb 1978 19 p refs  
(AD-A055040, USAAVS-TR-78-2) Avail NTIS  
HC A02/MF A01 CSCL 05/9

This evaluation addressed the effectiveness of training for antitorque system malfunctions. An evaluation team composed of 11 analysts reviewed 121 mishaps meeting established criteria. Results indicated that emergency antitorque training was effective in those situations involving loss or impaired control of the antitorque system. In the case of emergency situations involving a loss of thrust or loss of component, present antitorque training appears to be less than adequate. The data supports continuation of emergency antitorque training. Results further imply that written procedures for coping with loss of thrust in the UH-1 and OH-58 should be reviewed for clarity and revised for ease of application. Further study should be conducted to determine the optimal course of action to take in the event of antitorque failure or malfunction.

Author (GRA)

**N78-31093#** Arinc Research Corp, Annapolis, Md  
**PROGRAM ANALYSES FOR THE S-3 WEAPON SYSTEM IMPROVEMENT PROGRAM Final Summary Report, 15 Sep 1977 - 15 Jun 1978**

W. Amos, 15 Jun 1978 20 p  
(Contract N00019-77-C-0495)  
(AD-A055887, Rept-1708-01-1-1762) Avail NTIS  
HC A02/MF A01 CSCL 01/3

The overall objective of the program is to update major avionic and weapon subsystems of the S-3A to provide improvements and additional capabilities required to perform certain sea control mission elements during the late 1980s through the 1990s.

GRA

**N78-31094#** Army Aviation Research and Development Command, St. Louis, Mo

**COMPUTERIZED AIRCRAFT ATTRITION PROGRAM Final Report**

Ralph O. Tate, May 1978 35 p refs  
(AD-A055784, USAAVRADCOM-TR-78-9) Avail NTIS  
HC A03/MF A01 CSCL 01/3

The Computerized Aircraft Attrition Program (THAAP) presented in this report provides for a rapid method of calculating the forecasted attrition to be experienced by a given homogenous fleet of aircraft over a specified period of time. The THAAP program is designed to be a time-saving tool which will provide the quantity of aircraft attrited and resultant flying hour program for the adjusted operational fleet. The program will provide for the time-phased induction and withdrawal of aircraft from the fleet over the operational life of the system. The information or output from the program is intended to be used as input to time-phased cost estimates, particularly operating and support cost estimates. The program's output is ideally suited for those studies which are performed manually or by computerized cost models which do not have a fleet attrition capability.

Author (GRA)

**N78-31095#** Aeronautical Systems Div, Wright-Patterson AFB, Ohio

**CARGO AIRCRAFT AND SPACECRAFT FORWARD RESTRAINT CRITERIA Final Report, Jun 1976 - Dec 1977**

Joseph L. Weingarten, Dec 1977 91 p refs Revised  
(AD-A055343, ASD-TR-76-30) Avail NTIS HC A05/MF A01  
CSCL 01/2

This investigation was primarily conducted to review probability projections of crashes of Air Force cargo aircraft as developed in 1971. The 1971 effort resulted in considerable changes to the air cargo operations. This included a lowering of restraint criteria to 3Gs with an auxiliary 9G net system. The objective of this effort was to determine if further reductions could be made through removal of the auxiliary 9G net, in addition to both aircraft and spacecraft cargo restraint criteria. Restraint and aircraft modifications were also examined. This effort viewed probabilities, based on the original data from January 1960 to July 1971, and an expanded base to July 1976 for a total of 40.4 million hours. Further, the original study viewed only major accidents, minor accidents have been added to this review. The probabilities developed in 1971 were conservative relative to actual occurrence over the past few years. Further, new probabilities were developed that show removal of the barrier net is feasible and appropriate changes are recommended to the current criteria. Commercial experience with barrier nets was also investigated and accidents where barriers were impacted are detailed.

GRA

**N78-31096#** Mechanics Research, Inc., McLean, Va  
**DEMONSTRATION OF THE MICROWAVE ICE PROTECTION CONCEPT Final Report, Jun 1976 - Jun 1977**

Bertram Magenheimer, May 1978 127 p refs  
(Contract DAAJ02-76-C-0052, DA Proj 1L2-62209-AH-76)  
(AD-A055824, USAAMRDL-TR-77-34) Avail NTIS  
HC A07/MF A01 CSCL 01/3

An experimental demonstration of the microwave ice protection concept for helicopter rotor blades is presented. By shedding ice samples from experimental ice protection devices, microwave ice protection theory was verified. Increased power density in the ice layer is achieved by operating at higher microwave frequencies, resulting in significantly shorter shed times for the same microwave power. The microwave concept offers the possibility of constructing ice protection systems totally out of nonmetallic materials that will not deteriorate the radar cross section of composite blades. Incremental weight, cost, and power estimates for equipping various helicopters are presented. An evolving microwave tube technology promises significant improvements in cost, efficiency, weight, and power drain while providing higher microwave powers and consequently shorter shed times. It is demonstrated that a combination erosion shield/surface waveguide constructed from ultrahigh molecular weight polyethylene (UHMWPE) fortified with a layer of polyurethane near the tip did not deteriorate the mean time between unscheduled maintenance (MTBUM) of the blade below that of the polyurethane erosion shield by itself. When the erosion shield/surface waveguide reaches the MTBUM, it can be replaced without discarding the blade.

Author (GRA)

**N78-31097#** Massachusetts Inst of Tech Cambridge Aeroelastic and Structures Research Lab

**A STUDY OF ANALOG PROGRAMMING FOR PREDICTION OF CRACK GROWTH IN AIRCRAFT STRUCTURES SUBJECTED TO RANDOM LOADS Final Report, Sep 1976 - Jun 1977**

Michael Weinreich Richard F Harris, Oscar Orringer, and John F McCarthy, Jr Jun 1977 94 p refs  
(Contract F33615-76-C-3109)  
(AD-A055789, ASRL-TR-186-2, AFFDL-TR-77-58) Avail NTIS HC A05/MF A01 CSCL 01/3

Results of a program to study an analog approach to risk analysis of random-load crack growth are presented. The two major objectives were to implement certain specific simulations of crack growth on hybrid analog/digital hardware and to develop an improved approach to the modeling of random loads. Under the first objective all but two of the specific simulations were implemented and verified. One not implemented required hardware unavailable at the installation utilized for the simulations. The other was identified as not conducive to analog simulation. These simulations utilized a 'damage parameter' (rather than crack size itself as the random variable) to provide well behaved and stable analog behavior. Under the second objective, a method of generating load statistics by direct inspection of large quantities of flight data was developed. In the course of this development the applicability of estimation theory to the present problem was identified. The techniques of estimation theory applied to analysis of damage in terms of an appropriately chosen damage parameter promise to provide improved efficiency and accuracy in aircraft fatigue damage risk analysis. GRA

**N78-31098#** Naval Air Development Center Warminster Pa Aircraft and Crew Systems Technology Directorate  
**STATISTICAL REVIEW OF COUNTING ACCELEROMETER DATA FOR NAVY AND MARINE FLEET AIRCRAFT FROM 1 JANUARY 1962 TO 31 DECEMBER 1977 Semi-annual Summary Report, 1 Jan 1962 - 31 Dec 1977**

Alan M Kaniss 1 May 1978 153 p  
(AD-A055672 NADC-13920-2) Avail NTIS HC A08/MF A01 CSCL 01/3

This report is a specialized summary of normal acceleration data recorded by counting accelerometers. Data are separated by calendar time and mission category. Only data reported in the counting accelerometer program are included. Author (GRA)

**N78-31099#** Sandia Labs Livermore Calif Test Products Div 8412

**GRAPHICS FOR THE HYBRID STORES SEPARATION SIMULATION OF THE B77 SYSTEM**

R G Marmon Mar 1978 43 p refs  
(Contract EY-76-C-04-789)

(SAND-78-8212) Avail NTIS HC A03/MF A01

The B77 is pictorially illustrated with the B52 F111 F4 and A7 aircraft in hybrid simulations. The design goals are covered and pictorial plots are given to verify the results. Actual flight test film is compared to a simulation with good results. ERA

**N78-31100#** RAND Corp, Santa Monica Calif  
**ESTIMATED COSTS OF EXTENDED LOW-RATE AIRFRAME PRODUCTION Interim Report**

David J Dreyfuss and Joseph P Large Mar 1978 69 p refs  
(Contract F49620-77-C-0023)  
(AD-A054834, RAND/R-2243-AF) Avail NTIS HC A04/MF A01 CSCL 01/3

Achieving a high rate of production as quickly as possible has traditionally been viewed as the most effective way of satisfying time-urgent inventory requirements while keeping production costs low. One common consequence has been the delivery of less than fully qualified production articles. This report discusses the cost of extending initial low-rate production while tests of early production articles continue. The relatively

small resultant cost increases can potentially be offset by the delivery of more capable production items lessened needs for postdelivery modification or retrofit and lower total-life system costs. Author (GRA)

**N78-31101#** National Aeronautics and Space Administration Langley Research Center, Hampton, Va  
**SIMULATION AND FLIGHT EVALUATION OF A HEAD-UP LANDING AID FOR GENERAL AVIATION**

Randall L Harris, Sr, Maxwell W Goode and Kenneth R Yenni Sep 1978 38 p refs  
(NASA-TP-1276 L-12197) Avail NTIS HC A03/MF A01 CSCL 01D

A head-up general aviation landing aid called a landing site indicator (LASI) was tested in a fixed-base visual simulator and in an airplane to determine the effectiveness of the LASI. The display, which had a simplified format and method of implementation presented to the pilot in his line of sight through the windshield a graphic representation of the airplane's velocity vector in each testing model (simulation of flight) each of 4 pilots made 20 landing approaches with the LASI and 20 approaches without it. The standard deviations of approach and touchdown parameters were considered an indication of pilot consistency. Use of the LASI improved consistency and also reduced elevator aileron and rudder control activity. Pilots comments indicated that the LASI reduced work load. An appendix is included with a discussion of the simulator effectiveness for visual flight tasks. Author

**N78-31102#** Research Triangle Inst, Research Triangle Park N C

**AFAL SIMULATION FACILITY/CAPABILITY MANUAL VOLUME 1 EXECUTIVE SUMMARY AND SYSTEMS AVIONICS DIVISION Final Technical Report, Jul 1976 - Jun 1977**

Richard A Whisnant, W Howard Ruedger, Ronald L Earp and James Haidt Wright-Patterson AFB Ohio AFAL 30 Jun 1977 411 p refs

(Contract F33615-76-C-1308)  
(AD-A055591, AFAL-TR-77-118-Vol-1) Avail NTIS HC A18/MF A01 CSCL 01/3

The Air Force Avionics Laboratory (AFAL) at Wright-Patterson AFB is the focal point for development of new avionics technology for the Air Force. In order to carry out this responsibility a significant capability to simulate physical avionics systems and components has been created by the AFAL divisions. Of prime concern is the effective use of these simulation facilities in the face of continually increasing performance requirements, technological advances and rising flight-test costs. GRA

**N78-31103#** National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio

**GAS PATH SEAL Patent Application**

Robert C Bill and Lawrence P Ludwig inventors (to NASA) Filed 4 Aug 1978 9 p  
(NASA-Case-Law-12131-2, US-Patent-Appl-SN-931090) Avail NTIS HC A02/MF A01 CSCL 21E

A gas path seal for a turbine engine or compressor is provided. The gas path seal comprises a shroud of material wearable or abradable relative to the material of the turbine or compressor blades and closely spaced from the blade tips. A compliant backing preferably of several layers of corrugated metal or a compliant material covered with a thin layer of ductile material is provided about the shroud and a rigid mounting surrounds the compliant backing. The novel feature is a compliant backing between the shroud and mounting. As a result normal forces during a blade rub are limited and wear is reduced and the life of the shroud is lengthened for a design of comparable clearance of blade to shroud. NASA

**N78-31104** Aeronautical Research Labs, Melbourne (Australia)  
**A THEORETICAL STUDY OF THE PERFORMANCE OF A NUMBER OF DIFFERENT AXIAL-FLOW TURBINE CONFIGURATIONS UNDER CONDITIONS OF PULSATING FLOW**  
Lincoln Erm Jul 1977 55 p refs

(ARL-Mech-Eng-Rept-149 AR-000-734) Copyright Avail Issuing Activity

The best turbine configuration for operation with the pulsating flow occurring in a constant volume gas turbine was determined and described. The method of turbine performance prediction for steady flow operating conditions was developed for a single stage axial flow turbine. During this development it was found that existing correlations for determining turbine loss characteristics at high negative angles of incidence were inadequate, and consequently a modified approach was developed. Four basic two stage turbines each having different blades angles as well as several versions of one of these were chosen for analysis. The mean efficiencies of these machines for pulsating flow operating conditions were estimated by using a quasi-steady method of analysis. The results obtained for the selected turbines are presented and compared with the results for the radial inflow turbine. A configuration is proposed that could possibly give better mean efficiencies under pulsating flow conditions than those actually considered. B B

**N78-31105\*#** Naval Air Propulsion Test Center Trenton NJ  
**ROTOR BURST PROTECTION PROGRAM STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN US COMMERCIAL AVIATION DURING 1975 Final Report, 1974 - 1975**

R A DeLucia and G J Mangano May 1977 29 p  
(NASA Order C-41581-B)  
(NASA-CR-135304 NAPT-PE-106) Avail NTIS  
HC A03/MF A01 CSCL 21E

Statistics on gas turbine rotor failures that have occurred in U S commercial aviation during 1975 are presented. The compiled data were analyzed to establish (1) The incidence of rotor failures and the number of contained and uncontained rotor bursts (2) The distribution of rotor bursts with respect to engine rotor component, i.e fan compressor or turbine (3) The type of rotor fragment (disk rim or blade) typically generated at burst (4) The cause of failure, (5) The type of engines involved, and (6) The flight condition at the time of failure. B B

**N78-31106\*#** Pratt and Whitney Aircraft Group West Palm Beach Fla Government Products Div  
**ADVANCED OPTICAL BLADE TIP CLEARANCE MEASUREMENT SYSTEM**

M J Ford R E Honeycutt R E Nordlund and W W Robinson Jul 1978 85 p refs  
(Contract NAS3-20479)  
(NASA-CR-159402 FR-10200A) Avail NTIS  
HC A05/MF A01 CSCL 21E

An advanced electro-optical system was developed to measure single blade tip clearances and average blade tip clearances between a rotor and its gas path seal in an operating gas turbine engine. This system is applicable to fan compressor and turbine blade tip clearance measurement requirements and the system probe is particularly suitable for operation in the extreme turbine environment. A study of optical properties of blade tips was conducted to establish measurement system application limitations. A series of laboratory tests was conducted to determine the measurement system's operational performance characteristics and to demonstrate system capability under simulated operating gas turbine environmental conditions. Operational and environmental performance test data are presented. Author

**N78-31107\*#** Notre Dame Univ Ind Dept of Electrical Engineering

**ALTERNATIVES FOR JET ENGINE CONTROL Final Technical Report, 1 Mar 1977 - 28 Feb 1978**

R J Leake and M K Sain 28 Feb 1978 233 p refs  
(Grant NsG-3048)  
(NASA-CR-157578) Avail NTIS HC A11/MF A01 CSCL 21E

General goals of the research were classified into two categories. The first category involves the use of modern multivariable frequency domain methods for control of engine models in the neighborhood of a quiescent point. The second category involves the use of nonlinear modelling and optimization techniques for control of engine models over a more extensive

part of the flight envelope. In the frequency domain category, works were published in the areas of low-interaction design polynomial design and multiple setpoint studies. A number of these ideas progressed to the point at which they are starting to attract practical interest. In the nonlinear category, advances were made both in engine modelling and in the details associated with software for determination of time optimal controls. Nonlinear models for a two spool turbofan engine were expanded and refined and a promising new approach to automatic model generation was placed under study. A two time scale scheme was developed to do two-dimensional dynamic programming and an outward spiral sweep technique has greatly speeded convergence times in time optimal calculations. F O S

**N78-31108\*#** General Electric Co Cincinnati Ohio Aircraft Engine Group  
**ENERGY EFFICIENT ENGINE PRELIMINARY DESIGN AND INTEGRATION STUDIES Final Report, Jan 1977 - Apr 1978**

R P Johnston R Hirschkron C C Koch R E Neitzel and P W Vinson Sep 1978 417 p refs  
(Contract NAS3-20627)  
(NASA-CR-135444 R78AEG510) Avail NTIS  
HC A18/MF A01 CSCL 21E

Parametric design and mission evaluations of advanced turbofan configurations were conducted for future transport aircraft application. Economics, environmental suitability and fuel efficiency were investigated and compared with goals set by NASA. Of the candidate engines which included mixed- and separate-flow, direct-drive and geared configurations, an advanced mixed-flow direct-drive configuration was selected for further design and evaluation. All goals were judged to have been met except the acoustic goal. Also conducted was a performance risk analysis and a preliminary aerodynamic design of the 10 stage 23:1 pressure ratio compressor used in the study engines. Author

**N78-31111#** Mechanical Technology Inc Latham N Y  
**TURBINE ENGINE ROTORDYNAMIC EVALUATION, VOLUME 1 Final Report, 1 May 1975 - 1 Jun 1976**

R A Rio Wright-Patterson AFB Ohio AFAPL Jan 1978 218 p  
(Contract F33615-75-C-2035 AF Proj 3066)  
(AD-A055262 MTI-76TR41-Vol-1 AFAPL-TR-76-81-Vol-1)  
Avail NTIS HC A10/MF A01 CSCL 21/5

Eight jet engine models within the Air Force inventory (the T56 J57 J79 J85 TF30 TF33 TF39 and TF41) have been analyzed to determine critical speeds, unbalance response, blade loss effects and maneuver deflections. The effects of dampers, thrust loads and balancing requirements while not analyzed in depth were noted where applicable in the description of the engine's dynamic behavior. Each rotor design was then classified into categories of dynamic sensitivity. Five test elements were manufactured and vibrated to obtain experimental data for correlation with analytical modeling predictions. The four cylindrical elements, each of which incorporated either a steep cone, shallow cone, flat plate or thin shell were excited to obtain the first three lateral natural frequencies. Because of manufacturing problems with hardness and weld penetration, measured frequencies were below those predicted. The fifth test element was a machined flexible bearing support for use in parallel with a squeeze film damper. After static and dynamic testing of this representative flexible bearing support, the results were within 10% of the analytical prediction for this element. The information from this analytical and experimental study has resulted in a technology plan whose goal is to improve the technological capabilities for the purpose of reducing costs associated with reliability and maintainability of U S Air Force engines. Author (GRA)

**N78-31112#** Grumman Aerospace Corp Bethpage, N Y Research Dept

**GROUND IMPINGEMENT OF A FAN JET EXHAUST PLUME**

William G Hill Jr and Richard C Jenkins May 1978 52 p refs

(AD-A054832 RM-653) Avail NTIS HC A04/MF A01 CSCL 21/2

This report describes an investigation of the ground impingement properties of a fan jet engine exhaust. Measurements were taken using both a simulated fan jet of laboratory scale and a large scale operating fan jet engine. The results of this work will be used to modify existing models of exhaust-ground interactions to include the unique properties of fan jet impingement on the flow field under a hovering VTOL aircraft with particular application to the Grumman Design 698. The simulated fan jet exhaust was produced by cold air issuing from a concentric nozzle and utilizing a screen in the inner section to develop the lower dynamic pressure that is characteristic of a real fan jet engine. Measurements taken during impingement of the jet engine exhaust consisted of pitot pressure profiles above the ground. Wall jet velocity profiles obtained in these two impingement flows showed close agreement when scaled by size and nozzle pressure ratio. This favorable comparison demonstrates the effectiveness of using cold air scale model flows to simulate the impingement flow field of a real fan jet engine exhaust. The effects on the impingement flow of an immersed control vane were investigated in both the simulated and the fan jet engine exhausts. Author (GRA)

**N78-31113#** Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div  
**RADIOGRAPHIC EXAMINATION OF T55 ENGINE Final Report, Apr 1977 - Jan. 1978**  
John T Carroll Jan 1978 24 p refs  
(Contract DAAJ01-77-C-0354)  
(AD-A055108 FR-9560 USAAVRADCOM-CH47-M-78-01)  
Avail NTIS HC A02/MF A01 CSCL 21/5

Approximately 1000 radiographs and three hours of video fluoroscope tapes of a Lycoming T55-L-712 turbine engine were obtained at various engine operating conditions. These X-ray images were needed to determine certain static and running clearances in the T55 engine. Author (GRA)

**N78-31114#** Boeing Vertol Co., Philadelphia Pa  
**ENGINE/AIRFRAME/DRIVE TRAIN DYNAMIC INTERFACE DOCUMENTATION Final Report**  
D A Richardson and J R Alwang Apr 1978 209 p refs  
(Contract DAAJ02-77-C-0040)  
(AD-A055766 D210-11328-1, USARTL-TR-78-11) Avail  
NTIS HC A10/MF A01 CSCL 21/5

Engine/airframe/drive train dynamic interface problems of Boeing helicopters are described. The investigation leading to the problem solution, the solution and its limitations are discussed. Forecasts of potential future problems, recommendation for investigations, and specifications are included. Author (GRA)

**N78-31115#** General Electric Co. Lynn Mass. Aircraft Engine Group  
**TURBINE TIP CLEARANCE MEASUREMENT Final Report, Jun 1975 - Oct 1977**  
Lawrence C Baker, Gordon E Grady, and Hagen R Mauch  
Mar 1978 179 p refs  
(Contract DAAJ02-75-C-0046)  
(AD-A055765 R78AEG017 USARTL-TR-78-4) Avail NTIS  
HC A09/MF A01 CSCL 21/5

Turbine tip clearance design and prediction techniques have been limited to analytical methods for lack of an accurate direct measurement device. It was the purpose of this program to substantiate prediction correlations utilizing direct measurements from a laser-powered miniaturized turbine tip clearance device (MTCMD) previously developed under Applied Technology Laboratory support. The resultant comparisons of measured versus analytically determined clearances based on measured temperatures would be used to verify or to improve the analytical techniques. GRA

**N78-31117#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Brunswick (West Germany) Abt Flugkoerperantriebe

**FLAME STABILIZATION IN A RAMJET COMBUSTION CHAMBER BY MEANS OF A PILOT GAS GENERATOR**

Egbert Riestler 16 Dec 1977 54 p refs In GERMAN, ENGLISH summary. Report will also be announced as translation (ESA-TT-511)  
(DLR-FB-77-54) Avail NTIS HC A04/MF A01, DFVLR, Cologne DM 28,20

Flame stabilization in ramjet combustors being difficult because of the high combustion chamber entrance velocity and the low temperature, the shifting of the flame out limit towards lower equivalent ratios by use of a pilot gas generator was investigated. The velocity distributions are determined in a typical arrangement of a ramjet combustor. The flame-out limit was measured, at first without, afterwards with a pilot gas generator. The results were compared with each other. As pilot gas generator a small stoichiometrical propane-oxygen-burner was used. Author (ESA)

**N78-31118#** Iowa State Univ of Science and Technology Ames Engineering Research Inst  
**ANALYSIS OF MULTISTAGE, AXIAL FLOW TURBOMACHINE WAKE PRODUCTION, TRANSPORT, AND INTERACTION Interim Report, 1 Oct. 1976 - 30 Sep 1977**

J H Wagner and T H Okishi Dec 1977 113 p refs  
(Grant AF-AFOSR-2916-76)  
(AD-A055754, ISU-ERI-AMES-78173, TCRL-10  
AFOSR-78-1028TR) Avail NTIS HC A06/MF A01 CSCL 20/4

A periodic-average flow measurement technique involving a hot-wire anemometer system was used to measure the periodically unsteady and three-dimensional fluid velocity field between blade rows in the first stage of a low-speed multistage, axial-flow research compressor. These data suggest that the fluid flow through the imbedded rotor and stator rows is appreciably unsteady, in a periodic fashion in portions of the compressor annulus. Illustrative examples of periodic-average fluid flow field variation with rotor blade sampling position in stop-action sequence are presented for different locations in the compressor. A simple, first order approximation physical description of the blade wake flow transport and interaction process largely based on experimental data interpretation is proposed to organize and to help explain the observations made. Blade span variations of flow data reflect end-wall effects. Inlet guide vane exit flow data involve some unusual unsteady flow effects. Author (GRA)

**N78-31119#** Hughes Helicopters, Culver City, Calif  
**EVALUATION OF A CIRCULATION CONTROL TAIL BOOM FOR YAW CONTROL Final Report, 1 Mar 1977 - 1 Feb 1978**

A H Logan Apr 1978 52 p refs  
(Contract DAAJ02-77-C-0018)  
(AD-A055116, HH-77-307, USARTL-TR-78-10) Avail NTIS  
HC A04/MF A01 CSCL 01/3

An experimental tail boom which uses circulation control principles to produce antitorque force from the main rotor downwash was flight-tested over a typical flight regime. The flight envelope included hover, sideward and rearward flight to 30 knots, forward flight to 80 knots, climbs, turns, and maneuvers, such as pull-ups, and push-overs at 60 knots, and autorotation. GRA

**N78-31120#** Applied Devices Corp. Kissimmee, Fla  
**A MODULAR ADAPTIVE, VARIABLE FUNCTION FLIGHT CONTROL SENSOR Final Report, Mar 1975 - Feb 1977**  
Roland Pittman Oct 1977 80 p refs  
(Contract F33615-75-C-3154)  
(AD-A055175 AFFDL-TR-77-112) Avail NTIS  
HC A05/MF A01 CSCL 01/4

This development effort culminated in flight-worthy test articles of multi-function sensors, for use in 'strap-down' flight control systems. The multi-function sensor with one moving part, performs the equivalent to a two-axis rate gyro, two-axis linear accelerometer, a three-axis magnetic field sensor, a two-axis

electric field sensor and a two-axis air data probe This development effort demonstrated the feasibility of a multi-function sensor which brings together the elements of a multi-mode flight control sensing scheme that is one which takes a measure of the earth's electric and magnetic fields the air mass through which the carrying vehicle is moving, and a measure of vehicle angular velocity and linear acceleration Its use is intended to determine vehicle heading velocity, and attitude with respect to the magnetic north air mass flow and local vertical The aim of the effort was to reduce cost, power consumption, volume and mechanical complexity by an order of magnitude GRA

**N78-31121#** Air Force Inst of Tech Wright-Patterson AFB, Ohio School of Engineering  
**THE TERRAIN FOLLOWING TASK FOR THE ADVANCED TACTICAL FIGHTER USING DISCRETE OPTIMAL CONTROL M S Thesis**

Ross Leon Simmons Dec 1977 110 p refs  
 (AD-A055196 AFIT/GE/EE/77-39) Avail NTIS  
 HC A06/MF A01 CSCL 01/3

Through the use of state space continuous optimal control, and discrete optimal control, a digital flight control system was designed for the terrain following task After formulating the aircraft linear perturbation model the deterministic regulator problem was solved with a quadratic performance index to provide the desired continuous closed loop system The system and performance index were then discretized to form a discrete deterministic regulator problem This discrete regulator problem was then solved as a function of sample rate using eigenvector decomposition to determine a minimum acceptable rate for sampling The effects of sample rate on the system were then examined A sample rate of five hertz was shown to be high enough to adequately form the desired controls A reference command generator based on constant energy path legs was developed to provide the required reference states and control inputs The reference terrain following path was generated by an optimal cubic spline algorithm The aircraft was shown to track the desired path in a highly acceptable manner through the use of a hybrid simulation The design method utilized is recommended for consideration in designing the digital flight control system for other flight control tasks Author (GRA)

**N78-31122#** Air Force Inst of Tech Wright-Patterson AFB, Ohio School of Engineering  
**OPTIMAL TERRAIN FOLLOWING CONTROLLER FOR AN OPTIMIZED SPLINE REFERENCE PATH M S Thesis**

Ronald T Kelly Dec 1977 136 p refs  
 (AD-A055234 AFIT/GA/EE/77-3) Avail NTIS  
 HC A07/MF A01 CSCL 01/3

This thesis presents the design of a proposed terrain following flight controller capable of tracking a cubic spline reference path The controller tracks only the longitudinal motion, however, it provides both thrust and elevator control The controller is based on a nonlinear reference model constructed from an optimized spline path The spline path altitude and associated derivatives are computed The longitudinal equations of motion are linearized about the reference trajectory and a truth model of actual aircraft motion is developed Deviations from the nonlinear reference trajectory to the actual provide a linear system Optimal control theory is used to solve the resulting linear regulator problem The feedback gains are calculated from the steady-state Riccati matrix equation The two system controls are updated using these feedback gains Results show the feedback controller to be stable and capable of tracking the cubic spline reference path The performance index weighting matrices can be adjusted to improve the controller The resulting controller can provide both good path control and engine control to improve vehicle survivability engine life and fuel consumption Author (GRA)

**N78-31123#** Princeton Univ N J Dept of Aerospace and Mechanical Sciences  
**THE INFLUENCE OF THROTTLE AUGMENTED STABILITY (APCS) AND SHORT PERIOD CONTROL CHARACTERISTICS ON THE LANDING APPROACH Final Technical Report, Jul. 1975 - Jun. 1976**  
 George E Miller, Shigeo Sembongi, and Edward Seckel Mar

1978 182 p refs  
 (Contract N00019-75-C-0528)  
 (AD-A055892, AMS-1325) Avail NTIS HC A09/MF A01  
 CSCL 01/2

The results of an analysis and flight test research program sponsored by the Naval Air Systems Command are presented The equivalence between Approach Power Compensator System (APCS) feedbacks and aircraft stability derivatives is shown and expressions relating these terms to system decoupling are developed in the analysis Attitude command washout prefilter and conventional flight control systems are compared in ground and flight tests Pseudo-velocity-type APCS configurations were found to provide better flight path control than predominantly angle of attack type APCS configurations for the carrier approach task For typical levels of aircraft static stability, increasing the short period frequency through a simple pitch attitude command flight control system improved the flight path response

Author (GRA)

**N78-31124#** Missouri Univ - Columbia Dept of Electrical Engineering  
**INHERENT ERRORS IN ASYNCHRONOUS DIGITAL FLIGHT CONTROLS Annual Technical Report, 1 Feb 1977 - 31 Jan 1978**

Charles Shvinsky 31 Mar 1978 254 p refs  
 (Grant AF-AFOSR-2968-76)  
 (AD-A055649, AFOSR-78-1054TR) Avail NTIS  
 HC A12/MF A01 CSCL 01/4

This report describes research on redundancy management in digital flight control systems The emphasis is on the properties, techniques, and requirements associated with the operations of monitoring and voting and their effects on the closed loop system operation when asynchronous sampling is used Part 1 is concerned primarily with the monitoring operation for quadredundant input signals Part 2 presents three extensions to a previously reported model for closed loop flight control systems that have dual-redundant asynchronous digital controllers GRA

**N78-31125#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany) Abt Regelungssysteme

**CONTROL SYSTEM DESIGN USING VECTOR-VALUED PERFORMANCE CRITERIA WITH APPLICATION TO THE CONTROL RATE REDUCTION IN PARAMETER INSENSITIVE CONTROL SYSTEMS**

Gerhard Kreisselmeier 20 Dec 1977 36 p refs In GERMAN, ENGLISH summary Report will also be announced as translation (ESA-TT-512)  
 (DLR-FB-77-55) Avail NTIS HC A03/MF A01 DFVLR Cologne DM 17

For a realistic flight control problem it is shown that a vector performance criterion is a natural and meaningful criterion for the judgement and the design of a control system For the controller design then a strategy is suggested, which includes the vector-valued performance criterion in the optimization of the control system such that a systematic step by step improvement of the performance vector is achieved, i.e. improvement of certain of its components without undesirable deterioration of the remaining components which finally yields the best possible controller design This technique is applied to the design of a parameter insensitive flight path controller which shows a larger sensitivity reduction than obtained previously while a considerable reduction of the maximal control rate is achieved This controller is the first to prove, that a considerable sensitivity reduction can be possible without increasing the requirements of the actuator system These results are primarily due to the direct consideration of the control rate in the design

Author (ESA)

**N78-31126#** Advisory Group for Aerospace Research and Development, Paris (France)  
**CONSIDERATIONS ON WING STORES FLUTTER ASYMMETRY, FLUTTER SUPPRESSION**  
 Jul 1978 42 p Presented at the 46th Struct and Mater Panel Meeting, Aalborg, Denmark, 10-14 Apr 1978

(AGARD-R-668, ISBN-92-835-1290-1) Avail NTIS  
HC A03/MF A01

The problems pertaining to aeroelasticity and flutter of aircraft wing stores are explained and solutions are suggested

**N78-31127#** Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany)

**ASYMMETRIC STORE FLUTTER**

A Lotze *In* AGARD Considerations on Wing Stores Flutter Jul 1978 p 1-19 refs

Avail NTIS HC A03/MF A01

A large number of asymmetrical store configurations were investigated by analysis and wind tunnel testing, to establish the physical background for the flutter mechanism of asymmetrical stores and to find out whether unfavorable effects of asymmetries exist only for mild flutter or could also occur for flutter cases exhibiting large gradients of aerodynamic damping with airspeed. Based on the results it is recommended to establish flutter trends by variation of important parameters before actual store configurations are calculated. Once the regions with possible lower flutter speeds of asymmetrical stores are defined, those configurations can be selected which have to be investigated

LS

**N78-31128\*#** National Aeronautics and Space Administration Langley Research Center, Hampton, Va

**DEMONSTRATION OF AIRCRAFT WING/STORE FLUTTER SUPPRESSION SYSTEMS**

Chintsun Hwang (Northrop Corp., Hawthorne, Calif.), Bertil A Winther (Northrop Corp., Hawthorne, Calif.), Thomas E Noll (AFFDL, Wright-Patterson AFB, Ohio), and Moses G Farmer *In* AGARD Considerations on Wing Stores Flutter Jul 1978 p 21-37 refs

Avail NTIS HC A03/MF A01

Preliminary results are presented of the design analysis and the test progress of active wing/store flutter suppression systems on a lightweight fighter aircraft. Three configurations were selected for final testing. Two of these configurations were deliberately designed to exhibit low flutter speeds with rapid reduction in damping at the incipient flutter condition. After initial tunnel entries, which showed the need for certain improvements in the model and the control system design, substantial increases in the flutter speeds were achieved using both leading and trailing edge control surfaces separately. For the most critical configuration, a demonstrated improvement of 18% and a projected improvement of 29% in the dynamic pressure were accomplished

LS

**N78-31130#** Mitre Corp, McLean Va Metrek Div  
**PARAMETERS OF FUTURE ATC SYSTEMS RELATING TO AIRPORT CAPACITY/DELAY Final Report**

Andrew L Haines Apr 1978 25 p refs

(Contract DOT-FA78WA-4075)

(AD-A055482 MTR-7766, FAA-EM-78-8) Avail NTIS  
HC A02/MF A01 CSCL 01/5

Estimates of changes in longitudinal spacing on final approach that may be realized as the products of the engineering and development programs become available are presented. The potential for reducing interarrival errors and runway occupancy time is also discussed. The parametric values presented are to be used by the FAA/User Group Airport Case Study Teams in assessing the potential impact of future airport changes on delay/capacity. Parameter values related to the estimation of present day delay/capacity are also presented

SB S

**N78-31131#** Mitre Corp McLean, Va Metrek Div  
**ANALYSIS OF RUNWAY OCCUPANCY TIMES AT MAJOR AIRPORTS Final Report**

Steven E Koenig May 1978 56 p refs

(Contract DOT-FA78WA-4075)

(AD-A056052 MTR-7837 FAA-EM-78-9) Avail NTIS  
HC A04/MF A01 CSCL 01/5

Future airport capacity is greatly dependent on the levels to which interarrival spacings can be reduced. Specific causes of

longer runway occupancy times today are identified as they relate to airline, exit, aircraft, runway and airport. Identified are potential short-term improvements that might be expected at particular runways given an appropriately motivated environment

GG

**N78-31132#** National Aviation Facilities Experimental Center Atlantic City, N J

**DULLES CONTROL TOWER CONSOLE DESIGN STUDY Final Report, May 1977 - May 1978**

J Roy Bradley, Jr Jun 1978 46 p refs

(AD-A056200, FAA-NA-78-30, FAA-RD-78-69) Avail NTIS  
HC A03/MF A01 CSCL 01/5

The development and testing effort directed toward providing a plan for in-service improvements to the operational quarters of Dulles International Airport Control Tower is described. Through the use of full-scale mockups, console designs and equipment arrangements were established, modified and appraised. Opinions and recommendations of Air personnel from Dulles Tower were used as a basis for determining the advantages or disadvantages of particular equipments and their locations, console designs and modifications. A proposal for refurbishing the operational quarters of Dulles Tower is included along with drawings for a new console and a plan for an improved position and equipment arrangement

AR H

**N78-31133#** Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering

**SOFTWARE DESIGN FOR A VISUALLY-COUPLED AIRBORNE SYSTEMS SIMULATOR (VCASS) M.S. Thesis**

William H Reeve and Jerry L Stinson Mar 1978 215 p refs

(AD-A055226 AFIT/GCS/EE/78-6)

Avail NTIS

HC A10/MF A01 CSCL 01/4

This thesis contains an analysis of a Visually Coupled Airborne Systems Simulator (VCASS) and the design of the software for this system. The design is developed in three steps. First, an informal requirements definition is written to establish the viewpoint and the purpose on which the analyst bases his design. This requirements definition explains why the simulator is to be created and what it is to do. Second, a top-down strategy called structured analysis is applied to obtain a formal requirements definition. The structured analysis is presented in a blueprint-type language consisting of activity and data models. These models represent graphically the functions performed by the simulator and the information upon which those functions act. Third, a design is obtained through a structured design methodology consisting of transform analysis and transaction analysis techniques. The structure charts drawn during the analysis phase reveal system characteristics which illustrate design quality. The activity model is used to make a successful transition from a top-down analysis to a structured design which can be evaluated. The resulting simulator design with minor revisions satisfies the design goals established for the project. The methodologies used are highly recommended for the analysis and design of any software system

Author (GRA)

**N78-31134#** Arinc Research Corp Annapolis Md  
**EXPERIMENTAL TEST PLAN FOR THE EVALUATION OF AIRCRAFT SEPARATION ASSURANCE DISPLAYS USING AIRLINE FLIGHT SIMULATORS**

Thomas Berry Jun 1978 68 p

(Contract DOT-FA78WA-4091)

(AD-A055849 Rept-1343-01-1-1753)

Avail NTIS

HC A04/MF A01 CSCL 01/3

This test plan describes an experiment for evaluating the cockpit impact of the use of Aircraft Separation Assurance information using a jet transport aircraft simulator and operational airline flight crews. Three concepts for displaying ASA information will be utilized during the evaluation, six flight scenarios, each with a set of six flight conflicts will be used. Figures of merit for evaluating the display concepts include response delay times achieved, miss distances, deviation from desired flight path, achieved acceleration rates and qualitative crew opinions

Author (GRA)

**N78-31135#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Goettingen (West Germany) Inst fuer Aeroelastik

**INVESTIGATIONS ON UNSTEADY PRESSURE DISTRIBUTION MEASUREMENTS IN ROTATING SYSTEMS**

Karl Kienappel 5 Oct 1977 47 p refs In GERMAN, ENGLISH summary Report will also be announced as translation (ESA-TT-503) (DLR-FB-77-43) Avail NTIS HC A03/MF A01 DFVLR, Cologne DM 23 80

The theoretical basic requirements to measure unsteady periodic pressure distributions in a rotating system are discussed. An experimental test setup to investigate the problems of the measurement technology is described. First results of this experiment made in a 3 m windtunnel are presented. It is concluded that the indirect measurement method used is suitable to establish unsteady nonharmonic pressure distributions in rotating systems. Author (ESA)

**N78-31249# Bendix Corp Kansas City Mo MATERIAL EVALUATION OF POLYURETHANE FOAM, 0.06 g/cm<sup>3</sup> DENSITY**

J R Fender Mar 1978 57 p (Contract EY-76-C-04-0613)

(BDX-613-1836-Rev) Avail NTIS HC A04/MF A01

Rigifoam 6003-2 a CO<sub>2</sub> blown polyester polyurethane foam system was chosen for use as the prime material for production of parts with a foam density of 0.06 g/cm<sup>3</sup>. Studies of the 6003-2 physical properties, chemical analysis, dimensional stability, moisture content, and the machining and gaging capabilities of this material are summarized. ERA

**N78-31251# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Brunswick (West Germany) Abt Verbundwerkstoffe**

**THE INFLUENCE OF THE ENVIRONMENT ON THE ELASTOPLASTIC PROPERTIES OF ADHESIVES IN METAL BONDED JOINTS**

Walter Althof, Gerhard Klinger, Gerhard Neumann and Johanna Schlothauer 8 Mar 1978 82 p refs In GERMAN, ENGLISH summary Report will also be announced as translation (ESA-TT-521) (DLR-FB-77-63) Avail NTIS HC A05/MF A01, DFVLR, Cologne DM 43 40

The shear modulus, the stress at 1% shear-strain, the fracture strength, the strain at fracture, and the pertaining shear stress-strain diagrams were analyzed for 10 aircraft structural adhesives. The values were calculated from the measured load deformation behavior of the adhesives in the bond line of lap joints with a thick adherend and a small overlap length, as well as from the torsion pendulum testing (DIN 53 445) of cast adhesives. The measurements were made before and after a long exposure to heat, cold, moisture, heat combined with moisture, and changes between cold and combined heat and moisture. The environmental effects on the adhesion between adherend and adhesives as observed in the tests are described. Author (ESA)

**N78-31325# National Aviation Facilities Experimental Center Atlantic City, N J**

**TEST AND EVALUATION OF AIR/GROUND COMMUNICATIONS ANTENNAS Final Report, Jan - Dec 1977**

James J Coyle Jun 1978 130 p

(AD-A056148, FAA-NA-77-39)

Avail NTIS

HC A07/MF A01 CSCL 177\*

Data from the evaluation and analysis of a select group of very high frequency (VHF) and ultrahigh frequency (UHF) air/ground (A/G) communication antennas are presented. Antenna patterns, gain, and voltage standing wave ratio measurements were made at the National Aviation Facilities Experimental Center (NAFEC) antenna range on both Federal Aviation Administration (FAA) specified and commercially available off-the-shelf antennas. These antenna data show that improved A/G communications coverage can be obtained with some of the commercially available antennas. G G

**N78-31335# Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering**

**ANALYSIS OF MONOPOLE ANTENNA ARRAYS ON CYLINDERS BY THE GEOMETRICAL THEORY OF DIFFRACTION M.S. Thesis**

Bruce A Thieman Dec 1977 77 p refs

(AD-A055197, AFIT/GE/EE/77-41)

Avail NTIS

HC A05/MF A01 CSCL 17/2

Using the Geometrical Theory of Diffraction (GTD), the fields due to a monopole array mounted on an aircraft near the top or bottom were analyzed. The aircraft was modeled in its most basic form as an infinitely long elliptical cylinder. The aircraft cross-section at the location of the antenna was modeled as a 2 meter by 4 meter ellipse. The frequency band of operation was 250 MHz to 400 MHz with an average wavelength assumed of 1 meter. The three element array was found to have a beam broadening effect when compared to the array mounted on an infinite ground plane. The array exhibited a poor potential to form a single major lobe in its antenna pattern but had a high mobility of pattern nulls. Author (GRA)

**N78-31873\*# Kansas Univ, Lawrence Center for Research Inc**

**A RESEARCH PROGRAM TO REDUCE INTERIOR NOISE IN GENERAL AVIATION AIRPLANES NOISE REDUCTION THROUGH A CAVITY-BACKED FLEXIBLE PLATE**

Jan Roskam and Cornelis P G vanDam Aug 1978 103 p refs

(Grant NsG-1301)

(NASA-CR-157588, KU-FRL-317-8)

Avail NTIS

HC A06/MF A01 CSCL 20A

A prediction method is reported for noise reduction through a cavity-backed panel. The analysis takes into account only cavity modes in one direction. The results of this analysis were to find the effect of acoustic stiffness of a backing cavity on the panel behavior. The resulting changes in the noise reduction through the panel are significant. G G

**N78-31874\*# Kansas Univ Center for Research, Inc Lawrence Center for Research Inc**

**A RESEARCH PROGRAM TO REDUCE INTERIOR NOISE IN GENERAL AVIATION AIRPLANES INVESTIGATION OF THE CHARACTERISTICS OF AN ACOUSTIC PANEL TEST FACILITY**

Ferd Grosveld and Jan vanAken Sep 1978 151 p refs

(Grant NsG-1301)

(NASA-CR-157587, KU-FRL-317-9)

Avail NTIS

HC A08/MF A01 CSCL 20A

Sound pressure levels in the test facility were studied that are caused by varying (1) microphone positions, (2) equalizer setting, and (3) panel clamping forces. Measurements were done by using a Beranek tube or this Beranek tube in combinations with an extension tube and a special test section. In all configurations tests were executed with and without a test panel installed. The influence of the speaker back panel and the back panel of the Beranek tube on the sound pressure levels inside the test tube were also investigated. It is shown that the definition of noise reduction is more useful in relation to this test facility than transmission loss. G G

**N78-31946# General Accounting Office Washington, D C Procurement and Systems Acquisition Div**

**STATUS OF THE AIR FORCE'S F-16 AIRCRAFT PROGRAM Report to the Congress**

24 Apr 1978 48 p refs

(PB-280304/7, PSAD-78-36) Avail NTIS HC A03/MF A01 CSCL 01C

The Department of Defense approved full production for the F-16 on October 13, 1977. Although sufficient testing was accomplished for the program to enter full production, a number of uncertainties are associated with the program. The uncertainties include F-100 engine problems, an ambitious deployment schedule



and support requirements generated by this deployment, subsystem design problems support of European manufacturers and survivability/vulnerability issues GAO recommends that the Secretary of Defense require a complete program review before making any commitments for USAF F-16 purchases beyond the first 650 aircraft This review should include an updated military need assessment and comparison of F-16 performance under realistic operational conditions GRA

**N78-31952#** United Technologies Corp Windsor Locks Conn Hamilton Standard Div

**PRELIMINARY DESIGN OF AN ACCIDENT INFORMATION RETRIEVAL SYSTEM (AIRS) Final Report, Jun 1976 - Aug 1977**

Henry R Ask Marston E Moffatt, Ivor Hughes, Larry Brock and John Bikowski Apr 1978 277 p refs (Contract DAAJ02-76-C-0058 DA Proj 1F2-62209-AH-76) (AD-A055590, HSER-7342, USARTL-TR-77-51) Avail NTIS HC A13/MF A01 CSCL 01/2

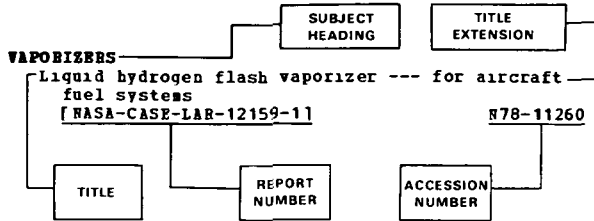
This report covers the phase 1 activity entitled Concept Investigation and phase 2 entitled Preliminary Design and System Analysis The report details the analyses involving requirements parameters trade-offs, and definition of a recommended AIRS The Phase 1 effort included the intense analysis of the airborne portion of the system since it is the most sensitive element in terms of size, weight, and cost This included examination of the parameter and sensor requirements, survivability and software Actual flight data was used to run a program on a large-scale computer to determine limits accuracy and sampling rate effects on flight data reconstruction and aircraft memory storage requirements Phase 2 included a detailed preliminary design of the AIRS A preliminary hardware concept was established and the essential features of the recommended concept are included The recommended system was analyzed to determine performance weight, size cost, installation, survivability, reliability data retrieval, maintenance and functional test factors Results indicate that the current state of the art will allow an AIRS to be developed for installation on production UTTAS and AAH aircraft The recommended system employs an all solid-state design including the mass data storage device Factors of two or more improvements in size, weight reliability maintainability are indicated over current data recording systems Author (GRA)

# SUBJECT INDEX

AERONAUTICAL ENGINEERING / *A Continuing Bibliography (Suppl 103)*

DECEMBER 1978

## 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 three 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

- TF41-A-2/A7E inflight engine condition monitoring system /IECMS/  
[AIAA PAPER 78-1472] A78-47918  
Application of the General Purpose Multiplex System to the A-7E avionics  
A78-49867

### A-10 AIRCRAFT

- Evolution of a cost-effective, task-oriented, lateral-directional SAS for the A-10 aircraft --- Stability Augmentation System  
[AIAA PAPER 78-1460] A78-47910

### AC GENERATORS

- Modeling refinements for the rectified superconducting alternator --- airborne power supply  
A78-49961

### ACCELERATION (PHYSICS)

- A compensation technique for acceleration-induced frequency changes in crystal oscillators  
A78-49859

### ACCELEROMETERS

- Statistical review of counting accelerometer data for Navy and Marine fleet aircraft from 1 January 1962 to 31 December 1977  
[AD-A055672] N78-31098

### ACOUSTIC FATIGUE

- Fatigue crack growth in pressurized fuselage panel  
A78-48231

### ACOUSTIC PROPAGATION

- Theoretical and experimental studies of acoustic propagation in inhomogeneous moving media  
[ESA-TT-477] N78-30909

### ACTUATORS

- Rolling tail design and behavior as affected by actuator hinge moment limits --- for B-1 maneuverability  
[AIAA PAPER 78-1500] A78-47940

### ADAPTIVE CONTROL

- Stability augmentation by eigenvalues control and model matching  
A78-46965

- A learning flight control system for the F8-DFBW aircraft --- Digital Fly-By-Wire  
[AIAA 78-1288] A78-50195

### ADAPTIVE FILTERS

- Constant false alarm rate detector for a pulse radar in a maritime environment  
A78-49975

### AERIAL EXPLOSIONS

- Hazard assessment of aircraft gun compartments  
[AD-A055026] N78-31064

### AERIAL PHOTOGRAPHY

- High-accuracy three-dimensional image reconstruction for an airborne line-scanning system  
A78-49988

### AEROACOUSTICS

- An acoustic range for the measurement of the noise signature of aircraft during flyby operations  
A78-47242

### AERODYNAMIC BRAKES

- Influence of slots on effectiveness of wing mechanization and control surfaces with separated flow  
A78-48229

### AERODYNAMIC CHARACTERISTICS

- Progress in propeller aerodynamics  
A78-47173

- Quiet, Short-Haul Research Aircraft - Current status and future plans  
[AIAA PAPER 78-1468] A78-47916

- Whitcomb winglet applications to general aviation aircraft  
[AIAA PAPER 78-1478] A78-47923

- Modeling ground plane influence on wing aerodynamic characteristics using a finite plane screen  
A78-48216

- Uniformly exact conformal transformation of exterior of circle onto exterior of wing profile  
A78-48224

- Influence of slots on effectiveness of wing mechanization and control surfaces with separated flow  
A78-48229

- Asymptotic theory of a wing moving near a solid wall  
A78-48248

- Application of cryogenics in experimental aerodynamics  
A78-48982

- Lateral-aerodynamic characteristics of highly-dihedral wings  
A78-49334

- Aerodynamic characteristics induced on a supercritical wing due to vectoring twin nozzles at Mach numbers from 0.40 to 0.95  
[NASA-TM-78746] N78-30039

- Rotary balance data for a typical single-engine low-wing general aviation design for an angle-of-attack range of 30 deg to 90 deg  
[NASA-CR-2972] N78-30049

- Theoretical estimation of the transonic aerodynamic characteristics of a supercritical-wing transport model with trailing-edge controls  
[NASA-TP-1253] N78-30056

- Analysis of stability contributions of high dihedral V-tails  
[NASA-TM-78729] N78-31044

- Aerodynamic characteristics of a hypersonic research airplane concept having a 70 deg swept double-delta wing at Mach number 0.2  
[NASA-TP-1252] N78-31045

### AERODYNAMIC COEFFICIENTS

- Section drag coefficients from pressure probe traverses of a wing wake at low speeds  
[AIAA PAPER 78-1479] A78-47924

- Method of calculating aerodynamic coefficients of some three-dimensional bodies with arbitrary cross section  
A78-48245

- Shockless airfoils with thicknesses of 20.6 and 20.7 percent chord analytically designed for a Mach number of 0.68 and a lift coefficient of 0.40 [NASA-TM-X-73917] N78-30046
- Maximum likelihood identification of the longitudinal aerodynamic coefficients of the EA-6B airplane in the catapult launch configuration [AD-A054243] N78-31046
- AERODYNAMIC CONFIGURATIONS**
- Correlation of model and airplane spin characteristics for a low-wing general aviation research airplane [AIAA PAPER 78-1477] A78-47922
- Studies of aerodynamic technology for VSTOL fighter/attack aircraft [AIAA PAPER 78-1511] A78-47946
- Definition of airplane fuselage longitudinal lines by the special contour method A78-48222
- Propulsion test facilities - Capabilities and use [AIAA PAPER 78-933] A78-48453
- Status of a nozzle-airframe study of a highly maneuverable fighter [AIAA PAPER 78-990] A78-48470
- Wing planforms for large military transports [AIAA PAPER 78-1470] A78-49786
- Ground effects testing of two, three, and four jet configurations [AIAA PAPER 78-1510] A78-49789
- Close encounters of the aeroservoelastic kind --- aerodynamics, structural dynamics, and automatic flight control systems for aircraft design applications [AIAA 78-1289] A78-50196
- Aerodynamics of the new generation of combat aircraft with delta wings N78-30106
- AERODYNAMIC DRAG**
- On the theory of drag calculation and profile optimization in shockless near free molecular flow A78-47887
- Section drag coefficients from pressure probe traverses of a wing wake at low speeds [AIAA PAPER 78-1479] A78-47924
- Design of a large span-distributed load flying-wing cargo airplane with laminar flow control [NASA-CR-145376] N78-30045
- Investigation of a wing-rotor interaction system for helicopters [AD-A054093] N78-30092
- AERODYNAMIC FORCES**
- Important simulation parameters for the experimental testing of propulsion induced lift effects [AIAA PAPER 78-1078] A78-48494
- Use of ground vibration test equipment to determine unsteady aerodynamic forces A78-49708
- An automated procedure for computing the three-dimensional transonic flow over wing-body combinations, including viscous effects. Volume 1: Description of analysis methods and applications [AD-A055899] N78-31052
- AERODYNAMIC INTERFERENCE**
- Induction of subsonic wind tunnels with slight perforation A78-48250
- Wind-tunnel testing of VTOL and STOL aircraft [NASA-TM-78750] N78-30040
- AERODYNAMIC LOADS**
- On the linear superposition of aerodynamic forces on wings in periodic gusts A78-47869
- Drones for aerodynamic and structural testing /DAST/ - A status report [AIAA PAPER 78-1485] A78-47929
- A calculator program for analyzing airloads on a wing of arbitrary planform and camber in subsonic flow [AD-A054180] N78-30058
- AERODYNAMIC STABILITY**
- Close encounters of the aeroservoelastic kind --- aerodynamics, structural dynamics, and automatic flight control systems for aircraft design applications [AIAA 78-1289] A78-50196
- F-15 inlet engine test techniques and distortion methodologies studies. Volume 9: Stability audits [NASA-CR-144874] N78-30131
- AERODYNAMIC STALLING**
- A method for localizing wing flow separation at stall to alleviate spin entry tendencies [AIAA PAPER 78-1476] A78-49787
- Simulation study of the oscillatory longitudinal motion of an airplane at the stall [NASA-TP-1242] N78-30141
- AEROELASTICITY**
- The influence of high twist on the dynamics of rotating blades A78-47599
- Assessment of dynamic coordinate alignment for elastic aircraft --- flight control Kalman filter estimates A78-49987
- Close encounters of the aeroservoelastic kind --- aerodynamics, structural dynamics, and automatic flight control systems for aircraft design applications [AIAA 78-1289] A78-50196
- AEROSPACE ENGINEERING**
- Teaching design at all levels --- in aerospace engineering curricula [AIAA PAPER 78-1455] A78-47906
- The use of the AIAA-Bendix Design Competition in aerospace design courses [AIAA PAPER 78-1488] A78-47931
- The value of aerospace design synthesis courses as viewed by aerospace professionals [AIAA PAPER 78-1493] A78-47934
- AEROSPACE SYSTEMS**
- The design process --- computer aided design for complex aerospace systems [AIAA PAPER 78-1483] A78-47928
- NAECON '78; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978. Volumes 1, 2 & 3 A78-49851
- AEROTHERMOELASTICITY**
- Optimal control synthesis in distributed systems with incomplete information --- noting aircraft applications A78-48215
- AFTERBODIES**
- Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions [AIAA PAPER 78-989] A78-48469
- AGRICULTURE**
- Status of aerial applications research in the Langley vortex research facility and the Langley full-scale wind tunnel [NASA-TM-78760] N78-30041
- AH-64 HELICOPTER**
- Flight controls of Army/Hughes YAH-64 advanced attack helicopter [AIAA 78-1237] A78-50160
- AILERONS**
- Flutter suppressor for transonic flight [ONERA, TP NO. 1978-102] A78-47346
- AIR DEFENSE**
- Modular target acquisition and designation systems A78-49954
- AIR DUCTS**
- Center-loaded duct integral rocket-to-ramjet transition testing [AIAA PAPER 78-937] A78-48456
- AIR LAUNCHING**
- In-flight alignment/calibration techniques for unaided tactical guidance --- of air-launched missiles A78-49929
- AIR NAVIGATION**
- RNAV - Corporate operators set the pace A78-47424
- Communication and navigation antennas for aircraft --- Russian book A78-48523
- The Omega radionavigation system comes to the Pacific Ocean area A78-49660
- In-flight alignment/calibration techniques for unaided tactical guidance --- of air-launched missiles A78-49929

- Station deselection procedures to support automatic Omega receiver operation A78-49965
- Performance of a differential Omega-ring laser strapdown aircraft navigator A78-49966
- Real-time simulators for augmented inertial navigation systems A78-49967
- Reliability of inertial navigation systems --- for military and commercial aircraft A78-49968
- Accuracy requirement and cost effectiveness of GPS-aided INS for tactical fighters A78-49989
- A parametric analysis of TERCOM false fix probability --- TERRAIN CONTOUR MATCHING A78-49997
- Optimal terrain-aided navigation systems [AIAA 78-1243] A78-50163
- Guidance and navigation for automatic landing, rollout, and turnoff using MLS and magnetic cable sensors [AIAA 78-1296] A78-50203
- TRSB microwave landing system demonstration program at Brussels, Belgium [AD-A054298] N78-30075
- AIR POLLUTION**
- Gas turbine engine emissions - Problems, progress and future A78-49336
- AIR TO AIR MISSILES**
- Bank-to-turn /BIT/ autopilot technology --- for missiles A78-49927
- AIR TO SURFACE MISSILES**
- Strapdown seeker guidance for tactical weapons A78-49928
- AIR TRAFFIC**
- Trailing vortices. II A78-47172
- AIR TRAFFIC CONTROL**
- Integrated avionics for future general aviation aircraft . [AIAA PAPER 78-1482] A78-47927
- Air traffic control in the terminal area - Use of a simulation technique for the definition of an operative model A78-49733
- Engineering and development program plan: Wake vortex [AD-A051443] N78-30071
- Characteristics of constrained optimum trajectories with specified range [NASA-TM-78519] W78-30072
- TRACALS evaluation report. TACAN, VOR, and ILS station evaluation report, Andersen AFB, Guam [AD-A054244] N78-30078
- Avionics cost development for alternatives of selected air traffic control systems [AD-A054823] N78-30080
- IFR aircraft handled forecast by air route traffic control center, fiscal years 1978-1989 [AD-A049305] N78-31075
- Future needs and opportunities in the air traffic control system [GPO-98-931] N78-31076
- Parameters of future ATC systems relating to airport capacity/delay [AD-A055482] N78-31130
- Dulles control tower console design study [AD-A056200] N78-31132
- Experimental test plan for the evaluation of aircraft separation assurance displays using airline flight simulators [AD-A055849] N78-31134
- Test and evaluation of air/ground communications antennas [AD-A056148] N78-31325
- AIR TRANSPORTATION**
- Stability of a helicopter carrying an underslung load A78-49398
- An integrated analysis of the fundamental problems of air transport A78-49447
- Operational regularity in air transport A78-49449
- Airliner numbers game - Does it add up --- political and technological aspects of international aircraft industries A78-49524
- Airfield pavement load evaluation - An international overview A78-49676
- Proposed load evaluation system for U.S. Air Force --- of airfield pavement A78-49677
- Transport Canada airfield pavement load evaluation A78-49678
- Model of aircraft passenger acceptance A78-49684
- 'Supermarket' airplanes --- aircraft replacement cycle in major airlines [AIAA PAPER 78-1533] A78-49769
- Operations and economics of U.S. air transportation [AIAA PAPER 78-1545] A78-49770
- Demand modelling of passenger air travel: An analysis and extension, volume 2 [NASA-CR-157402] N78-30069
- AIRBORNE EQUIPMENT**
- Flight application of optical fiber transmission on a Falcon 10 aircraft [ONERA, TP NO. 1978-105] A78-47349
- Application of rare earth/transition metal permanent magnets to 400 Hz aircraft systems - An AF overview A78-49935
- Prediction of angular disturbances from airframe members to airborne electro-optical packages A78-49952
- Modeling refinements for the rectified superconducting alternator --- airborne power supply A78-49961
- Impact of aircraft electrical power quality on utilization equipment A78-49962
- Dual band airborne SATCOM terminal A78-49972
- Infrared receiver performance --- airborne warning system by detection of target spectral signature A78-49985
- High-accuracy three-dimensional image reconstruction for an airborne line-scanning system A78-49988
- Combinatorially derived limits on the surface return for an air/surface monopulse ranging radar A78-50001
- A frequency-selective YIG limiter for airborne PH/CW X-band radar A78-50002
- AIRBORNE/SPACEBORNE COMPUTERS**
- RNAV - Corporate operators set the pace A78-47424
- AIDS in military aircraft --- Airborne Integrated Data Systems Computer A78-47866
- Use of onboard computerized flight test analysis systems [AIAA PAPER 78-1462] A78-47912
- Software engineering a must for success in computerized flight test [AIAA PAPER 78-1463] A78-47913
- L-1011 flight data recording systems - Background, features, implications and benefits [AIAA PAPER 78-1471] A78-47917
- NAECON '78; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978. Volumes 1, 2 & 3 A78-49851
- Modular Missionization Systems /MMS/, an adaptive system interface concept A78-49852
- Pattern recognition as an aid to radar navigation A78-49855
- In-line monitoring of digital flight control computers A78-49860
- A qualitative analysis of redundant asynchronous operation A78-49863
- MIL-STD-1553B proposed --- data bus development in avionic architecture A78-49866

- A hierarchical network for avionic systems  
A78-49868
- Non-volatile memory system for severe environment  
flight recorders  
A78-49872
- Software structured weapon delivery  
A78-49875
- Peace Rhine - A digital Weapon Control System for  
the F-4 aircraft  
A78-49876
- Approach for identifying avionics flight software  
operational support requirements - PAVE TACK an  
example  
A78-49900
- Comparison study of MLS airborne signal processing  
techniques  
A78-49904
- Digital simulation and flight verification of the  
F-5E/F Flight Director Computer  
A78-49905
- An interface management approach to software  
development  
A78-49933
- AIRCRAFT ACCIDENT INVESTIGATION**
- Preliminary design of an accident Information  
Retrieval System (AIRS)  
[AD-A055590]  
N78-31952
- AIRCRAFT ANTENNAS**
- Communication and navigation antennas for aircraft  
--- Russian book  
A78-48523
- Volumetric pattern analysis of airborne antennas  
A78-49427
- Conformal microstrip phased array for aircraft  
tests with ATS-6  
A78-49428
- Scan-limited near field testing for directive  
airborne antennas  
A78-49897
- Test and evaluation of air/ground communications  
antennas  
[AD-A056148]  
N78-31325
- Analysis of monopole antenna arrays on cylinders  
by the geometrical theory of diffraction  
[AD-A055197]  
N78-31335
- AIRCRAFT APPROACH SPACING**
- Parameters of future ATC systems relating to  
airport capacity/delay  
[AD-A05482]  
N78-31130
- AIRCRAFT CARRIERS**
- The influence of throttle augmented stability  
(APCS) and short period control characteristics  
on the landing approach  
[AD-A055892]  
N78-31123
- AIRCRAFT COMMUNICATION**
- Communication and navigation antennas for aircraft  
--- Russian book  
A78-48523
- Conformal microstrip phased array for aircraft  
tests with ATS-6  
A78-49428
- Fading at 9.6 GHz on an experimentally simulated  
aircraft-to-ground path  
A78-49439
- The AN/APX-100/V/ transponder --- for military  
aircraft  
A78-49971
- Dual band airborne SATCOM terminal  
A78-49972
- AIRCRAFT COMPARTMENTS**
- Experimental determination of parameters of  
mathematical model of airplane cabin as  
regulated object with respect to air temperature  
in the cabin  
A78-48234
- A preliminary comparison of thermal decomposition  
products of aircraft interior materials using  
the National Bureau of Standards smoke chamber  
and the combustion tube furnace  
[AD-A054811]  
N78-30088
- AIRCRAFT CONFIGURATIONS**
- Canard configured aircraft with 2-D nozzle  
[AIAA PAPER 78-1450]  
A78-47904
- Design evolution of a supersonic cruise  
strike-fighter  
[AIAA PAPER 78-1452]  
A78-49783
- AIRCRAFT CONSTRUCTION MATERIALS**
- Some sound transmission loss characteristics of  
typical general aviation structural materials  
[AIAA PAPER 78-1480]  
A78-47925
- Assessment of relative flammability and  
thermochemical properties of some thermoplastic  
materials  
A78-49693
- A preliminary comparison of thermal decomposition  
products of aircraft interior materials using  
the National Bureau of Standards smoke chamber  
and the combustion tube furnace  
[AD-A054811]  
N78-30088
- New structures made of composite materials for  
high performance combat aircraft  
N78-30114
- Engineering data on new aerospace materials  
structural materials  
[AD-A054461]  
N78-30213
- Safety against fatigue in flight: A perspective  
of Australian experience and research  
N78-30272
- Fibre composite reinforcement of cracked aircraft  
structures  
N78-30288
- The influences of residual stresses on oscillating  
tensile strength and the measurement of residual  
stress, with emphasis on aircraft construction  
--- fatigue life of aircraft construction  
materials  
[BMVG-PBWT-77-23]  
N78-30603
- Material evaluation of polyurethane foam, 0.05 g/  
cm<sup>3</sup> density  
[BDX-613-1836-REV]  
N78-31249
- AIRCRAFT CONTROL**
- Digital control law synthesis in the w prime domain  
A78-46962
- Stability augmentation by eigenvalues control and  
model matching  
A78-46965
- Drones for aerodynamic and structural testing  
/DAST/ - A status report  
[AIAA PAPER 78-1485]  
A78-47929
- Improved aircraft dynamic response and fatigue  
life during ground operations using an active  
control landing gear system  
[AIAA PAPER 78-1499]  
A78-47939
- Rolling tail design and behavior as affected by  
actuator hinge moment limits --- for B-1  
maneuverability  
[AIAA PAPER 78-1500]  
A78-47940
- Optimal control synthesis in distributed systems  
with incomplete information --- noting aircraft  
applications  
A78-48215
- A method for determining the stability  
characteristics of aircraft in a helicoid flight  
path  
A78-49741
- Piloted flight simulation for active control  
design development  
[AIAA PAPER 78-1553]  
A78-49771
- The influence of propulsion and control system  
concepts on design of a Navy Type A V/STOL  
airplane  
[AIAA PAPER 78-1505]  
A78-49788
- Aviation control system devices --- Russian book  
A78-49850
- A qualitative analysis of redundant asynchronous  
operation  
A78-49863
- A hierarchical network for avionic systems  
A78-49868
- Assessment of dynamic coordinate alignment for  
elastic aircraft --- flight control Kalman  
filter estimates  
A78-49987
- An investigation of potential control-display  
configurations for V/STOL aircraft  
[AIAA 78-1238]  
A78-50161
- BPV flying qualities design criteria  
[AIAA 78-1271]  
A78-50181
- Guidance and navigation for automatic landing,  
rollout, and turnoff using MLS and magnetic  
cable sensors  
[AIAA 78-1296]  
A78-50203
- The effect of prefilter design on sample rate  
selection in digital flight control systems  
[AIAA 78-1308]  
A78-50209

- Advanced control concepts for future fighter aircraft N78-30104
- Impact of active control on structures design N78-30113
- AIRCRAFT DESIGN**
- Progress in propeller aerodynamics A78-47173
- The promise of tilt rotor A78-47266
- Design philosophy for airframes A78-47453
- From Challenger to winner --- Canadair executive jet design and development A78-47570
- On the linear superposition of aerodynamic forces on wings in periodic gusts A78-47869
- Gates Learjet Model 28/29, the first 'Longhorn' Learjet [AIAA PAPER 78-1445] A78-47901
- The effect on block fuel consumption of a strutted versus cantilever wing for a short-haul transport including strut aeroelastic considerations [AIAA PAPER 78-1454] A78-47905
- The HiMAT RPRV system [AIAA PAPER 78-1457] A78-47908
- Conceptual design study of power augmented ram wing in ground effect aircraft [AIAA PAPER 78-1466] A78-47915
- Quiet, Short-Haul Research Aircraft - Current status and future plans [AIAA PAPER 78-1468] A78-47916
- Whitcomb winglet applications to general aviation aircraft [AIAA PAPER 78-1478] A78-47923
- The design process --- computer aided design for complex aerospace systems [AIAA PAPER 78-1483] A78-47928
- Application of advanced high speed turboprop technology to future civil short-haul transport aircraft design [AIAA PAPER 78-1487] A78-47930
- The use of the AIAA-Bendix Design Competition in aerospace design courses [AIAA PAPER 78-1488] A78-47931
- A computerized undergraduate aircraft design course [AIAA PAPER 78-1492] A78-47933
- The value of aerospace design synthesis courses as viewed by aerospace professionals [AIAA PAPER 78-1493] A78-47934
- Effect of performance objectives on the design and cost of future USAF pilot training aircraft [AIAA PAPER 78-1498] A78-47938
- Studies of aerodynamic technology for VSTOL fighter/attack aircraft [AIAA PAPER 78-1511] A78-47946
- Aerodynamic hull design for HASPA LTA optimization --- High Altitude Superpressure Powered Aerostat Lighter Than Air A78-48100
- Definition of airplane fuselage longitudinal lines by the special contour method A78-48222
- Status of a nozzle-airframe study of a highly maneuverable fighter [AIAA PAPER 78-990] A78-48470
- Non-axisymmetric nozzle design and evaluation for F-111 flight demonstration [AIAA PAPER 78-1025] A78-48483
- Propulsion system airframe integration studies - Advanced supersonic transport [AIAA PAPER 78-1053] A78-48488
- Highly survivable integrated avionics A78-49163
- Mirage 2000 - Dassault's better delta A78-49169
- The U.S. Navy bets on V/STOL --- technological integration for next generation aircraft design A78-49550
- Model of aircraft passenger acceptance A78-49684
- Design of a horizontal tail unit and related adjustments A78-49736
- Piloted flight simulation for active control design development [AIAA PAPER 78-1553] A78-49771
- Design evolution of a supersonic cruise strike-fighter [AIAA PAPER 78-1452] A78-49783
- Prospects for commercial commonality in military transports [AIAA PAPER 78-1467] A78-49784
- A method for localizing wing flow separation at stall to alleviate spin entry tendencies [AIAA PAPER 78-1476] A78-49787
- The influence of propulsion and control system concepts on design of a Navy Type A V/STOL airplane [AIAA PAPER 78-1505] A78-49788
- Modular Missionization Systems /MMS/, an adaptive system interface concept A78-49852
- The terrain following task for the advanced tactical fighter using discrete optimal control A78-49862
- Interface design considerations for P-76 sensors and weapons A78-49874
- RPV flying qualities design criteria [AIAA 78-1271] A78-50181
- Close encounters of the aeroservoelastic kind --- aerodynamics, structural dynamics, and automatic flight control systems for aircraft design applications [AIAA 78-1289] A78-50196
- Fighter aircraft design --- conferences [AGARD-CP-241] N78-30099
- Fighter superiority by design N78-30105
- Analysis of advanced variable camber concepts N78-30108
- Intake design for fighter aircraft N78-30110
- Impact of active control on structures design N78-30113
- Metal technology for future aircraft design N78-30115
- The design of a high g cockpit N78-30118
- Analysis of a suspension system for a wheel rolling on a flat track [NASA-CR-157563] N78-30583
- An assessment of the effect of supersonic aircraft operations on the stratospheric ozone content [NASA-RP-1026] N78-30774
- Graphics for the hybrid stores separation simulation of the B77 system [SAND-78-8212] N78-31099
- AIRCRAFT ENGINES**
- Operation of oil seals of aircraft piston engines under conditions of cavitation. I A78-47175
- The second generation of high-bypass turbofans - A market clouded by uncertainty A78-47423
- TF41-A-2/A7E inflight engine condition monitoring system /IECMS/ [AIAA PAPER 78-1472] A78-47918
- Analysis of GTE tolerance monitoring parameter formation --- gas turbine engine A78-48212
- NASA engine system technology programs - An overview [AIAA PAPER 78-928] A78-48452
- Propulsion for future supersonic transports - 1978 status [AIAA PAPER 78-1051] A78-48486
- Design for durability - The F101-GE-100 engine [AIAA PAPER 78-1084] A78-48497
- Boundary layers in axisymmetric inlets at angle of attack. I - Measurements [AIAA PAPER 78-1109] A78-48499
- Aspects of the thermal fatigue strength of gas-turbine engine components A78-49176
- Gas turbine engine emissions - Problems, progress and future A78-49336
- Choice of cycle for a regenerative bypass turbojet for long-range aircraft A78-49723
- A laser-powered flight transportation system [AIAA PAPER 78-1484] A78-49781
- Operating characteristics of bypass turbojet engines --- Russian book A78-50125

## AIRCRAFT EQUIPMENT

Variable-cycle engine fighter aircraft: Advance  
in performance and development problems N78-30109

Turbine engine rotordynamic evaluation, volume 1  
[AD-A055262] N78-31111

**AIRCRAFT EQUIPMENT**

IDS in military aircraft --- Airborne Integrated  
Data Systems Computer A78-47866

Evaluating avionics weight efficiency A78-48228

Dynamic analysis of electrical systems A78-49934

A standard programmable I/O for the advanced  
aircraft electrical system power control set A78-49936

Aircraft electrical system testing and data  
reduction using digital techniques A78-49937

The AN/APX-100/V/ transponder --- for military  
aircraft A78-49971

Air-to-air designate/track with time sharing A78-49977

Damping, static, dynamic, and impact  
characteristics of laminated beams typical of  
windshield construction N78-30093  
[AD-A054463]

Computer program for vibration prediction of  
fighter aircraft equipments N78-30094  
[AD-A054598]

HMSD demonstration model development N78-30120  
[AD-A054437]

Fundamentals of noncuring sealants for aircraft  
fuel tanks N78-30247  
[AD-A054627]

Modified helicopter icing spray system evaluation N78-31091  
[AD-A055039]

Statistical review of counting accelerometer data  
for Navy and Marine fleet aircraft from 1  
January 1962 to 31 December 1977 N78-31098  
[AD-A055672]

**AIRCRAFT FUEL SYSTEMS**

Solid-state displays for fuel management systems  
--- for aircraft A78-47900

Investigation of electrostatic discharge in  
aircraft fuel tanks during refueling A78-47941  
[AIAA PAPER 78-1501]

Study of fuel systems for LH2-fueled subsonic  
transport aircraft, volume 1 N78-31085  
[NASA-CR-145369-VOL-1]

Study of fuel systems for LH2-fueled subsonic  
transport aircraft, volume 2 N78-31086  
[NASA-CR-145369-VOL-2]

**AIRCRAFT FUELS**

Let's put fuel efficiency into perspective A78-47269

Effects of high availability fuels on combustor  
properties N78-30259  
[AD-A054229]

**AIRCRAFT GUIDANCE**

Advances in inertial navigation A78-47481

Improving the accuracy of HUD approaches in  
windshear with a new control law A78-47935  
[AIAA PAPER 78-1494]

Interscan - A new microwave approach and landing  
guidance system A78-48736

Comparison study of MLS airborne signal processing  
techniques A78-49904

Advanced pattern matching for navigation and  
guidance A78-49998

Guidance and control problems in semiautomatic  
recovery of the Aquila RPV A78-50182  
[AIAA 78-1272]

Approach guidance logic for a tilt-rotor aircraft A78-50202  
[AIAA 78-1295]

Guidance and navigation for automatic landing,  
rollout, and turnoff using MLS and magnetic  
cable sensors A78-50203  
[AIAA 78-1296]

Characteristics of constrained optimum  
trajectories with specified range N78-30072  
[NASA-TM-78519]

## SUBJECT INDEX

**AIRCRAFT HAZARDS**

Investigation of electrostatic discharge in  
aircraft fuel tanks during refueling A78-47941  
[AIAA PAPER 78-1501]

Simultaneous measurements of ozone outside and  
inside cabins of two B-747 airliners and a Gates  
Learjet business jet N78-31061  
[NASA-TM-78983]

**AIRCRAFT INDUSTRY**

Airliner numbers game - Does it add up ---  
political and technological aspects of  
international aircraft industries A78-49524

'Supermarket' airplanes --- aircraft replacement  
cycle in major airlines A78-49769  
[AIAA PAPER 78-1533]

**AIRCRAFT INSTRUMENTS**

COMED - The cockpit display of the future ---  
Combined Map and Electronic Display A78-47268

Flight deck display trends A78-47899

Solid-state displays for fuel management systems  
--- for aircraft A78-47900

The airborne detection of low-level wind shear  
[AIAA PAPER 78-1495] A78-47936

Aviation control system devices --- Russian book A78-49850

In-flight alignment/calibration techniques for  
unaided tactical guidance --- of air-launched  
missiles A78-49929

Multi-Function Inertial Reference Assembly /MIRA/  
update --- digital aircraft systems A78-49941

Digital area correlation tracker A78-49951

Autothreshold autoscreener/PLIR system ---  
airborne target screener/Forward-Looking  
Infrared imaging system A78-49984

Display systems and cockpit design N78-30116

**AIRCRAFT LANDING**

Probabilistic model of an instrument landing system  
A78-47407

Improving the accuracy of HUD approaches in  
windshear with a new control law A78-47935  
[AIAA PAPER 78-1494]

Improved aircraft dynamic response and fatigue  
life during ground operations using an active  
control landing gear system A78-47939  
[AIAA PAPER 78-1499]

Interscan - A new microwave approach and landing  
guidance system A78-48736

Use of the U.S. interim standard microwave  
landing system in Canada A78-49333

Landing aircraft under poor conditions A78-49549

Flight investigation and theory of direct  
side-force control A78-50194  
[AIAA 78-1287]

TRSB microwave landing system demonstration  
program at John F. Kennedy International  
Airport, Long Island, New York, USA N78-31070  
[AD-A055447]

The influence of throttle augmented stability  
(APCS) and short period control characteristics  
on the landing approach N78-31123  
[AD-A055892]

**AIRCRAFT LAUNCHING DEVICES**

Maximum likelihood identification of the  
longitudinal aerodynamic coefficients of the  
EA-6B airplane in the catapult launch  
configuration N78-31046  
[AD-A054243]

**AIRCRAFT MAINTENANCE**

LOGNOD - The fault-isolator --- for helicopter  
electronic systems A78-49239

F-15 avionics Built-in-Test A78-49991

**AIRCRAFT MANEUVERS**

Constant-control rolling maneuver A78-46961

## SUBJECT INDEX

## AIRCRAFT STRUCTURES

- The HiMAT RPHV system  
[AIAA PAPER 78-1457] A78-47908
- Rolling tail design and behavior as affected by  
actuator hinge moment limits --- for B-1  
maneuverability  
[AIAA PAPER 78-1500] A78-47940
- Status of a nozzle-airframe study of a highly  
maneuverable fighter  
[AIAA PAPER 78-990] A78-48470
- Subsystem verification of an AFPLC organically  
developed F-15 simulation --- Air Force  
Logistics Command  
A78-49901
- Flight investigation and theory of direct  
side-force control  
[AIAA 78-1287] A78-50194
- AIRCRAFT MODELS**
- Experimental determination of parameters of  
mathematical model of airplane cabin as  
regulated object with respect to air temperature  
in the cabin  
A78-48234
- Application of cryogenics in experimental  
aerodynamics  
A78-48982
- AIRCRAFT NOISE**
- Long-distance focusing of Concorde sonic boom  
A78-48052
- Noise in airports, its measurement, and its effect  
on the communities in the vicinity  
A78-48374
- Experimental determination of the rattle of simple  
models  
[NASA-TM-78756] N78-30291
- A further survey of some effects of aircraft noise  
in residential communities near London  
(Heathrow) airport  
[TT-7705] N78-30910
- A comparison of annoyance caused by aircraft noise  
near London, Manchester and Liverpool airports  
[TT-7706] N78-30911
- AIRCRAFT PARTS**
- Extending the service life of aircraft components  
made of high-strength steels --- Russian book  
A78-48518
- AIRCRAFT PERFORMANCE**
- Gates Learjet Model 28/29, the first 'Longhorn'  
Learjet  
[AIAA PAPER 78-1445] A78-47901
- B-1 flight test progress report  
[AIAA PAPER 78-1448] A78-47903
- Use of onboard computerized flight test analysis  
systems  
[AIAA PAPER 78-1462] A78-47912
- The airborne detection of low-level wind shear  
[AIAA PAPER 78-1495] A78-47936
- Effects of wind on aircraft cruise performance  
[AIAA PAPER 78-1496] A78-47937
- Status of a nozzle-airframe study of a highly  
maneuverable fighter  
[AIAA PAPER 78-990] A78-48470
- Installed performance of vectoring/reversing  
non-axisymmetric nozzles  
[AIAA PAPER 78-1022] A78-48482
- Takeoff performance of STOL aircraft  
A78-49744
- Electromagnetic coupling analysis of a Learjet  
aircraft in a lightning environment  
A78-49920
- Performance of a ring laser strapdown attitude and  
heading reference for aircraft  
[AIAA 78-1240] A78-50162
- Status of aerial applications research in the  
Langley vortex research facility and the Langley  
full-scale wind tunnel  
[NASA-TM-78760] N78-30041
- Fighter superiority by design  
N78-30105
- Effects of dynamic aeroelasticity on handling  
qualities and pilot rating  
N78-31084
- AIRCRAFT PRODUCTION**
- Pavement strength rating methods as viewed by  
airframe manufacturers  
A78-49682
- AIRCRAFT RELIABILITY**
- Integrated avionics for future general aviation  
aircraft  
[AIAA PAPER 78-1482] A78-47927
- Distribution of reliability characteristics among  
airplane system units to ensure given flight  
safety level  
A78-48221
- In-line monitoring of digital flight control  
computers  
A78-49860
- Laboratory testing of lightning and EMP  
susceptibility of avionic systems  
A78-49861
- Aircraft structural reliability and risk theory:  
A review  
N78-30284
- AIRCRAFT SAFETY**
- Safety against fatigue in flight: A perspective  
of Australian experience and research  
N78-30272
- Hazard assessment of aircraft gun compartments  
[AD-A055026] N78-31064
- AIRCRAFT SPECIFICATIONS**
- Aeronautical procurement - The primary  
specification system  
[AIAA PAPER 78-1489] A78-47932
- AIRCRAFT STABILITY**
- Stability augmentation by eigenvalues control and  
model matching  
A78-46965
- Gates Learjet Model 28/29, the first 'Longhorn'  
Learjet  
[AIAA PAPER 78-1445] A78-47901
- Evolution of a cost-effective, task-oriented,  
lateral-directional SAS for the A-10 aircraft  
--- Stability Augmentation System  
[AIAA PAPER 78-1460] A78-47910
- Nacelle effects on stability of VSTOL  
configurations including conventional, canard,  
and tandem wing arrangements  
[AIAA PAPER 78-1504] A78-47942
- Dynamics of the longitudinal motion of an airplane  
with a variable-geometry wing  
A78-49285
- Stability of a helicopter carrying an underslung  
load  
A78-49398
- Design of a horizontal tail unit and related  
adjustments  
A78-49736
- A method for determining the stability  
characteristics of aircraft in a helicoid flight  
path  
A78-49741
- Airplane stability calculations with a card  
programmable pocket calculator  
[NASA-TM-78678] N78-30138
- AIRCRAFT STRUCTURES**
- Large electroformed nickel moulds for aircraft parts  
A78-47267
- Large deflection static analysis of typical  
tail-wheel structure of light aircraft by finite  
element method  
A78-48864
- Minimum weight design of stiffened panels with  
fracture constraints  
A78-49837
- Aircraft structural fatigue  
[ARL/STRUC-REPT-363] N78-30271
- Mechanisms of fatigue and fracture  
N78-30273
- Fracture mechanics fundamentals with reference to  
aircraft structural applications  
N78-30274
- Gust measurements and the N sub o problem  
N78-30276
- Development of a load sequence for a structural  
fatigue test  
N78-30277
- Fatigue S/N data in relation to variability in  
predicted life  
N78-30278
- Structural fatigue testing  
N78-30279
- Current developments in the life of aircraft  
structure  
N78-30280
- Aircraft structural life monitoring and the  
problem of corrosion  
N78-30281
- NDI and the detection of fatigue  
N78-30282



## AIRCRAFT SURVIVABILITY

## SUBJECT INDEX

- The development of the theory of structural fatigue  
N78-30283
- Load interaction effects in fatigue crack  
propagation N78-30285
- A model of crack-tip behaviour for fatigue life  
determination N78-30286
- Fibre composite reinforcement of cracked aircraft  
structures N78-30288
- The influences of residual stresses on oscillating  
tensile strength and the measurement of residual  
stress, with emphasis on aircraft construction  
--- fatigue life of aircraft construction  
materials [BMVG-FBWT-77-23] N78-30603
- Recent developments in analysis of crack  
propagation and fracture of practical materials  
--- stress analysis in aircraft structures  
[NASA-TM-78766] N78-30606
- A study of analog programming for prediction of  
crack growth in aircraft structures subjected to  
random loads [AD-A055789] N78-31097
- Estimated costs of extended low-rate airframe  
production [AD-A054834] N78-31100
- The influence of the environment on the  
elastoplastic properties of adhesives in metal  
bonded joints --- in aircraft structures  
[DLR-FB-77-63] N78-31251
- AIRCRAFT SURVIVABILITY**
- Highly survivable integrated avionics A78-49163
- Technology analysis - Candidate advanced tactical  
fighters [AIAA PAPER 78-1451] A78-49782
- Improved combat survivability for fly-by-wire  
sensor systems [AIAA 78-1277] A78-50186
- Computerized aircraft attrition program  
[AD-A055784] N78-31094
- AIRCRAFT WAKES**
- Trailing vortices. II A78-47172
- Status of aerial applications research in the  
Langley vortex research facility and the Langley  
full-scale wind tunnel [NASA-TM-78760] N78-30041
- Engineering and development program plan:  
wake vortex [AD-A051143] N78-30071
- AIRFIELD SURFACE MOVEMENTS**
- Airfield pavement load evaluation - An  
international overview A78-49676
- Proposed load evaluation system for U.S. Air Force  
--- of airfield pavement A78-49677
- Transport Canada airfield pavement load evaluation  
A78-49678
- French procedures for airfield pavement load  
evaluation A78-49679
- Airfield pavement evaluation - The airline view  
A78-49680
- Airfield pavement evaluation - FAA viewpoint  
A78-49681
- AIRFOIL PROFILES**
- Progress in propeller aerodynamics A78-47173
- On the theory of drag calculation and profile  
optimization in shockless near free molecular flow  
A78-47887
- A mean camberline singularity method for  
two-dimensional steady and oscillatory aerofoils  
and control surfaces in inviscid incompressible  
flow [ARC-CP-1391] N78-30066
- Two-dimensional aerofoils and control surfaces in  
simple harmonic motion in incompressible  
inviscid flow [ARC-CP-1392] N78-30068
- AIRFOILS**
- Hermite closed splines A78-49713
- REXOR 2 rotorcraft simulation model. Volume 1:  
Engineering documentation [NASA-CR-145331] N78-30042
- REXOR 2 rotorcraft simulation model. Volume 2:  
Computer implementation [NASA-CR-145332] N78-30043
- Shockless airfoils with thicknesses of 20.6 and  
20.7 percent chord analytically designed for a  
Mach number of 0.68 and a lift coefficient of 0.40  
[NASA-TM-X-73917] N78-30046
- Two-dimensional subsonic wind tunnel evaluation of  
two related cambered 15-percent thick  
circulation control airfoils [AD-A055140] N78-31047
- AIRFRAME MATERIALS**
- Design philosophy for airframes A78-47453
- AIRFRAMES**
- Status of a nozzle-airframe study of a highly  
maneuverable fighter [AIAA PAPER 78-990] A78-48470
- Propulsion system airframe integration studies -  
Advanced supersonic transport [AIAA PAPER 78-1053] A78-48488
- Pavement strength rating methods as viewed by  
airframe manufacturers A78-49682
- Prediction of angular disturbances from airframe  
members to airborne electro-optical packages  
A78-49952
- Engineering data on new aerospace materials  
structural materials [AD-A054461] N78-30213
- Estimated costs of extended low-rate airframe  
production [AD-A054834] N78-31100
- Engine/airframe/drive train dynamic interface  
documentation [AD-A055766] N78-31114
- AIRLINE OPERATIONS**
- Distribution of reliability characteristics among  
airplane system units to ensure given flight  
safety level A78-48221
- An integrated analysis of the fundamental problems  
of air transport A78-49447
- Operational regularity in air transport A78-49449
- Airliner numbers game - Does it add up ---  
political and technological aspects of  
international aircraft industries A78-49524
- 'Supermarket' airplanes --- aircraft replacement  
cycle in major airlines [AIAA PAPER 78-1533] A78-49769
- Operations and economics of U.S. air transportation  
[AIAA PAPER 78-1545] A78-49770
- IPR aircraft handled forecast by air route traffic  
control center, fiscal years 1978-1989  
[AD-A049305] N78-31075
- Analysis of runway occupancy times at major airports  
[AD-A056052] N78-31131
- AIRPORT PLANNING**
- Noise in airports, its measurement, and its effect  
on the communities in the vicinity A78-48374
- Airfield pavement load evaluation - An  
international overview A78-49676
- Proposed load evaluation system for U.S. Air Force  
--- of airfield pavement A78-49677
- Transport Canada airfield pavement load evaluation  
A78-49678
- French procedures for airfield pavement load  
evaluation A78-49679
- Airfield pavement evaluation - The airline view  
A78-49680
- Airfield pavement evaluation - FAA viewpoint  
A78-49681
- Pavement strength rating methods as viewed by  
airframe manufacturers A78-49682
- AIRPORT TOWERS**
- Dulles control tower console design study  
[AD-A056200] N78-31132

## AIRPORTS

- TRSB microwave landing system demonstration program at Brussels, Belgium  
[AD-A054298] N78-30075
- A further survey of some effects of aircraft noise in residential communities near London (Heathrow) airport  
[TT-7705] N78-30910
- A comparison of annoyance caused by aircraft noise near London, Manchester and Liverpool airports  
[TT-7706] N78-30911
- TRSB microwave landing system demonstration program at Kristiansand, Norway  
[AD-A055317] N78-31071
- TRSB microwave landing system demonstration program at Charleroi, Belgium  
[AD-A055920] N78-31072
- Parameters of future ATC systems relating to airport capacity/delay  
[AD-A055482] N78-31130
- Analysis of runway occupancy times at major airports  
[AD-A056052] N78-31131

## ALGORITHMS

- Guaranteed cost control of linear systems with uncertain parameters - Application to remotely piloted vehicle flight control systems  
[AIAA 78-1274] A78-50184
- Performance in a jamming environment of a low-cost GPS user receiver algorithm for aiding a tactical INS  
[AD-A055239] N78-31078

## ALIGNMENT

- In-flight alignment/calibration techniques for unaided tactical guidance --- of air-launched missiles  
A78-49929

## ALL-WEATHER AIR NAVIGATION

- An investigation of potential control-display configurations for V/STOL aircraft  
[AIAA 78-1238] A78-50161

## ALL-WEATHER LANDING SYSTEMS

- InterScan - A new microwave approach and landing guidance system  
A78-48736
- Landing aircraft under poor conditions  
A78-49549
- Navigation performance of the Triscan concept for shipboard VTOL aircraft operations  
[AIAA 78-1293] A78-50200

## ALUMINUM

- Some sound transmission loss characteristics of typical general aviation structural materials  
[AIAA PAPER 78-1480] A78-47925

## ALUMINUM ALLOYS

- Metal technology for future aircraft design  
N78-30115

## AMBIENT TEMPERATURE

- Experimental determination of parameters of mathematical model of airplane cabin as regulated object with respect to air temperature in the cabin  
A78-48234

## ANALOG COMPUTERS

- A study of analog programming for prediction of crack growth in aircraft structures subjected to random loads  
[AD-A055789] N78-31097

## ANGLE OF ATTACK

- Boundary layers in axisymmetric inlets at angle of attack. I - Measurements  
[AIAA PAPER 78-1109] A78-48499
- Static aerodynamic characteristics of a typical single-engine low-wing general aviation design for an angle-of-attack range of -8 deg to 90 deg  
[NASA-CR-2971] N78-30048
- Rotary balance data for a typical single-engine low-wing general aviation design for an angle-of-attack range of 30 deg to 90 deg  
[NASA-CR-2972] N78-30049

## ANGULAR VELOCITY

- Prediction of angular disturbances from airframe members to airborne electro-optical packages  
A78-49952
- Diverse forms and derivations of the equations of motion of deformable aircraft and their mutual relationship  
[RAE-TR-77077] N78-30097

## ANTENNA ARRAYS

- Analysis of monopole antenna arrays on cylinders by the geometrical theory of diffraction  
[AD-A055197] N78-31335

## ANTENNA DESIGN

- Communication and navigation antennas for aircraft --- Russian book  
A78-48523
- Conformal microstrip phased array for aircraft tests with ATS-6  
A78-49428

## ANTENNA RADIATION PATTERNS

- Volumetric pattern analysis of airborne antennas  
A78-49427
- Scan-limited near field testing for directive airborne antennas  
A78-49897

## APPROACH CONTROL

- InterScan - A new microwave approach and landing guidance system  
A78-48736
- Guidance and control problems in semiautomatic recovery of the Aquila RPV  
[AIAA 78-1272] A78-50182
- Approach guidance logic for a tilt-rotor aircraft  
[AIAA 78-1295] A78-50202
- The influence of throttle augmented stability (APCS) and short period control characteristics on the landing approach  
[AD-A055892] N78-31123

## ARCHITECTURE (COMPUTERS)

- MIL-STD-1553B proposed --- data bus development in avionic architecture  
A78-49866
- Digital system architecture for a 1980's jammer --- for military aircraft and ships  
A78-49973

## AREA NAVIGATION

- RNAV - Corporate operators set the pace  
A78-47424

## ARROW WINGS

- Stability and performance characteristics of a fixed arrow wing supersonic transport configuration (SCAT 15F-9898) at Mach numbers from 0.60 to 1.20  
[NASA-TM-78726] N78-30087

## ASTRONOMICS

- NPECON '78; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978. Volumes 1, 2 & 3  
A78-49851

## ASTRONAUT PERFORMANCE

- Safety of space flights  
A78-47952

## ATMOSPHERIC COMPOSITION

- Simultaneous measurements of ozone outside and inside cabins of two B-747 airliners and a Gates Learjet business jet  
[NASA-TM-78983] N78-31061

## ATMOSPHERIC DIFFUSION

- On the use of zirconium 95 data from Chinese atmospheric thermonuclear explosions to study stratospheric transport in a one-dimensional parameterization  
A78-48062

## ATMOSPHERIC TURBULENCE

- Gust measurements and the N sub 0 problem  
N78-30276

## ATS 6

- Conformal microstrip phased array for aircraft tests with ATS-6  
A78-49428

## ATTACK AIRCRAFT

- COMED - The cockpit display of the future --- Combined Map and Electronic Display  
A78-47268
- Software structured weapon delivery  
A78-49875
- Flight controls of Army/Hughes YAH-64 advanced attack helicopter  
[AIAA 78-1237] A78-50160
- ATTITUDE CONTROL
- The effect of thrust vectoring and attitude control concepts on the propulsion system of V/STOL aircraft  
[AIAA PAPER 78-1020] A78-48481
- Bank-to-turn /BIT/ autopilot technology --- for missiles  
A78-49927

## ATTITUDE INDICATORS

## SUBJECT INDEX

Performance of a ring laser strapdown attitude and heading reference for aircraft  
[AIAA 78-1240] A78-50162

A learning flight control system for the F8-DPBW aircraft --- Digital Fly-By-Wire  
[AIAA 78-1288] A78-50195

**ATTITUDE INDICATORS**

Twosay - A position and orientation measurement system --- helicopter/VTOL landing aid application  
A78-49661

**AUDITORY TASKS**

Evaluation of several secondary tasks in the determination of permissible time delays in simulator visual and motion cues  
[NASA-TP-1214] N78-30089

Simulator study of the effect of visual-motion time delays on pilot tracking performance with an audio side task  
[NASA-TP-1216] N78-30090

**AUTOCORRELATION**

F-15 inlet/engine test techniques and distortion methodologies studies. Volume 4: Autocorrelation functions  
[NASA-CR-144869] N78-30126

**AUTOMATIC CONTROL**

Digital area correlation tracker  
A78-49951

**AUTOMATIC FLIGHT CONTROL**

Design and development of a multifunctional helicopter control system  
A78-49396

In-line monitoring of digital flight control computers  
A78-49860

Comparison monitoring in redundant digital flight control systems  
A78-49865

The evolution of a remotely piloted vehicle microprocessor flight control system  
[AIAA 78-1273] A78-50183

Guaranteed cost control of linear systems with uncertain parameters - Application to remotely piloted vehicle flight control systems  
[AIAA 78-1274] A78-50184

Software development for fly-by-wire flight control systems  
[AIAA 78-1276] A78-50185

Improved combat survivability for fly-by-wire sensor systems  
[AIAA 78-1277] A78-50186

Close encounters of the aeroservoelastic kind --- aerodynamics, structural dynamics, and automatic flight control systems for aircraft design applications  
[AIAA 78-1289] A78-50196

The effect of prefilter design on sample rate selection in digital flight control systems  
[AIAA 78-1308] A78-50209

Control system design using vector-valued performance criteria with application to the control rate reduction in parameter insensitive control systems  
[DLR-FB-77-55] N78-31125

**AUTOMATIC LANDING CONTROL**

Shipboard launch and recovery of RPV helicopters in high sea states  
[AIAA 78-1269] A78-50179

Guidance and navigation for automatic landing, rollout, and turnoff using MLS and magnetic cable sensors  
[AIAA 78-1296] A78-50203

Flight demonstrations of curved, descending approaches and automatic landings using time referenced scanning beam guidance  
[NASA-TM-78745] N78-30074

**AUTOMATIC PILOTS**

Bank-to-turn /BIT/ autopilot technology --- for missiles  
A78-49927

**AUTOMATIC TEST EQUIPMENT**

Integrated test mission control - Present and future at the Air Force Flight Test Center  
[AIAA PAPER 78-1461] A78-47911

TF41-A-2/A7E inflight engine condition monitoring system /IECMS/  
[AIAA PAPER 78-1472] A78-47918

Ground test facility for integral rocket ramjets  
[AIAA PAPER 78-934] A78-48454

F-15 avionics Built-in-Test  
A78-49991

**AVIONICS**

Advances in inertial navigation  
A78-47481

AIDS in military aircraft --- Airborne Integrated Data Systems Computer  
A78-47866

Flight deck display trends  
A78-47899

L-1011 flight data recording systems - Background, features, implications and benefits  
[AIAA PAPER 78-1471] A78-47917

Integrated avionics for future general aviation aircraft  
[AIAA PAPER 78-1482] A78-47927

Evaluating avionics weight efficiency  
A78-48228

Highly survivable integrated avionics  
A78-49163

LOGMOD - The fault-isolator --- for helicopter electronic systems  
A78-49239

Design of a horizontal tail unit and related adjustments  
A78-49736

Aviation control system devices --- Russian book  
A78-49850

NAECON '78; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978. Volumes 1, 2 & 3  
A78-49851

A Costas loop with tangent error signal for use in Navstar GPS avionics  
A78-49858

Laboratory testing of lightning and EMP susceptibility of avionic systems  
A78-49861

A qualitative analysis of redundant asynchronous operation  
A78-49863

Comparison monitoring in redundant digital flight control systems  
A78-49865

MIL-STD-1553B proposed --- data bus development in avionic architecture  
A78-49866

Application of the General Purpose Multiplex System to the A-7E avionics  
A78-49867

A hierarchical network for avionic systems  
A78-49868

Multiprocessing for electronic warfare avionics  
A78-49869

Interface design considerations for P-16 sensors and weapons  
A78-49874

Approach for identifying avionics flight software operational support requirements - PAVE TACK an example  
A78-49900

Digital avionics support - A retrospective view of the future  
A78-49903

Digital simulation and flight verification of the F-5E/F Flight Director Computer  
A78-49905

The DAIS Executive - An introduction --- avionics computer software  
A78-49932

Multi-Function Inertial Reference Assembly /MIRA/ update --- digital aircraft systems  
A78-49941

The versatility of Jovial J73 in avionics systems  
A78-49956

Higher order languages for avionics software - A survey, summary and critique  
A78-49959

Impact of aircraft electrical power quality on utilization equipment  
A78-49962

The AN/APX-100/V/ transponder --- for military aircraft  
A78-49971

Digital system architecture for a 1980's jammer --- for military aircraft and ships  
A78-49973

F-15 avionics Built-in-Test  
A78-49991

- A flight qualified graphics generator --- for B-1 defense system A78-50007
- Flight demonstrations of curved, descending approaches and automatic landings using time referenced scanning beam guidance [NASA-TM-78745] N78-30074
- Avionics cost development for alternatives of selected air traffic control systems [AD-A054823] N78-30080
- The feasibility of estimating avionics support costs early in the acquisition cycle. Volume 1: The basic report [AD-A054016] N78-30119
- Program analyses for the S-3 weapon system improvement program [AD-A055887] N78-31093
- AFAL simulation facility/capability manual. Volume 1: Executive summary and Systems Avionics Division [AD-A055591] N78-31102
- A modular adaptive, variable function flight control sensor [AD-A055175] N78-31120
- AXES OF ROTATION**  
Diverse forms and derivations of the equations of motion of deformable aircraft and their mutual relationship [RAE-TR-77077] N78-30097
- AXIAL FLOW**  
A theoretical study of the performance of a number of different axial-flow turbine configurations under conditions of pulsating flow [JRL/MECH-ENG-REPT-149] N78-31104
- AXIAL FLOW TURBINES**  
Analysis of multistage, axial flow turbomachine wake production, transport, and interaction [AD-A055754] N78-31118
- AXISYMMETRIC FLOW**  
Analysis of multistage, axial flow turbomachine wake production, transport, and interaction [AD-A055754] N78-31118
- B**
- B-1 AIRCRAFT**  
B-1 flight test progress report [AIAA PAPER 78-1448] A78-47903  
Rolling tail design and behavior as affected by actuator hinge moment limits --- for B-1 maneuverability [AIAA PAPER 78-1500] A78-47940  
Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions [AIAA PAPER 78-989] A78-48469  
The role of system performance analysis in the independent assessment of B-1 navigation software A78-49902
- A flight qualified graphics generator --- for B-1 defense system A78-50007
- BEAM RIDER GUIDANCE**  
Flight demonstrations of curved, descending approaches and automatic landings using time referenced scanning beam guidance [NASA-TM-78745] N78-30074
- BEAMS (SUPPORTS)**  
Damping, static, dynamic, and impact characteristics of laminated beams typical of windshield construction [AD-A054463] N78-30093
- BELGIUM**  
TRSE microwave landing system demonstration program at Charleroi, Belgium [AD-A055920] N78-31072
- BLADE TIPS**  
Advanced optical blade tip clearance measurement system [NASA-CR-159402] N78-31106  
Turbine tip clearance measurement [AD-A055765] N78-31115
- BLOWDOWN WIND TUNNELS**  
Application of cryogenics in experimental aerodynamics A78-48982
- BLOWING**  
Calculations of the effects of blowing from the leading edges of a cambered delta wing [ARC-R/M-3800] N78-30064
- BODY-WING AND TAIL CONFIGURATIONS**  
Wacelle effects on stability of VSTOL configurations including conventional, canard, and tandem wing arrangements [AIAA PAPER 78-1504] A78-47942
- BODY-WING CONFIGURATIONS**  
Modification of the Douglas Neumann program to improve the efficiency of predicting component interference and high lift characteristics [NASA-CR-3020] N78-30051  
An automated procedure for computing the three-dimensional transonic flow over wing-body combinations, including viscous effects. Volume 1: Description of analysis methods and applications [AD-A055899] N78-31052
- BOEING 747 AIRCRAFT**  
Short-term performance deterioration in JT9D-7A (SP) engine 695743 [NASA-CR-135431] N78-30121
- BOMBING EQUIPMENT**  
Software structured weapon delivery A78-49875
- BOUNDARY LAYER CONTROL**  
Two-dimensional subsonic wind tunnel evaluation of two related cambered 15-percent thick circulation control airfoils [AD-A055140] N78-31047  
Evaluation of a circulation control tail boom for yaw control --- OH-6 helicopter [AD-A055116] N78-31119
- BOUNDARY LAYER FLOW**  
Solution of an adjoint problem of steady-state heat transfer associated with the cooling of gas-turbine blades, by means of a quasi-analog/digital system A78-47402  
Boundary layers in axisymmetric inlets at angle of attack. I - Measurements [AIAA PAPER 78-1109] A78-48499  
Evaluation of a circulation control tail boom for yaw control --- OH-6 helicopter [AD-A055116] N78-31119
- BUILDINGS**  
Experimental determination of the rattle of simple models [NASA-TM-78756] N78-30291
- BYPASSES**  
Evaluation of inlet reingestion for large bypass ratio V/STOL aircraft [AIAA PAPER 78-1079] A78-48495  
Operating characteristics of bypass turbojet engines --- Russian book A78-50125
- C**
- C BAND**  
Landing aircraft under poor conditions A78-49549
- CABIN ATMOSPHERES**  
Simultaneous measurements of ozone outside and inside cabins of two B-747 airliners and a Gates Learjet business jet [NASA-TM-78983] N78-31061
- CALCULATORS**  
Airplane stability calculations with a card programmable pocket calculator [NASA-TM-78678] N78-30138
- CALIBRATING**  
In-flight alignment/calibration techniques for unaided tactical guidance --- of air-launched missiles A78-49929
- CAMBER**  
A mean camberline singularity method for two-dimensional steady and oscillatory aerofoils and control surfaces in inviscid incompressible flow [ARC-CP-1391] N78-30066  
Analysis of advanced variable camber concepts N78-30108

Two-dimensional subsonic wind tunnel evaluation of two related cambered 15-percent thick circulation control airfoils  
[AD-A055140] N78-31047

**CAMBERED WINGS**  
Calculations of the effects of blowing from the leading edges of a cambered delta wing  
[ARC-R/M-3800] N78-30064

**CANADAIR AIRCRAFT**  
From Challenger to winner --- Canadair executive jet design and development  
A78-47570

**CANARD CONFIGURATIONS**  
Canard configured aircraft with 2-D nozzle  
[AIAA PAPER 78-1450] A78-47904  
Nacelle effects on stability of VSTOL configurations including conventional, canard, and tandem wing arrangements  
[AIAA PAPER 78-1504] A78-47942

**CANTILEVER MEMBERS**  
The effect on block fuel consumption of a strutted versus cantilever wing for a short-haul transport including strut aeroelastic considerations  
[AIAA PAPER 78-1454] A78-47905

**CAPACITY**  
Analysis of runway occupancy times at major airports  
[AD-A056052] N78-31131

**CAPTURE EFFECT**  
Capture effect array glide slope guidance study  
[AD-A055678] N78-31073

**CARGO AIRCRAFT**  
Cargo aircraft and spacecraft forward restraint criteria  
[AD-A055343] N78-31095

**CARGO SPACECRAFT**  
Cargo aircraft and spacecraft forward restraint criteria  
[AD-A055343] N78-31095

**CASCADE FLOW**  
Linearized theory of plane, unsteady, supersonic flow through a cascade - Subsonic part of the leading edge  
[ONERA, TP NO. 1978-103] A78-47347  
Linearized supersonic unsteady flow in cascades  
[ARC-R/M-3811] N78-30065

**CATHODE RAY TUBES**  
HMSD demonstration model development  
[AD-A054437] N78-30120

**CAVITATION CORROSION**  
Operation of oil seals of aircraft piston engines under conditions of cavitation. I  
A78-47175

**CAVITIES**  
A research program to reduce interior noise in general aviation airplanes: Noise reduction through a cavity-backed flexible plate  
[NASA-CR-157588] N78-31873

**CENTRAL PROCESSING UNITS**  
Comparison study of MLS airborne signal processing techniques  
A78-49904

**CENTRIFUGAL PUMPS**  
10 years of contract research for the pump/compressor industrial concern  
A78-49175

**CH-47 HELICOPTER**  
Modified helicopter icing spray system evaluation  
[AD-A055039] N78-31091

**CHANNELS (DATA TRANSMISSION)**  
MIL-STD-1553B proposed --- data bus development in avionics architecture  
A78-49866

**CHEMICAL ANALYSIS**  
Material evaluation of polyurethane foam, 0.05 g/cm<sup>3</sup> density  
[BDX-613-1836-REV] N78-31249

**CHIRP SIGNALS**  
A high duty factor chirp radar  
A78-49976

**CHROMIUM**  
Extending the service life of aircraft components made of high-strength steels --- Russian book  
A78-48518

**CLEARANCES**  
Advanced optical blade tip clearance measurement system  
[NASA-CR-159402] N78-31106

**CLUTTER**  
Constant false alarm rate detector for a pulse radar in a maritime environment  
A78-49975  
A high duty factor chirp radar  
A78-49976

**CMOS**  
Non-volatile memory system for severe environment flight recorders  
A78-49872

**COCKPITS**  
COMED - The cockpit display of the future --- Combined Map and Electronic Display  
A78-47268  
Display systems and cockpit design  
N78-30116  
The design of a high g cockpit  
N78-30118

**COLLISION AVOIDANCE**  
IPC design validation and flight testing  
[AD-A05529] N78-31074  
Experimental test plan for the evaluation of aircraft separation assurance displays using airline flight simulators  
[AD-A055849] N78-31134

**COMBAT**  
Air-to-air combat simulation  
A78-47868  
Computerized aircraft attrition program  
[AD-A055784] N78-31094

**COMBINATORIAL ANALYSIS**  
Combinatorially derived limits on the surface return for an air/surface monopulse ranging radar  
A78-50001

**COMBUSTION CHAMBERS**  
Methods available to ONERA for analysis of combustion chambers  
[ONERA, TP NO. 1978-93] A78-46915  
Effects of high availability fuels on combustor properties  
[AD-A054229] N78-30259  
Flame stabilization in a ramjet combustion chamber by means of a pilot gas generator  
[DLR-FB-77-54] N78-31117

**COMBUSTION EFFICIENCY**  
Let's put fuel efficiency into perspective  
A78-47269

**COMBUSTION PHYSICS**  
Methods available to ONERA for analysis of combustion chambers  
[ONERA, TP NO. 1978-93] A78-46915

**COMBUSTION PRODUCTS**  
A preliminary comparison of thermal decomposition products of aircraft interior materials using the National Bureau of Standards smoke chamber and the combustion tube furnace  
[AD-A054811] N78-30088

**COMPART**  
Model of aircraft passenger acceptance  
A78-49684

**COMMAND AND CONTROL**  
Dual band airborne SATCOM terminal  
A78-49972

**COMMERCIAL AIRCRAFT**  
RNAV - Corporate operators set the pace  
A78-47424  
Prospects for commercial commonality in military transports  
[AIAA PAPER 78-1467] A78-49784  
Operating characteristics of bypass turbojet engines --- Russian book  
A78-50125  
Rotor burst protection program: Statistics on aircraft gas turbine engine rotor failures that occurred in US commercial aviation during 1975  
[NASA-CR-135304] N78-31105

**COMMONALITY (EQUIPMENT)**  
Prospects for commercial commonality in military transports  
[AIAA PAPER 78-1467] A78-49784

**COMMUNICATION CABLES**  
Fiber optic development for tactical fighter applications  
A78-49906

**COMPETITION**  
The use of the AIAA-Bendix Design Competition in aerospace design courses  
[AIAA PAPER 78-1488] A78-47931

<b>COMPILERS</b>		<b>COMPUTER STORAGE DEVICES</b>	
The versatility of Jovial J73 in avionics systems	A78-49956	Non-volatile memory system for severe environment flight recorders	A78-49872
<b>COMPLEX SYSTEMS</b>		<b>COMPUTER SYSTEMS DESIGN</b>	
The design process --- computer aided design for complex aerospace systems [AIAA PAPER 78-1483]	A78-47928	A hierarchical network for avionic systems	A78-49868
<b>COMPOSITE MATERIALS</b>		Digital avionics support - A retrospective view of the future	A78-49903
New structures made of composite materials for high performance combat aircraft	N78-30114	An interface management approach to software development	A78-49933
Rotor design implications for composite material properties [UCRL-80117]	N78-30182	Multi-Function Inertial Reference Assembly /MIRA/ update --- digital aircraft systems	A78-49941
Fibre composite reinforcement of cracked aircraft structures	N78-30288	Application techniques for digital flight control systems	N78-30117
<b>COMPOSITE STRUCTURES</b>		<b>COMPUTER SYSTEMS PROGRAMS</b>	
New structures made of composite materials for high performance combat aircraft	N78-30114	The role of system performance analysis in the independent assessment of B-1 navigation software	A78-49902
<b>COMPRESSORS</b>		The DAIS Executive - An introduction --- avionics computer software	A78-49932
10 years of contract research for the pump/compressor industrial concern	A78-49175	Higher order languages for avionics software - A survey, summary and critique	A78-49959
<b>COMPUTER GRAPHICS</b>		Real-time simulators for augmented inertial navigation systems	A78-49967
A flight qualified graphics generator --- for B-1 defense system	A78-50007	Software development for fly-by-wire flight control systems [AIAA 78-1276]	A78-50185
<b>COMPUTER PROGRAMMING</b>		Software design for a Visually-Coupled Airborne Systems Simulator (VCASS) [AD-A055226]	N78-31133
The DAIS Executive - An introduction --- avionics computer software	A78-49932	<b>COMPUTER TECHNIQUES</b>	
The versatility of Jovial J73 in avionics systems	A78-49956	Methods available to ONERA for analysis of combustion chambers [ONERA, TP NO. 1978-93]	A78-46915
A flight simulation high order language study	A78-49957	<b>COMPUTERIZED DESIGN</b>	
Higher order languages for avionics software - A survey, summary and critique	A78-49959	The design process --- computer aided design for complex aerospace systems [AIAA PAPER 78-1483]	A78-47928
<b>COMPUTER PROGRAMS</b>		Definition of airplane fuselage longitudinal lines by the special contour method	A78-48222
Software engineering a must for success in computerized flight test [AIAA PAPER 78-1463]	A78-47913	Minimum weight design of stiffened panels with fracture constraints	A78-49837
A computerized undergraduate aircraft design course [AIAA PAPER 78-1492]	A78-47933	AFAL simulation facility/capability manual. Volume 1: Executive summary and Systems Avionics Division [AD-A055591]	N78-31102
Software structured weapon delivery	A78-49875	<b>COMPUTERIZED SIMULATION</b>	
Approach for identifying avionics flight software operational support requirements - PAVE TACK an example	A78-49900	Solution of an adjoint problem of steady-state heat transfer associated with the cooling of gas-turbine blades, by means of a quasi-analog/digital system	A78-47402
An interface management approach to software development	A78-49933	V/STOL aircraft simulation - Requirements and capabilities at Ames Research Center [AIAA PAPER 78-1515]	A78-49790
High-accuracy three-dimensional image reconstruction for an airborne line-scanning system	A78-49988	A Costas loop with tangent error signal for use in Navstar GPS avionics	A78-49858
REXOR 2 rotorcraft simulation model. Volume 1: Engineering documentation [NASA-CR-145331]	N78-30042	The terrain following task for the advanced tactical fighter using discrete optimal control	A78-49862
REXOR 2 rotorcraft simulation model. Volume 2: Computer implementation [NASA-CR-145332]	N78-30043	Subsystem verification of an APLC organically developed F-15 simulation --- Air Force Logistics Command	A78-49901
A calculator program for analyzing airloads on a wing of arbitrary planform and camber in subsonic flow [AD-A054180]	N78-30058	Real-time simulators for augmented inertial navigation systems	A78-49967
Computer program for vibration prediction of fighter aircraft equipments [AD-A054598]	N78-30094	REXOR 2 rotorcraft simulation model. Volume 1: Engineering documentation [NASA-CR-145331]	N78-30042
Helicopter transmission vibration and noise reduction program. Volume 2: User's manual [AD-A054827]	N78-30095	REXOR 2 rotorcraft simulation model. Volume 2: Computer implementation [NASA-CR-145332]	N78-30043
Computer program for the design and off-design performance of turbojet and turbofan engine cycles [NASA-TN-78653]	N78-30122	REXOR 2 rotorcraft simulation model. Volume 3: User's manual [NASA-CR-145333]	N78-30044
General aviation airplane structural crashworthiness user's manual. Volume 1: Program KRASH theory [AD-A055898]	N78-31088		
Computerized aircraft attrition program [AD-A055784]	N78-31094		
A study of analog programming for prediction of crack growth in aircraft structures subjected to random loads [AD-A055789]	N78-31097		

CONCORDE AIRCRAFT

SUBJECT INDEX

Description and performance of the Langley visual landing display system [NASA-TM-78742]	N78-30073	<b>CONTROL THEORY</b> Optimal control synthesis in distributed systems with incomplete information --- noting aircraft applications	A78-48215
Procedures for generation and reduction of linear models of a turbofan engine [NASA-TP-126*]	N78-30896	Experimental determination of parameters of mathematical model of airplane cabin as regulated object with respect to air temperature in the cabin	A78-48234
Graphics for the hybrid stores separation simulation of the B77 system [SAND-78-8212]	N78-31099	Optimization techniques for air traffic control problems --- Russian book	A78-48504
APPL simulation facility/capability manual. Volume 1: Executive summary and Systems Avionics Division [AD-A055591]	N78-31102	Advanced control concepts for future fighter aircraft	N78-30104
<b>CONCORDE AIRCRAFT</b> Long-distance focusing of Concorde sonic boom	A78-48052	<b>CONVERGENT-DIVERGENT NOZZLES</b> Investigation of nonequilibrium two-phase flows in axisymmetric Laval nozzles	A78-48244
<b>CONFERENCES</b> Fighter aircraft design --- conferences [AGARD-CP-241]	N78-30099	<b>CORROSION PREVENTION</b> Operation of oil seals of aircraft piston engines under conditions of cavitation. I	A78-47175
<b>CONFORMAL MAPPING</b> Uniformly exact conformal transformation of exterior of circle onto exterior of wing profile	A78-48224	<b>CORROSION RESISTANCE</b> Aircraft structural life monitoring and the problem of corrosion	N78-30281
<b>CONGRESSIONAL REPORTS</b> Future needs and opportunities in the air traffic control system [GPO-98-931]	N78-31076	<b>COST ANALYSIS</b> Technology analysis - Candidate advanced tactical fighters [AIAA PAPER 78-1451]	A78-49782
<b>CONNECTORS</b> Fiber optic development for tactical fighter applications	A78-49906	Avionics cost development for alternatives of selected air traffic control systems [AD-A054823]	N78-30080
<b>CONSOLES</b> Dulles control tower console design study [AD-A056200]	N78-31132	<b>COST EFFECTIVENESS</b> Non-volatile memory system for severe environment flight recorders	A78-49872
<b>CONTINUOUS WAVE RADAR</b> A frequency-selective YIG limiter for airborne FM/CW X-band radar	A78-50002	Accuracy requirement and cost effectiveness of GPS-aided INS for tactical fighters	A78-49989
<b>CONTOURS</b> Definition of airplane fuselage longitudinal lines by the special contour method	A78-48222	<b>COST ESTIMATES</b> The feasibility of estimating avionics support costs early in the acquisition cycle. Volume 1: The basic report [AD-A054016]	N78-30119
<b>CONTROL CONFIGURED VEHICLES</b> Highly survivable integrated avionics	A78-49163	Estimated costs of extended low-rate airframe production [AD-A054834]	N78-31100
Assessment of dynamic coordinate alignment for elastic aircraft --- flight control Kalman filter estimates	A78-49987	<b>COST REDUCTION</b> A Costas loop with tangent error signal for use in Navstar GPS avionics	A78-49858
<b>CONTROL EQUIPMENT</b> Aviation control system devices --- Russian book	A78-49850	<b>CRACK PROPAGATION</b> Fatigue crack growth in pressurized fuselage panel	A78-48231
A standard programmable I/O for the advanced aircraft electrical system power control set	A78-49936	Load interaction effects in fatigue crack propagation	N78-30285
Control system design using vector-valued performance criteria with application to the control rate reduction in parameter insensitive control systems [DLR-FB-77-55]	N78-31125	A model of crack-tip behaviour for fatigue life determination	N78-30286
<b>CONTROL SIMULATION</b> Digital control law synthesis in the w prime domain	A78-46962	Recent developments in analysis of crack propagation and fracture of practical materials --- stress analysis in aircraft structures [NASA-TM-78766]	N78-30606
Air traffic control in the terminal area - Use of a simulation technique for the definition of an operative model	A78-49733	Compilation of test data from an investigation on the effect of environment on crack growth under flight-simulation loading [NLR-TR-76096-U]	N78-30620
A qualitative analysis of redundant asynchronous operation	A78-49863	<b>CRACKING (FRACTURING)</b> A study of analog programming for prediction of crack growth in aircraft structures subjected to random loads [AD-A055789]	N78-31097
Comparison monitoring in redundant digital flight control systems	A78-49865	<b>CRANES</b> A study of the precision hover capabilities of the aerocrane hybrid heavy lift vehicles [AD-A054281]	N78-30091
<b>CONTROL SURFACES</b> Influence of slots on effectiveness of wing mechanization and control surfaces with separated flow	A78-48229	<b>CRASHES</b> General aviation airplane structural crashworthiness user's manual. Volume 1: Program KRASH theory [AD-A055898]	N78-31088
Two-dimensional aerofoils and control surfaces in simple harmonic motion in incompressible inviscid flow [ARC-CP-1392]	N78-30068	<b>CREEP RUPTURE STRENGTH</b> Engineering data on new aerospace materials structural materials [AD-A054461]	N78-30213
Control-surface hinge-moment calculations for a high-aspect-ratio supercritical wing [NASA-TM-78664]	N78-31043		
Two-dimensional subsonic wind tunnel evaluation of two related cambered 15-percent thick circulation control airfoils [AD-A055140]	N78-3*047		

**CROSS CORRELATION**  
 F-15 inlet/engine test techniques and distortion methodologies studies. Volume 7: Cross correlation functions. [NASA-CR-144872] N78-30129

**CROSS SECTIONS**  
 Method of calculating aerodynamic coefficients of some three-dimensional bodies with arbitrary cross section A78-48245

**CRUISE MISSILES**  
 Center-loaded duct integral rocket-to-ramjet transition testing [AIAA PAPER 78-937] A78-48456

**CRUISING FLIGHT**  
 Effects of wind on aircraft cruise performance [AIAA PAPER 78-1496] A78-47937

**CRYOGENIC WIND TUNNELS**  
 Application of cryogenics in experimental aerodynamics A78-48982

**CRYSTAL OSCILLATORS**  
 A compensation technique for acceleration-induced frequency changes in crystal oscillators A78-49859

**CUSHIONCRAFT GROUND EFFECT MACHINE**  
 Test and demonstration prototype tracked air cushion vehicle (PTACV): Phase IIIC [PB-279970/8] N78-31007

**CYCLIC LOADS**  
 Fatigue S/N data in relation to variability in predicted life N78-30278

**D**

**DASSAULT AIRCRAFT**  
 Mirage 2000 - Dassault's better delta A78-49169

**DATA ACQUISITION**  
 Use of onboard computerized flight test analysis systems [AIAA PAPER 78-1462] A78-47912  
 The role of the computer in the flight testing of general aviation aircraft [AIAA PAPER 78-1465] A78-47914  
 TRACALS evaluation report. TRACAN, VOR, and ILS station evaluation report, Andersen AFB, Guam [AD-A054244] N78-30078  
 IPC design validation and flight testing [AD-A055529] N78-31074

**DATA MANAGEMENT**  
 The design process --- computer aided design for complex aerospace systems [AIAA PAPER 78-1483] A78-47928  
 An interface management approach to software development A78-49933

**DATA RECORDING**  
 L-1011 flight data recording systems - Background, features, implications and benefits [AIAA PAPER 78-1471] A78-47917

**DATA REDUCTION**  
 Aircraft electrical system testing and data reduction using digital techniques A78-49937

**DATA SAMPLING**  
 The effect of prefilter design on sample rate selection in digital flight control systems [AIAA 78-1308] A78-50209

**DATA SYSTEMS**  
 AIDS in military aircraft --- Airborne Integrated Data Systems Computer A78-47866  
 Integrated test mission control - Present and future at the Air Force Flight Test Center [AIAA PAPER 78-1461] A78-47911  
 High-accuracy three-dimensional image reconstruction for an airborne line-scanning system A78-49988

**DATA TRANSMISSION**  
 Application of the General Purpose Multiplex System to the A-7E avionics A78-49867

**DEICERS**  
 Demonstration of the microwave ice protection concept [AD-A055824] N78-31096

**DELTA WINGS**  
 Mirage 2000 - Dassault's better delta A78-49169  
 Calculations of the effects of blowing from the leading edges of a cambered delta wing [ARC-R/M-3800] N78-30064  
 Aerodynamics of the new generation of combat aircraft with delta wings N78-30106  
 Aerodynamic characteristics of a hypersonic research airplane concept having a 70 deg swept double-delta wing at Mach number 0.2 [NASA-TP-1252] N78-31045

**DEMAND (ECONOMICS)**  
 Demand modelling of passenger air travel: An analysis and extension, volume 2 [NASA-CR-157402] N78-30069

**DESIGN ANALYSIS**  
 Design philosophy for engine forgings A78-47452  
 Design philosophy for airframes A78-47453  
 A computerized undergraduate aircraft design course [AIAA PAPER 78-1492] A78-47933  
 Effect of performance objectives on the design and cost of future USAF pilot training aircraft [AIAA PAPER 78-1498] A78-47938  
 Design for durability - The F101-GE-100 engine [AIAA PAPER 78-1084] A78-48497

**DETECTORS**  
 A modular adaptive, variable function flight control sensor [AD-A055175] N78-31120

**DETERIORATION**  
 Detecting abnormal turbine engine deterioration using electrostatic methods [AIAA PAPER 78-1473] A78-47919

**DIGITAL COMMAND SYSTEMS**  
 Highly survivable integrated avionics A78-49163  
 The terrain following task for the advanced tactical fighter using discrete optimal control A78-49862  
 Comparison monitoring in redundant digital flight control systems A78-49865

**DIGITAL COMPUTERS**  
 The role of the computer in the flight testing of general aviation aircraft [AIAA PAPER 78-1465] A78-47914  
 Digital simulation and flight verification of the F-5E/P Flight Director Computer A78-49905  
 Application techniques for digital flight control systems N78-30117  
 General aviation airplane structural crashworthiness user's manual. Volume 1: Program KRASH theory [AD-A055898] N78-31088

**DIGITAL FILTERS**  
 Synthesis of digital flight control systems by the method of entire eigenstructure assignment A78-49864  
 The effect of prefilter design on sample rate selection in digital flight control systems [AIAA 78-1308] A78-50209

**DIGITAL NAVIGATION**  
 In-line monitoring of digital flight control computers A78-49860  
 Synthesis of digital flight control systems by the method of entire eigenstructure assignment A78-49864

**DIGITAL SIMULATION**  
 Digital control law synthesis in the w prime domain A78-46962  
 Comparison monitoring in redundant digital flight control systems A78-49865  
 Digital simulation and flight verification of the F-5E/P Flight Director Computer A78-49905  
 Air-to-air designate/track with time sharing A78-49977  
 Guidance and navigation for automatic landing, rollout, and turnoff using MLS and magnetic cable sensors [AIAA 78-1296] A78-50203



## DIGITAL SYSTEMS

Stability augmentation by eigenvalues control and model matching A78-46965

Design and development of a multifunctional helicopter control system A78-49396

Peace Rhine - A digital Weapon Control System for the F-4 aircraft A78-49876

Digital avionics support - A retrospective view of the future A78-49903

Multi-Function Inertial Reference Assembly /MIRA/ update --- digital aircraft systems A78-49941

Digital area correlation tracker A78-49951

Digital system architecture for a 1980's jammer --- for military aircraft and ships A78-49973

A flight qualified graphics generator --- for B-1 defense system A78-50007

Triplex digital fly-by-wire redundancy management techniques [AIAA 78-1279] A78-50187

The effect of prefilter design on sample rate selection in digital flight control systems [AIAA 78-1308] A78-50209

Inherent errors in asynchronous digital flight controls [AD-A055649] N78-31124

**DIGITAL TECHNIQUES**  
Aircraft electrical system testing and data reduction using digital techniques A78-49937

**DIRECTIONAL ANTENNAS**  
Scan-limited near field testing for directive airborne antennas A78-49897

**DIRECTIONAL STABILITY**  
Evolution of a cost-effective, task-oriented, lateral-directional SAS for the A-10 aircraft --- Stability Augmentation System [AIAA PAPER 78-1460] A78-47910

**DISPLACEMENT MEASUREMENT**  
Measurement of vibratory displacements of a rotating blade A78-49397

French procedures for airfield pavement load evaluation A78-49679

**DISPLAY DEVICES**  
COMED - The cockpit display of the future --- Combined Map and Electronic Display A78-47268

Flight deck display trends A78-47899

Solid-state displays for fuel management systems --- for aircraft A78-47900

A flight qualified graphics generator --- for B-1 defense system A78-50007

An investigation of potential control-display configurations for V/STOL aircraft [AIAA 78-1238] A78-50164

Description and performance of the Langley visual landing display system [NASA-TM-78742] N78-30073

Display systems and cockpit design N78-30116

HHSD demonstration model development [AD-A054437] N78-30120

Dulles control tower console design study [AD-A056200] N78-31132

Experimental test plan for the evaluation of aircraft separation assurance displays using airline flight simulators [AD-A055849] N78-31134

**DISTANCE MEASURING EQUIPMENT**  
Two-way - 3 position and orientation measurement system --- helicopter/VTOL landing aid application A78-49661

A design of trajectory estimator using multiple DME range measurements [AD-A055191] N78-31077

## DISTORTION

F-15 inlet/engine test techniques and distortion methodologies studies. Volume 2: Time variant data quality analysis plots [NASA-CR-144867] N78-30124

**DISTRIBUTED PARAMETER SYSTEMS**  
Optimal control synthesis in distributed systems with incomplete information --- noting aircraft applications A78-48215

**DRAG REDUCTION**  
Flight experience on the need and use of inflight leading edge washing for a laminar flow airfoil [AIAA PAPER 78-1512] A78-47947

**DYNAMIC CHARACTERISTICS**  
Dynamic analysis of electrical systems A78-49934

Airplane stability calculations with a card programmable pocket calculator [NASA-TM-78678] N78-30138

Turbine engine rotordynamic evaluation, volume 1 [AD-A055262] N78-31111

**DYNAMIC LOADS**  
Airfield pavement load evaluation - An international overview A78-49676

**DYNAMIC MODELS**  
Optimal flight control synthesis via pilot modeling [AIAA 78-1286] A78-50193

**DYNAMIC RESPONSE**  
Improved aircraft dynamic response and fatigue life during ground operations using an active control landing gear system [AIAA PAPER 78-1499] A78-47939

Experimental investigation of gust response of hingeless helicopter rotors [AD-A054752] N78-30142

Engine/airframe/drive train dynamic interface documentation [AD-A055766] N78-31114

**DYNAMIC STABILITY**  
Use of ground vibration test equipment to determine unsteady aerodynamic forces A78-49708

**DYNAMIC STRUCTURAL ANALYSIS**  
Structural dynamics, stability, and control of helicopters [NASA-CR-158909] N78-30139

## E

**ECONOMIC ANALYSIS**  
An integrated analysis of the fundamental problems of air transport A78-49447

'Supermarket' airplanes --- aircraft replacement cycle in major airlines [AIAA PAPER 78-1533] A78-49769

Operations and economics of U.S. air transportation [AIAA PAPER 78-1545] A78-49770

**EDUCATION**  
Teaching design at all levels --- in aerospace engineering curricula [AIAA PAPER 78-1455] A78-47906

A computerized undergraduate aircraft design course [AIAA PAPER 78-1492] A78-47933

The value of aerospace design synthesis courses as viewed by aerospace professionals [AIAA PAPER 78-1493] A78-47934

**EIGENVALUES**  
Synthesis of digital flight control systems by the method of entire eigenstructure assignment A78-49864

**EIGENVECTORS**  
Synthesis of digital flight control systems by the method of entire eigenstructure assignment A78-49864

**EJECTORS**  
An analytical and experimental investigation of diffusers for VSTOL thrust augmenting ejectors [AIAA PAPER 78-1509] A78-47945

**ELASTIC BODIES**  
Assessment of dynamic coordinate alignment for elastic aircraft --- flight control Kalman filter estimates A78-49987

<b>ELASTOPLASTICITY</b>		<b>ELECTROSTATIC PROBES</b>	
The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints --- in aircraft structures [DLR-PB-77-63]	N78-31251	Detecting abnormal turbine engine deterioration using electrostatic methods [AIAA PAPER 78-1473]	A78-47919
<b>ELECTRIC DISCHARGES</b>		<b>ENERGY CONSERVATION</b>	
Flight application of optical fiber transmission on a Falcon '0 aircraft [ONERA, TP NO. 1978-105]	A78-47349	The second generation of high-bypass turbofans - A market clouded by uncertainty	A78-47423
<b>ELECTRIC EQUIPMENT TESTS</b>		<b>ENERGY CONVERSION</b>	
Aircraft electrical system testing and data reduction using digital techniques	A78-49937	10 years of contract research for the pump/compressor industrial concern	A78-49175
<b>ELECTRIC POTENTIAL</b>		<b>ENERGY CONVERSION EFFICIENCY</b>	
Neutralization problem for a Space Shuttle	A78-47124	Energy efficient engine: Preliminary design and integration studies [NASA-CR-135444]	N78-31108
<b>ELECTRIC POWER SUPPLIES</b>		<b>ENERGY DISSIPATION</b>	
Dynamic analysis of electrical systems	A78-49934	Short-term performance deterioration in JT9D-7A (SP) engine 695743 [NASA-CR-135431]	N78-30121
Application of rare earth/transition metal permanent magnets to 400 Hz aircraft systems - An AP overview	A78-49935	<b>ENERGY REQUIREMENTS</b>	
A standard programmable I/O for the advanced aircraft electrical system power control set	A78-49936	Impact of aircraft electrical power quality on utilization equipment	A78-49962
Modeling refinements for the rectified superconducting alternator --- airborne power supply	A78-49961	<b>ENGINE CONTROL</b>	
Impact of aircraft electrical power quality on utilization equipment	A78-49962	Alternatives for jet engine control [NASA-CR-157578]	N78-31107
<b>ELECTRO-OPTICS</b>		<b>ENGINE COOLANTS</b>	
Prediction of angular disturbances from airframe members to airborne electro-optical packages	A78-49952	Solution of an adjoint problem of steady-state heat transfer associated with the cooling of gas-turbine blades, by means of a quasi-analog/digital system	A78-47402
Advanced optical blade tip clearance measurement system [NASA-CR-159402]	N78-31106	<b>ENGINE DESIGN</b>	
<b>ELECTROFORMING</b>		Design philosophy for engine forgings	A78-47452
Large electroformed nickel moulds for aircraft parts	A78-47267	NASA engine system technology programs - An overview [AIAA PAPER 78-928]	A78-48452
<b>ELECTROMAGNETIC INTERACTIONS</b>		Propulsion for future supersonic transports - 1978 status [AIAA PAPER 78-1051]	A78-48486
Electromagnetic coupling analysis of a Learjet aircraft in a lightning environment	A78-49920	Advanced supersonic transport engine integration studies for near-term technology readiness date [AIAA PAPER 78-1052]	A78-48487
<b>ELECTROMAGNETIC PULSES</b>		Design for durability - The F101-GE-100 engine [AIAA PAPER 78-1084]	A78-48497
Laboratory testing of lightning and EMP susceptibility of avionics systems	A78-49861	Operating characteristics of bypass turbojet engines --- Russian book	A78-50125
<b>ELECTRON BEAMS</b>		Advance nozzle technology	N78-30111
Neutralization problem for a Space Shuttle	A78-47124	Computer program for the design and off-design performance of turbojet and turbofan engine cycles [NASA-TM-78653]	N78-30122
<b>ELECTRONIC COUNTERMEASURES</b>		Energy efficient engine: Preliminary design and integration studies [NASA-CR-135444]	N78-31108
Comparisons of high anti-jam design techniques for GPS receivers --- Global Positioning System	A78-49857	<b>ENGINE FAILURE</b>	
Multiprocessing for electronic warfare avionics	A78-49869	Rotor burst protection program: Statistics on aircraft gas turbine engine rotor failures that occurred in US commercial aviation during 1975 [NASA-CR-135304]	N78-31105
Performance in a jamming environment of a low-cost GPS user receiver algorithm for aiding a tactical INS [AD-A055239]	N78-31078	<b>ENGINE INLETS</b>	
<b>ELECTRONIC EQUIPMENT</b>		Boundary layers in axisymmetric inlets at angle of attack. I - Measurements [AIAA PAPER 78-1109]	A78-48499
Evaluation of methods for calculating system operating time in accordance with Reliability Improvement Warranty (RIW) contractual terms [AD-A054822]	N78-30079	Intake design for fighter aircraft	N78-30110
<b>ELECTRONIC EQUIPMENT TESTS</b>		F-15 inlet/engine test techniques and distortion methodologies studies. Volume 1: Technical discussion [NASA-CR-144866]	N78-30123
LOGMOD - The fault-isolator --- for helicopter electronic systems	A78-49239	F-15 inlet/engine test techniques and distortion methodologies studies. Volume 2: Time variant data quality analysis plots [NASA-CR-144867]	N78-30124
Laboratory testing of lightning and EMP susceptibility of avionics systems	A78-49861	F-15 inlet/engine test techniques and distortion methodologies studies. Volume 3: Power spectral density plots [NASA-CR-144868]	N78-30125
<b>ELECTRONIC MODULES</b>		F-15 inlet/engine test techniques and distortion methodologies studies. Volume 4: Autocorrelation functions [NASA-CR-144869]	N78-30126
Modular Missionization Systems /MMS/, an adaptive system interface concept	A78-49852	F-15 inlet/engine test techniques and distortion methodologies studies. Volume 5: Effect of filter cutoff frequency on turbulence plots [NASA-CR-144870]	N78-30127
A modular adaptive, variable function flight control sensor [AD-A055175]	N78-31120		
<b>ELECTROSTATIC CHARGE</b>			
Investigation of electrostatic discharge in aircraft fuel tanks during refueling [AIAA PAPER 78-1501]	A78-47941		

- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 6: Distortion analysis plots  
[NASA-CR-144871] N78-30128
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 7: Cross correlation functions.  
[NASA-CR-144872] N78-30129
- ENGINE MONITORING INSTRUMENTS**
- IDS in engine management programmes --- Airborne Integrated Data Systems  
A78-47865
- Detecting abnormal turbine engine deterioration using electrostatic methods  
[AIAA PAPER 78-1473] A78-47919
- Sensor technology for turbine engine monitoring systems  
[AIAA PAPER 78-1474] A78-47920
- Engine vibration in flight  
[AIAA PAPER 78-1475] A78-47921
- Use of a field bench for testing turbojet engines  
A78-49731
- ENGINE PARTS**
- Operation of oil seals of aircraft piston engines under conditions of cavitation. I  
A78-47175
- Aspects of the thermal fatigue strength of gas-turbine engine components  
A78-49176
- Turbine tip clearance measurement  
[AD-A055765] N78-31115
- ENGINE TESTS**
- TP41-A-2/A7E inflight engine condition monitoring system /IECMS/  
[AIAA PAPER 78-1472] A78-47918
- Analysis of GTE tolerance monitoring parameter formation --- gas turbine engine  
A78-48212
- Ground test facility for integral rocket ramjets  
[AIAA PAPER 78-934] A78-48454
- Ramjet engine testing and simulation techniques  
[AIAA PAPER 78-935] A78-48455
- Center-loaded duct integral rocket-to-ramjet transition testing  
[AIAA PAPER 78-937] A78-48456
- Use of a field bench for testing turbojet engines  
A78-49731
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 1: Technical discussion  
[NASA-CR-144866] N78-30123
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 2: Time variant data quality analysis plots  
[NASA-CR-144867] N78-30124
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 3: Power spectral density plots  
[NASA-CR-144868] N78-30125
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 4: Autocorrelation functions  
[NASA-CR-144869] N78-30126
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 5: Effect of filter cutoff frequency on turbulence plots  
[NASA-CR-144870] N78-30127
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 7: Cross correlation functions.  
[NASA-CR-144872] N78-30129
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 8: Cross spectral density plots  
[NASA-CR-144873] N78-30130
- F-15 inlet engine test techniques and distortion methodologies studies. Volume 9: Stability audits  
[NASA-CR-144874] N78-30131
- ENVIRONMENT EFFECTS**
- An assessment of the effect of supersonic aircraft operations on the stratospheric ozone content  
[NASA-RP-1026] N78-30774
- The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints --- in aircraft structures  
[DLR-FB-77-63] N78-31251
- ENVIRONMENTAL QUALITY**
- Noise in airports, its measurement, and its effect on the communities in the vicinity  
A78-48374
- ENVIRONMENTAL TESTS**
- Fiber optic development for tactical fighter applications  
A78-49906
- EQUATIONS OF MOTION**
- REXOR 2 rotorcraft simulation model. Volume 2: Computer implementation  
[NASA-CR-145332] N78-30043
- A study of the precision hover capabilities of the aerocrane hybrid heavy lift vehicles  
[AD-A054281] N78-30091
- Diverse forms and derivations of the equations of motion of deformable aircraft and their mutual relationship  
[RAE-TR-77077] N78-30097
- EQUIPMENT SPECIFICATIONS**
- Aeronautical procurement - The primary specification system  
[AIAA PAPER 78-1489] A78-47932
- Rotor design implications for composite material properties  
[UCRL-80117] N78-30182
- ERROR ANALYSIS**
- Inherent errors in asynchronous digital flight controls  
[AD-A055649] N78-31124
- ERROR SIGNALS**
- A Costas loop with tangent error signal for use in Navstar GPS avionics  
A78-49858
- EXHAUST DIFFUSERS**
- An analytical and experimental investigation of diffusers for VSTOL thrust augmenting ejectors  
[AIAA PAPER 78-1509] A78-47945
- EXHAUST GASES**
- Gas turbine engine emissions - Problems, progress and future  
A78-49336
- EXHAUST NOZZLES**
- Aerodynamic characteristics induced on a supercritical wing due to vectoring twin nozzles at Mach numbers from 0.40 to 0.95  
[NASA-TN-78746] N78-30039
- Advance nozzle technology  
N78-30111
- EXTERNAL STORES**
- Wing/store active flutter suppression - Correlation of analyses and wind tunnel data  
[AIAA PAPER 78-1459] A78-47909
- Graphics for the hybrid stores separation simulation of the B77 system  
[SAND-78-8212] N78-31099
- EXTERNAL SURFACE CURRENTS**
- Flight application of optical fiber transmission on a Falcon 10 aircraft  
[ONERA, TP NO. 1978-105] A78-47349
- EXTREMELY HIGH FREQUENCIES**
- Dual band airborne SATCOM terminal  
A78-49972

## F

- F-4 AIRCRAFT**
- Synthesis of digital flight control systems by the method of entire eigenstructure assignment  
A78-49864
- Peace Rhine - A digital Weapon Control System for the F-4 aircraft  
A78-49876
- F-5 AIRCRAFT**
- Some observations on the mechanism of aircraft wing rock  
[AIAA PAPER 78-1456] A78-47907
- Digital simulation and flight verification of the F-5E/F Flight Director Computer  
A78-49905
- F-8 AIRCRAFT**
- A learning flight control system for the F8-DFBW aircraft --- Digital Fly-By-Wire  
[AIAA 78-1288] A78-50195
- The effect of prefilter design on sample rate selection in digital flight control systems  
[AIAA 78-1308] A78-50209

<b>F-15 AIRCRAFT</b>		Fracture mechanics fundamentals with reference to aircraft structural applications	N78-30274
Subsystem verification of an AFLC organically developed F-15 simulation --- Air Force Logistics Command	A78-49901	Structural fatigue testing	N78-30279
<b>F-15 avionics Built-in-Test</b>	A78-49991	NDI and the detection of fatigue	N78-30282
<b>F-15 inlet/engine test techniques and distortion methodologies studies. Volume 1: Technical discussion</b> [NASA-CR-144866]	N78-30123	The development of the theory of structural fatigue	N78-30283
<b>F-15 inlet/engine test techniques and distortion methodologies studies. Volume 2: Time variant data quality analysis plots</b> [NASA-CR-144867]	N78-30124	Load interaction effects in fatigue crack propagation	N78-30285
<b>F-15 inlet/engine test techniques and distortion methodologies studies. Volume 3: Power spectral density plots</b> [NASA-CR-144868]	N78-30125	Recent developments in analysis of crack propagation and fracture of practical materials --- stress analysis in aircraft structures [NASA-TM-78766]	N78-30606
<b>F-15 inlet/engine test techniques and distortion methodologies studies. Volume 4: Autocorrelation functions</b> [NASA-CR-144869]	N78-30126	<b>FATIGUE LIFE</b> Improved aircraft dynamic response and fatigue life during ground operations using an active control landing gear system [AIAA PAPER 78-1499]	A78-47939
<b>F-15 inlet/engine test techniques and distortion methodologies studies. Volume 5: Effect of filter cutoff frequency on turbulence plots</b> [NASA-CR-144870]	N78-30127	Aircraft structural fatigue [ARL/STRUC-REPT-363]	N78-30271
<b>F-15 inlet/engine test techniques and distortion methodologies studies. Volume 6: Distortion analysis plots</b> [NASA-CR-144871]	N78-30128	Fatigue S/N data in relation to variability in predicted life	N78-30278
<b>F-15 inlet/engine test techniques and distortion methodologies studies. Volume 7: Cross correlation functions.</b> [NASA-CR-144872]	N78-30129	Current developments in the life of aircraft structure	N78-30280
<b>F-15 inlet/engine test techniques and distortion methodologies studies. Volume 8: Cross spectral density plots</b> [NASA-CR-144873]	N78-30130	Aircraft structural life monitoring and the problem of corrosion	N78-30281
<b>F-15 inlet engine test techniques and distortion methodologies studies. Volume 9: Stability audits</b> [NASA-CR-144874]	N78-30131	A model of crack-tip behaviour for fatigue life determination	N78-30286
Hazard assessment of aircraft gun compartments [AD-A055026]	N78-31064	The influences of residual stresses on oscillating tensile strength and the measurement of residual stress, with emphasis on aircraft construction --- fatigue life of aircraft construction materials [BMVG-FBWT-77-23]	N78-30603
<b>F-16 AIRCRAFT</b>		<b>FATIGUE TESTS</b> Development of a load sequence for a structural fatigue test	N78-30277
Interface design considerations for F-16 sensors and weapons	A78-49874	Structural fatigue testing	N78-30279
An interface management approach to software development	A78-49933	Current developments in the life of aircraft structure	N78-30280
Status of the Air Force's F-16 aircraft program [PB-280304/7]	N78-31946	Aircraft structural life monitoring and the problem of corrosion	N78-30281
<b>F-18 AIRCRAFT</b>		NDI and the detection of fatigue	N78-30282
Software development for fly-by-wire flight control systems [AIAA 78-1276]	A78-50185	The development of the theory of structural fatigue	N78-30283
Fighter superiority by design	N78-30105	<b>FEEDBACK CONTROL</b> Digital control law synthesis in the w prime domain	A78-46962
<b>F-111 AIRCRAFT</b>		Wing/store active flutter suppression - Correlation of analyses and wind tunnel data [AIAA PAPER 78-1459]	A78-47909
Non-axisymmetric nozzle design and evaluation for F-111 flight demonstration [AIAA PAPER 78-1025]	A78-48483	Improving the accuracy of HUD approaches in windshear with a new control law [AIAA PAPER 78-1494]	A78-47935
<b>FAIL-SAFE SYSTEMS</b>		Guaranteed cost control of linear systems with uncertain parameters - Application to remotely piloted vehicle flight control systems [AIAA 78-1274]	A78-50184
<b>F-15 avionics Built-in-Test</b>	A78-49991	Software development for fly-by-wire flight control systems [AIAA 78-1276]	A78-50185
<b>FAILURE ANALYSIS</b>		Inherent errors in asynchronous digital flight controls [AD-A055649]	N78-31124
Detecting abnormal turbine engine deterioration using electrostatic methods [AIAA PAPER 78-1473]	A78-47919	<b>FIBER OPTICS</b> Flight application of optical fiber transmission on a Falcon 10 aircraft [ONERA, TP NO. 1978-105]	A78-47349
<b>FALLOUT</b>		Fiber optic development for tactical fighter applications	A78-49906
On the use of zirconium 95 data from Chinese atmospheric thermonuclear explosions to study stratospheric transport in a one-dimensional parameterization	A78-48062	<b>FIGHTER AIRCRAFT</b> Air-to-air combat simulation	A78-47868
<b>FANS</b>		Canard configured aircraft with 2-D nozzle [AIAA PAPER 78-1450]	A78-47904
Ground impingement of a fan jet exhaust plume [AD-A054832]	N78-31112		
<b>FATIGUE (MATERIALS)</b>			
Aircraft structural fatigue [ARL/STRUC-REPT-363]	N78-30271		
Safety against fatigue in flight: A perspective of Australian experience and research	N78-30272		
Mechanisms of fatigue and fracture	N78-30273		

FIGURE OF MERIT

SUBJECT INDEX

The HiMAT RPRV system [AIAA PAPER 78-1457]	A78-47908	Large deflection static analysis of typical tail-wheel structure of light aircraft by finite element method	A78-48864
Studies of aerodynamic technology for VSTOL fighter/attack aircraft [AIAA PAPER 78-1511]	A78-47946	<b>FIREBEE 2 TARGET DRONE AIRCRAFT</b> Drones for aerodynamic and structural testing /DAST/ - A status report [AIAA PAPER 78-1485]	A78-47929
Status of a nozzle-airframe study of a highly maneuverable fighter [AIAA PAPER 78-990]	A78-48470	<b>FIXED WINGS</b> Effects of wind on aircraft cruise performance [AIAA PAPER 78-1496]	A78-47937
Installed performance of vectoring/reversing non-axisymmetric nozzles [AIAA PAPER 78-1022]	A78-48482	<b>PLANE STABILITY</b> Flame stabilization in a ramjet combustion chamber by means of a pilot gas generator [DLR-FB-77-54]	N78-31117
Vectoring non-axisymmetric nozzle jet induced effects on a V/STOL fighter model [AIAA PAPER 78-1080]	A78-48496	<b>FLAMMABILITY</b> Assessment of relative flammability and thermochemical properties of some thermoplastic materials	A78-49693
Mirage 2000 - Dassault's better delta	A78-49169	<b>FLAMMABLE GASES</b> Hazard assessment of aircraft gun compartments [AD-A055026]	N78-31064
Technology analysis - Candidate advanced tactical fighters [AIAA PAPER 78-1451]	A78-49782	<b>FLAT PLATES</b> Some sound transmission loss characteristics of typical general aviation structural materials [AIAA PAPER 78-1480]	A78-47925
Design evolution of a supersonic cruise strike-fighter [AIAA PAPER 78-1452]	A78-49783	<b>FLAT SURFACES</b> Analysis of a suspension system for a wheel rolling on a flat track [NASA-CR-157563]	N78-30583
The terrain following task for the advanced tactical fighter using discrete optimal control	A78-49862	<b>FLIGHT CHARACTERISTICS</b> Ride quality evaluation. IV - Models of subjective reaction to aircraft motion	A78-47490
Fiber optic development for tactical fighter applications	A78-49906	<b>IDS in engine management programmes --- Airborne Integrated Data Systems</b>	A78-47865
Accuracy requirement and cost effectiveness of GPS-aided INS for tactical fighters	A78-49989	Dynamics of the longitudinal motion of an airplane with a variable-geometry wing	A78-49285
Improved combat survivability for fly-by-wire sensor systems [AIAA 78-1277]	A78-50186	RPV flying qualities design criteria [AIAA 78-1271]	A78-50181
Computer program for vibration prediction of fighter aircraft equipments [AD-A054598]	N78-30094	<b>FLIGHT CONDITIONS</b> Landing aircraft under poor conditions	A78-49549
Fighter aircraft design --- conferences [AGARD-CP-241]	N78-30099	<b>FLIGHT CONTROL</b> Constant-control rolling maneuver	A78-46961
Advanced control concepts for future fighter aircraft	N78-30104	Non-axisymmetric nozzle design and evaluation for F-111 flight demonstration [AIAA PAPER 78-1025]	A78-48483
Aerodynamics of the new generation of combat aircraft with delta wings	N78-30106	Optimization techniques for air traffic control problems --- Russian book	A78-48504
Supercruiser fighter analysis	N78-30107	Design of a horizontal tail unit and related adjustments	A78-49736
Analysis of advanced variable camber concepts	N78-30108	V/STOL aircraft simulation - Requirements and capabilities at Ames Research Center [AIAA PAPER 78-1515]	A78-49790
Variable-cycle engine fighter aircraft: Advance in performance and development problems	N78-30109	A qualitative analysis of redundant asynchronous operation	A78-49863
Intake design for fighter aircraft	N78-30110	Synthesis of digital flight control systems by the method of entire eigenstructure assignment	A78-49864
Advance nozzle technology	N78-30111	Bank-to-turn /BIT/ autopilot technology --- for missiles	A78-49927
Impact of active control on structures design	N78-30113	Strapdown seeker guidance for tactical weapons	A78-49928
New structures made of composite materials for high performance combat aircraft	N78-30114	Assessment of dynamic coordinate alignment for elastic aircraft --- flight control Kalman filter estimates	A78-49987
Metal technology for future aircraft design	N78-30115	Flight controls of Army/Hughes YAH-64 advanced attack helicopter [AIAA 78-1237]	A78-50160
Display systems and cockpit design	N78-30116	An investigation of potential control-display configurations for V/STOL aircraft [AIAA 78-1238]	A78-50161
Application techniques for digital flight control systems	N78-30117	Optimal terrain-aided navigation systems [AIAA 78-1243]	A78-50163
The design of a high g cockpit	N78-30118	RPV flying qualities design criteria [AIAA 78-1271]	A78-50181
The feasibility of estimating avionics support costs early in the acquisition cycle. Volume 1: The basic report [AD-A054016]	N78-30119	Optimal flight control synthesis via pilot modeling [AIAA 78-1286]	A78-50193
The terrain following task for the advanced tactical fighter using discrete optimal control [AD-A055196]	N78-31121		
<b>FIGURE OF MERIT</b> Operational regularity in air transport	A78-49449		
<b>FINITE ELEMENT METHOD</b> Calculation of exchange coefficients for high-temperature turbine blades [ONERA, TP NO. 1978-104]	A78-47348		
Superelement method for helicopter fuselage analysis	A78-48209		

SUBJECT INDEX

FLIGHT TESTS

A learning flight control system for the P8-DPBW aircraft --- Digital Fly-By-Wire [AIAA 78-1288]	A78-50195	Piloted flight simulation for active control design development [AIAA PAPER 78-1553]	A78-49771
Characteristics of constrained optimum trajectories with specified range [NASA-TM-78519]	N78-30072	V/STOL aircraft simulation - Requirements and capabilities at Ames Research Center [AIAA PAPER 78-1515]	A78-49790
Application techniques for digital flight control systems	N78-30117	Subsystem verification of an AFLC organically developed P-15 simulation --- Air Force Logistics Command	A78-49901
A pyramid skewed axis sensor set for multiplex flight control systems [ARC-R/M-3808]	N78-30143	A flight simulation high order language study	A78-49957
A modular adaptive, variable function flight control sensor [AD-A055175]	N78-31120	Flight investigation and theory of direct side-force control [AIAA 78-1287]	A78-50194
The terrain following task for the advanced tactical fighter using discrete optimal control [AD-A055196]	N78-31121	Approach guidance logic for a tilt-rotor aircraft [AIAA 78-1295]	A78-50202
Optimal terrain following controller for an optimized spline reference path [AD-A055234]	N78-31122	Simulation study of the oscillatory longitudinal motion of an airplane at the stall [NASA-TP-1242]	N78-30141
The influence of throttle augmented stability (APCS) and short period control characteristics on the landing approach [AD-A055892]	N78-31123	Compilation of test data from an investigation on the effect of environment on crack growth under flight-simulation loading [NLR-TR-76096-U]	N78-30620
Inherent errors in asynchronous digital flight controls [AD-A055649]	N78-31124	Simulation and flight evaluation of a head-up landing aid for general aviation [NASA-TP-1276]	N78-31101
<b>FLIGHT HAZARDS</b>		Software design for a Visually-Coupled Airborne Systems Simulator (VCASS) [AD-A055226]	N78-31133
The airborne detection of low-level wind shear [AIAA PAPER 78-1495]	A78-47936	<b>FLIGHT SIMULATORS</b>	
<b>FLIGHT INSTRUMENTS</b>		Air-to-air combat simulation	A78-47868
Flight deck display trends	A78-47899	V/STOL aircraft simulation - Requirements and capabilities at Ames Research Center [AIAA PAPER 78-1515]	A78-49790
Aviation control system devices --- Russian book	A78-49850	Evaluation of several secondary tasks in the determination of permissible time delays in simulator visual and motion cues [NASA-TP-1214]	N78-30089
A modular adaptive, variable function flight control sensor [AD-A055175]	N78-31120	Simulator study of the effect of visual-motion time delays on pilot tracking performance with an audio side task [NASA-TP-1216]	N78-30090
<b>FLIGHT OPERATIONS</b>		Software design for a Visually-Coupled Airborne Systems Simulator (VCASS) [AD-A055226]	N78-31133
Approach for identifying avionics flight software operational support requirements - PAVE TACK an example	A78-49900	Experimental test plan for the evaluation of aircraft separation assurance displays using airline flight simulators [AD-A055849]	N78-31134
<b>FLIGHT OPTIMIZATION</b>		<b>FLIGHT TEST VEHICLES</b>	
Trajectory optimization for some sailplane performance problems	N78-31083	Drones for aerodynamic and structural testing /DAST/ - A status report [AIAA PAPER 78-1485]	A78-47929
<b>FLIGHT PATHS</b>		<b>FLIGHT TESTS</b>	
A method for determining the stability characteristics of aircraft in a helicoid flight path	A78-49741	Flight application of optical fiber transmission on a Falcon 10 aircraft [ONERA, TP NO. 1978-105]	A78-47349
Optimal terrain following controller for an optimized spline reference path [AD-A055234]	N78-31122	B-1 flight test progress report [AIAA PAPER 78-1448]	A78-47903
<b>FLIGHT PLANS</b>		Integrated test mission control - Present and future at the Air Force Flight Test Center [AIAA PAPER 78-1461]	A78-47911
IFR aircraft handled forecast by air route traffic control center, fiscal years 1978-1989 [AD-A049305]	N78-31075	Use of onboard computerized flight test analysis systems [AIAA PAPER 78-1462]	A78-47912
<b>FLIGHT RECORDERS</b>		Software engineering a must for success in computerized flight test [AIAA PAPER 78-1463]	A78-47913
L-1011 flight data recording systems - Background, features, implications and benefits [AIAA PAPER 78-1471]	A78-47917	The role of the computer in the flight testing of general aviation aircraft [AIAA PAPER 78-1465]	A78-47914
Non-volatile memory system for severe environment flight recorders	A78-49872	Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions [AIAA PAPER 78-989]	A78-48469
Preliminary design of an accident information Retrieval System (AIRS) [AD-A055590]	N78-31952	Non-axisymmetric nozzle design and evaluation for F-111 flight demonstration [AIAA PAPER 78-1025]	A78-48483
<b>FLIGHT SAFETY</b>		Navstar GPS field test results	A78-49856
Flutter suppressor for transonic flight [ONERA, TP NO. 1978-102]	A78-47346	Digital simulation and flight verification of the F-5E/F Flight Director Computer	A78-49905
AIDS in engine management programmes --- Airborne Integrated Data Systems	A78-47865	Flight measurements of the effects of simulated leading-edge erosion on helicopter blade stall, torsional loads and performance [ARC-R/M-3809]	N78-30098
Safety of space flights	A78-47952		
Distribution of reliability characteristics among airplane system units to ensure given flight safety level	A78-48221		
<b>FLIGHT SIMULATION</b>			
Ramjet engine testing and simulation techniques [AIAA PAPER 78-935]	A78-48455		
Important simulation parameters for the experimental testing of propulsion induced lift effects [AIAA PAPER 78-1078]	A78-48494		

- Compilation of test data from an investigation on the effect of environment on crack growth under flight-simulation loading  
[NLR-TR-76096-U] N78-30620
- TFSB microwave landing system demonstration program at Kristiansand, Norway  
[AD-A055317] N78-31071
- TRSB microwave landing system demonstration program at Charleroi, Belgium  
[AD-A055920] N78-31072
- IPC design validation and flight testing  
[AD-A055529] N78-31074
- FLIGHT TRAINING**
- Antitorque training: Evaluation of effectiveness in reducing mishap losses  
[AD-A055040] N78-31092
- FLIGHT VEHICLES**
- Optimization techniques for air traffic control problems --- Russian book A78-48504
- FLIR DETECTORS**
- Autothreshold autoscreener/FLIR system --- airborne target screener/Forward-Looking Infrared imaging system A78-49984
- FLOW CHARACTERISTICS**
- Calculation of the longitudinal aerodynamic characteristics of upper-surface-blown wing-flap configurations  
[NASA-CR-3004] N78-30050
- FLOW DISTORTION**
- F-5 inlet/engine test techniques and distortion methodologies studies. Volume 1: Technical discussion  
[NASA-CR-144866] N78-30123
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 3: Power spectral density plots  
[NASA-CR-144868] N78-30125
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 4: Autocorrelation functions  
[NASA-CR-144869] N78-30126
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 5: Effect of filter cutoff frequency on turbulence plots  
[NASA-CR-144870] N78-30127
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 6: Distortion analysis plots  
[NASA-CR-144871] N78-30128
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 7: Cross correlation functions.  
[NASA-CR-144872] N78-30129
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 8: Cross spectral density plots  
[NASA-CR-144873] N78-30130
- F-15 inlet engine test techniques and distortion methodologies studies. Volume 9: Stability audits  
[NASA-CR-144874] N78-30131
- FLOW MEASUREMENT**
- Boundary layers in axisymmetric inlets at angle of attack. I - Measurements  
[AIAA PAPER 78-1109] A78-48499
- FLOW VISUALIZATION**
- Measurements and analysis of the forces acting on a small aircraft flying in the upwash of a large aircraft  
[AD-A0552861] N78-31048
- FLUTTER ANALYSIS**
- Wing/store active flutter suppression - Correlation of analyses and wind tunnel data  
[AIAA PAPER 78-1459] A78-47909
- Use of ground vibration test equipment to determine unsteady aerodynamic forces A78-49708
- Close encounters of the aeroservoelastic kind --- aerodynamics, structural dynamics, and automatic flight control systems for aircraft design applications  
[AIAA 78-1289] A78-50196
- Considerations on wing stores flutter: Asymmetry, flutter suppression  
[AGARD-R-668] N78-31126
- Asymmetric store flutter N78-31127
- FLY BY WIRE CONTROL**
- In-line monitoring of digital flight control computers A78-49860
- Laboratory testing of lightning and EMP susceptibility of avionics systems A78-49861
- Software development for fly-by-wire flight control systems  
[AIAA 78-1276] A78-50185
- Improved combat survivability for fly-by-wire sensor systems  
[AIAA 78-1277] A78-50186
- Triplex digital fly-by-wire redundancy management techniques  
[AIAA 78-1279] A78-50187
- A learning flight control system for the F8-DFBW aircraft --- Digital Fly-By-Wire  
[AIAA 78-1288] A78-50195
- The terrain following task for the advanced tactical fighter using discrete optimal control  
[AD-A055196] N78-31121
- FOCUSING**
- Long-distance focusing of Concorde sonic boom A78-48052
- FORECASTING**
- IFR aircraft handled forecast by air route traffic control center, fiscal years 1978-1989  
[AD-A049305] N78-31075
- FORGING**
- Design philosophy for engine forgings A78-47452
- Design philosophy for airframes A78-47453
- FRACTURE MECHANICS**
- Minimum weight design of stiffened panels with fracture constraints A78-49837
- Mechanisms of fatigue and fracture N78-30273
- Fracture mechanics fundamentals with reference to aircraft structural applications N78-30274
- Recent developments in analysis of crack propagation and fracture of practical materials --- stress analysis in aircraft structures  
[NASA-TN-78766] N78-30606
- FRACTURE STRENGTH**
- Engineering data on new aerospace materials structural materials  
[AD-A054461] N78-30213
- FREE FALL**
- Operator work capacity during parachutist free-fall A78-47978
- FREE VIBRATION**
- The influence of high twist on the dynamics of rotating blades A78-47599
- FREQUENCY DISTRIBUTION**
- F-15 inlet/engine test techniques and distortion methodologies studies. Volume 5: Effect of filter cutoff frequency on turbulence plots  
[NASA-CR-144870] N78-30127
- FREQUENCY RESPONSE**
- Prediction of angular disturbances from airframe members to airborne electro-optical packages A78-49952
- FREQUENCY STABILITY**
- A compensation technique for acceleration-induced frequency changes in crystal oscillators A78-49859
- FUEL CONSUMPTION**
- Let's put fuel efficiency into perspective A78-47269
- The second generation of high-bypass turbofans - A market clouded by uncertainty A78-47423
- The effect on block fuel consumption of a strutted versus cantilever wing for a short-haul transport including strut aeroelastic considerations  
[AIAA PAPER 78-1454] A78-47905
- Choice of cycle for a regenerative bypass turbojet for long-range aircraft A78-49723
- FUEL CORROSION**
- Effect of jet fuel autooxidation products on thermooxidation stability A78-49025

## SUBJECT INDEX

## GROUND TESTS

- FUEL GAGES**  
Solid-state displays for fuel management systems  
--- for aircraft  
A78-47900
- FUEL TANKS**  
Investigation of electrostatic discharge in  
aircraft fuel tanks during refueling  
[AIAA PAPER 78-1501] A78-47941  
Fundamentals of noncuring sealants for aircraft  
fuel tanks  
[AD-A054627] N78-30247
- FUSELAGES**  
Superelement method for helicopter fuselage analysis  
A78-48209  
Definition of airplane fuselage longitudinal lines  
by the special contour method  
A78-48222  
Fatigue crack growth in pressurized fuselage panel  
A78-48231
- FV-12A AIRCRAFT**  
An analytical and experimental investigation of  
diffusers for VSTOL thrust augmenting ejectors  
[AIAA PAPER 78-1509] A78-47945
- G**
- GAS ANALYSIS**  
A preliminary comparison of thermal decomposition  
products of aircraft interior materials using  
the National Bureau of Standards smoke chamber  
and the combustion tube furnace  
[AD-A054811] N78-30088
- GAS GENERATORS**  
Flame stabilization in a ramjet combustion chamber  
by means of a pilot gas generator  
[DLR-FB-77-54] N78-31117
- GAS TURBINE ENGINES**  
Operation of oil seals of aircraft piston engines  
under conditions of cavitation. I  
A78-47175  
Engine vibration in flight  
[AIAA PAPER 78-1475] A78-47921  
Analysis of GTE tolerance monitoring parameter  
formation --- gas turbine engine  
A78-48212  
Aspects of the thermal fatigue strength of  
gas-turbine engine components  
A78-49176  
Gas turbine engine emissions - Problems, progress  
and future  
A78-49336  
Computer program for the design and off-design  
performance of turbojet and turbofan engine cycles  
[NASA-TM-78653] N78-30122  
A theoretical study of the performance of a number  
of different axial-flow turbine configurations  
under conditions of pulsating flow  
[ARL/MECH-ENG-REPT-149] N78-31104  
Rotor burst protection program: Statistics on  
aircraft gas turbine engine rotor failures that  
occurred in US commercial aviation during 1975  
[NASA-CR-135304] N78-31105  
Advanced optical blade tip clearance measurement  
system  
[NASA-CR-159402] N78-31106
- GAS TURBINES**  
Application of electrical analogy to the  
substantiation and comparison of some analytical  
methods of determining temperature fields in  
gas-turbine blades  
A78-47404  
Turbine engine rotordynamic evaluation, volume 1  
[AD-A055262] N78-31111
- GENERAL AVIATION AIRCRAFT**  
From Challenger to winner --- Canadair executive  
jet design and development  
A78-47570  
The role of the computer in the flight testing of  
general aviation aircraft  
[AIAA PAPER 78-1465] A78-47914  
Correlation of model and airplane spin  
characteristics for a low-wing general aviation  
research airplane  
[AIAA PAPER 78-1477] A78-47922  
Whitcomb winglet applications to general aviation  
aircraft  
[AIAA PAPER 78-1478] A78-47923
- Some sound transmission loss characteristics of  
typical general aviation structural materials  
[AIAA PAPER 78-1480] A78-47925  
Integrated avionics for future general aviation  
aircraft  
[AIAA PAPER 78-1482] A78-47927  
Phase-locked tracking loops for LOPAN-C  
[NASA-CR-157582] N78-31068  
General aviation airplane structural  
crashworthiness user's manual. Volume 1:  
Program KRASH theory  
[AD-A055898] N78-31088  
Simulation and flight evaluation of a head-up  
landing aid for general aviation  
[NASA-TP-1276] N78-31101  
A research program to reduce interior noise in  
general aviation airplanes: Noise reduction  
through a cavity-backed flexible plate  
[NASA-CR-157588] N78-31873  
A research program to reduce interior noise in  
general aviation airplanes: Investigation of  
the characteristics of an acoustic panel test  
facility  
[NASA-CR-157587] N78-31874
- GLIDE PATHS**  
Capture effect array glide slope guidance study  
[AD-A055678] N78-31073
- GLIDERS**  
Trajectory optimization for some sailplane  
performance problems  
N78-31083
- GLOBAL POSITIONING SYSTEM**  
Navstar GPS field test results  
A78-49856  
Comparisons of high anti-jam design techniques for  
GPS receivers --- Global Positioning System  
A78-49857  
A Costas loop with tangent error signal for use in  
Navstar GPS avionics  
A78-49858  
A compensation technique for acceleration-induced  
frequency changes in crystal oscillators  
A78-49859  
Accuracy requirement and cost effectiveness of  
GPS-aided INS for tactical fighters  
A78-49989
- GOVERNMENT PROCUREMENT**  
Aeronautical procurement - The primary  
specification system  
[AIAA PAPER 78-1489] A78-47932
- GRAVITATIONAL EFFECTS**  
Constant-control rolling maneuver  
A78-46961
- GROUND BASED CONTROL**  
The HLMAT RPRV system  
[AIAA PAPER 78-1457] A78-47908  
Capture effect array glide slope guidance study  
[AD-A055678] N78-31073
- GROUND EFFECT (AERODYNAMICS)**  
Conceptual design study of power augmented ram  
wing in ground effect aircraft  
[AIAA PAPER 78-1466] A78-47915  
Experimental determination of propulsion induced  
ground effects of typical three fan type A  
V/STOL configurations  
[AIAA PAPER 78-1507] A78-47943  
Modeling ground plane influence on wing  
aerodynamic characteristics using a finite plane  
screen  
A78-48216  
Asymptotic theory of a wing moving near a solid wall  
A78-48248  
Important simulation parameters for the  
experimental testing of propulsion induced lift  
effects  
[AIAA PAPER 78-1078] A78-48494  
Ground effects testing of two, three, and four jet  
configurations  
[AIAA PAPER 78-1510] A78-49789
- GROUND STATIONS**  
IPR aircraft handled forecast by air route traffic  
control center, fiscal years 1978-1989  
[AD-A049305] N78-31075
- GROUND TESTS**  
Ground test facility for integral rocket ramjets  
[AIAA PAPER 78-934] A78-48454



## GUIDANCE SENSORS

## SUBJECT INDEX

Important simulation parameters for the experimental testing of propulsion induced lift effects  
[AIAA PAPER 78-1078] A78-48494

Use of ground vibration test equipment to determine unsteady aerodynamic forces A78-49708

**GUIDANCE SENSORS**  
Strapdown seeker guidance for tactical weapons A78-49928

Multi-Function Inertial Reference Assembly /MIRA/ update --- digital aircraft systems A78-49941

**GUNS (ORDNANCE)**  
Hazard assessment of aircraft gun compartments [AD-A055026] N78-31064

**GUST LOADS**  
On the linear superposition of aerodynamic forces on wings in periodic gusts A78-47869

Experimental investigation of gust response of hingeless helicopter rotors [AD-A054752] N78-30142

Gust measurements and the N sub o problem N78-30276

**GYROSCOPES**  
A pyramid skewed axis sensor set for multiplex flight control systems [ARC-R/M-3808] N78-30143

**H**

**HEAD-UP DISPLAYS**  
Improving the accuracy of HUD approaches in windshear with a new control law [AIAA PAPER 78-1494] A78-47935

Simulation and flight evaluation of a head-up landing aid for general aviation [NASA-TP-1276] N78-31101

**HEAT TRANSFER**  
Application of electrical analogy to the substantiation and comparison of some analytical methods of determining temperature fields in gas-turbine blades A78-47404

**HELICOPTER CONTROL**  
Design and development of a multifunctional helicopter control system A78-49396

Flight controls of Army/Hughes YAH-64 advanced attack helicopter [AIAA 78-1237] A78-50160

Shipboard launch and recovery of RPV helicopters in high sea states [AIAA 78-1269] A78-50179

**HELICOPTER DESIGN**  
Superelement method for helicopter fuselage analysis A78-48209

Flight controls of Army/Hughes YAH-64 advanced attack helicopter [AIAA 78-1237] A78-50160

**HELICOPTER ENGINES**  
Engine/airframe/drive train dynamic interface documentation [AD-A055766] N78-31114

**HELICOPTER PERFORMANCE**  
A systems approach to heliport lighting A78-49238

LOGMOD - The fault-isolator --- for helicopter electronic systems A78-49239

Stability of a helicopter carrying an underslung load A78-49398

Flight measurements of the effects of simulated leading-edge erosion on helicopter blade stall, torsional loads and performance [ARC-R/M-3809] N78-30098

Evaluation of a circulation control tail boom for yaw control --- OH-6 helicopter [AD-A055116] N78-31119

**HELICOPTERS**  
Measurement of vibratory displacements of a rotating blade A78-49397

Helicopter rotor vibration isolation A78-49399

A study of the precision hover capabilities of the aerocrane hybrid heavy lift vehicles [AD-A054281] N78-30091

Helicopter transmission vibration and noise reduction program. Volume 2: User's manual [AD-A054827] N78-30095

Structural dynamics, stability, and control of helicopters [NASA-CR-158909] N78-30139

Helicopter transmission vibration and noise reduction program. Volume 1: Technical report [AD-A055104] N78-31089

**HELIPORTS**  
A systems approach to heliport lighting A78-49238

**HERMITIAN POLYNOMIAL**  
Hermite closed splines A78-49713

**HIGH ALTITUDE BALLOONS**  
Aerodynamic hull design for HASPA LTA optimization --- High Altitude Superpressure Powered Aerostat Lighter Than Air A78-48100

**HIGH ASPECT RATIO**  
Control-surface hinge-moment calculations for a high-aspect-ratio supercritical wing [NASA-TM-78664] N78-31043

**HIGH GRAVITY ENVIRONMENTS**  
The design of a high g cockpit N78-30118

**HIGH STRENGTH STEELS**  
Extending the service life of aircraft components made of high-strength steels --- Russian book A78-48518

**HIGH TEMPERATURE**  
Calculation of exchange coefficients for high-temperature turbine blades [ONERA, TP NO. 1978-104] A78-47348

**HOLOGRAPHY**  
HHSD demonstration model development [AD-A054437] N78-30120

**HORIZONTAL TAIL SURFACES**  
Design of a horizontal tail unit and related adjustments A78-49736

**HOVERING**  
A study of the precision hover capabilities of the aerocrane hybrid heavy lift vehicles [AD-A054281] N78-30091

**HULLS (STRUCTURES)**  
Aerodynamic hull design for HASPA LTA optimization --- High Altitude Superpressure Powered Aerostat Lighter Than Air A78-48100

**HUMAN FACTORS ENGINEERING**  
Model of aircraft passenger acceptance A78-49684

**HUMAN PERFORMANCE**  
Operator work capacity during parachutist free-fall A78-47978

**HUMAN REACTIONS**  
Ride quality evaluation. IV - Models of subjective reaction to aircraft motion A78-47490

Model of aircraft passenger acceptance A78-49684

Requirements for regional short-haul air service and the definition of a flight program to determine neighborhood reactions to small transport aircraft [NASA-CR-152151] N78-30070

A further survey of some effects of aircraft noise in residential communities near London (Heathrow) airport [TT-7705] N78-30910

**HYDROCARBON FUELS**  
Effect of jet fuel autooxidation products on thermooxidation stability A78-49025

**HYPERSONIC AIRCRAFT**  
Aerodynamic characteristics of a hypersonic research airplane concept having a 70 deg swept double-delta wing at Mach number 0.2 [NASA-TP-1252] N78-31045

**HYPERSONIC FLOW**  
Unsteady hypersonic gas flow past a thin wing of finite span A78-49792

**ICE FORMATION**  
Modified helicopter icing spray system evaluation  
[AD-A055039] N78-31091

**IMAGE CORRELATORS**  
Advanced pattern matching for navigation and guidance  
A78-49998

**IMAGE ENHANCEMENT**  
Pattern recognition as an aid to radar navigation  
A78-49855

**IMAGE PROCESSING**  
Pattern recognition as an aid to radar navigation  
A78-49855  
High-accuracy three-dimensional image reconstruction for an airborne line-scanning system  
A78-49988

**IMAGING TECHNIQUES**  
A flight qualified graphics generator --- for B-1 defense system  
A78-50007

**IMPINGEMENT**  
Ground impingement of a fan jet exhaust plume  
[AD-A054832] N78-31112

**IN-FLIGHT MONITORING**  
Integrated test mission control - Present and future at the Air Force Flight Test Center  
[AIAA PAPER 78-1461] A78-47911  
Use of onboard computerized flight test analysis systems  
[AIAA PAPER 78-1462] A78-47912  
Software engineering a must for success in computerized flight test  
[AIAA PAPER 78-1463] A78-47913  
L-1011 flight data recording systems - Background, features, implications and benefits  
[AIAA PAPER 78-1471] A78-47917  
TF41-A-2/A7E inflight engine condition monitoring system /IECMS/  
[AIAA PAPER 78-1472] A78-47918  
Sensor technology for turbine engine monitoring systems  
[AIAA PAPER 78-1474] A78-47920  
Engine vibration in flight  
[AIAA PAPER 78-1475] A78-47921  
In-line monitoring of digital flight control computers  
A78-49860  
Comparison monitoring in redundant digital flight control systems  
A78-49865  
Electromagnetic coupling analysis of a Learjet aircraft in a lightning environment  
A78-49920

**INCOMPRESSIBLE FLOW**  
Approximate indicial lift function for tapered, swept wings in incompressible flow  
[NASA-TP-1241] N78-30054

**INDUCTION MOTORS**  
Test and demonstration prototype tracked air cushion vehicle (PTACV): Phase IIIC  
[PB-279970/8] N78-31007

**INERTIAL GUIDANCE**  
RNAV - Corporate operators set the pace  
A78-47424

**INERTIAL NAVIGATION**  
Advances in inertial navigation  
A78-47481  
Real-time simulators for augmented inertial navigation systems  
A78-49967  
Reliability of inertial navigation systems --- for military and commercial aircraft  
A78-49968  
Accuracy requirement and cost effectiveness of GPS-aided INS for tactical fighters  
A78-49989

**INFORMATION FLOW**  
An interface management approach to software development  
A78-49933

**INFORMATION RETRIEVAL**  
Preliminary design of an accident information Retrieval System (AIRS)  
[AD-A055590] N78-31952

**INFRARED DETECTORS**  
Infrared receiver performance --- airborne warning system by detection of target spectral signature  
A78-49985

**INFRARED IMAGERY**  
Autothreshold autoscreener/FLIR system --- airborne target screener/Forward-Looking Infrared imaging system  
A78-49984

**INFRASONIC FREQUENCIES**  
Long-distance focusing of Concorde sonic boom  
A78-48052

**INHOMOGENEITY**  
Theoretical and experimental studies of acoustic propagation in inhomogeneous moving media  
[ESA-TT-477] N78-30909

**INPUT/OUTPUT ROUTINES**  
A standard programmable I/O for the advanced aircraft electrical system power control set  
A78-49936  
REXOR 2 rotorcraft simulation model. Volume 3: User's manual  
[NASA-CR-145333] N78-30044

**INSECTS**  
Flight experience on the need and use of inflight leading edge washing for a laminar flow airfoil  
[AIAA PAPER 78-1512] A78-47947

**INSTRUMENT COMPENSATION**  
A compensation technique for acceleration-induced frequency changes in crystal oscillators  
A78-49859

**INSTRUMENT ERRORS**  
Accuracy requirement and cost effectiveness of GPS-aided INS for tactical fighters  
A78-49989

**INSTRUMENT FLIGHT RULES**  
IFR aircraft handled forecast by air route traffic control center, fiscal years 1978-1989  
[AD-A049305] N78-31075

**INSTRUMENT LANDING SYSTEMS**  
Probabilistic model of an instrument landing system  
A78-47407  
TRSB microwave landing system demonstration program at Brussels, Belgium  
[AD-A054298] N78-30075  
TRACALS evaluation report. TACAN, VOR, and ILS station evaluation report, Andersen AFB, Guam  
[AD-A054244] N78-30078  
Capture effect array glide slope guidance study  
[AD-A055678] N78-31073

**INTAKE SYSTEMS**  
Investigation of electrostatic discharge in aircraft fuel tanks during refueling  
[AIAA PAPER 78-1501] A78-47941  
Performance with and without inlet radial distortion of a transonic fan stage designed for reduced loading in the tip region  
[NASA-TP-1294] N78-30057  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 8: Cross spectral density plots  
[NASA-CR-144873] N78-30130

**INTERFERENCE**  
Investigation of a wing-rotor interaction system for helicopters  
[AD-A054093] N78-30092

**INTERNATIONAL COOPERATION**  
Airliner numbers game - Does it add up --- political and technological aspects of international aircraft industries  
A78-49524

**INVENTIONS**  
Gas path seal  
[NASA-CASE-LEW-12131-2] N78-31103

**IONOSPHERIC PROPAGATION**  
Station deselection procedures to support automatic Omega receiver operation  
A78-49965

**J**

**JANNERS**  
Comparisons of high anti-jam design techniques for GPS receivers --- Global Positioning System  
A78-49857  
Digital system architecture for a 1980's jammer --- for military aircraft and ships  
A78-49973

## JAMMING

Performance in a jamming environment of a low-cost GPS user receiver algorithm for aiding a tactical INS [AD-A055239] N78-31078

**JET AIRCRAFT**  
From Challenger to winner --- Canadair executive jet design and development A78-47570

**JET AIRCRAFT NOISE**  
An acoustic range for the measurement of the noise signature of aircraft during flyby operations A78-47242  
Theoretical and experimental studies of acoustic propagation in inhomogeneous moving media [ESA-TT-477] N78-30909

**JET ENGINE FUELS**  
Let's put fuel efficiency into perspective A78-47269  
Effect of jet fuel autooxidation products on thermooxidation stability A78-49025

**JET ENGINES**  
Design philosophy for engine forgings A78-47452  
Detecting abnormal turbine engine deterioration using electrostatic methods [AIAA PAPER 78-1473] A78-47919  
Sensor technology for turbine engine monitoring systems [AIAA PAPER 78-1474] A78-47920  
Alternatives for jet engine control [NASA-CR-157578] N78-31107  
Status of the Air Force's F-16 aircraft program [PB-280304/7] N78-31946

**JET NOZZLES**  
Vectoring non-axisymmetric nozzle jet induced effects on a V/STOL fighter model [AIAA PAPER 78-1080] A78-48496

**JP-5 JET FUEL**  
Effects of high availability fuels on combustor properties [AD-A054229] N78-30259

## K

## KALMAN FILTERS

Assessment of dynamic coordinate alignment for elastic aircraft --- flight control Kalman filter estimates A78-49987  
Performance of a ring laser strapdown attitude and heading reference for aircraft [AIAA 78-1240] A78-50162  
Optimal terrain-aided navigation systems [AIAA 78-1243] A78-50163

## L

## L-1011 AIRCRAFT

L-1011 flight data recording systems - Background, features, implications and benefits [AIAA PAPER 78-1471] A78-47917

## LAMINAR FLOW

Flight experience on the need and use of inflight leading edge washing for a laminar flow airfoil [AIAA PAPER 78-1512] A78-47947  
Design of a large span-distributed load flying-wing cargo airplane with laminar flow control [NASA-CR-145376] N78-30045

## LANDING AIDS

A systems approach to heliport lighting A78-49238  
Navigation performance of the Triscan concept for shipboard VTOL aircraft operations [AIAA 78-1293] A78-50200  
Description and performance of the Langley visual landing display system [NASA-TM-78742] N78-30073  
Simulation and flight evaluation of a head-up landing aid for general aviation [NASA-TP-1276] N78-31101  
Parameters of future ATC systems relating to airport capacity/delay [AD-A055482] N78-31130

## LANDING GEAR

Improved aircraft dynamic response and fatigue life during ground operations using an active control landing gear system [AIAA PAPER 78-1499] A78-47939

## LANDING INSTRUMENTS

Probabilistic model of an instrument landing system A78-47407  
Use of the U.S. interim standard microwave landing system in Canada A78-49333

## LASER APPLICATIONS

A laser-powered flight transportation system [AIAA PAPER 78-1484] A78-49781

## LASER GUIDANCE

Performance of a differential Omega-ring laser strapdown aircraft navigator A78-49966

## LASER RANGER/TRACKER

Navstar GPS field test results A78-49856

## LATERAL CONTROL

Rolling tail design and behavior as affected by actuator hinge moment limits --- for B-1 maneuverability [AIAA PAPER 78-1500] A78-47940

## LATERAL STABILITY

Constant-control rolling maneuver A78-46961  
Evolution of a cost-effective, task-oriented, lateral-directional SAS for the A-10 aircraft --- Stability Augmentation System [AIAA PAPER 78-1460] A78-47910  
Lateral-aerodynamic characteristics of highly-dihedral wings A78-49334

Analysis of stability contributions of high dihedral V-tails [NASA-TM-78729] N78-31044

## LEADING EDGES

Flight experience on the need and use of inflight leading edge washing for a laminar flow airfoil [AIAA PAPER 78-1512] A78-47947  
A method for localizing wing flow separation at stall to alleviate spin entry tendencies [AIAA PAPER 78-1476] A78-49787  
Calculations of the effects of blowing from the leading edges of a cambered delta wing [ARC-R/M-3800] N78-30064  
Flight measurements of the effects of simulated leading-edge erosion on helicopter blade stall, torsional loads and performance [ARC-R/M-3809] N78-30098

## LEAR JET AIRCRAFT

Gates Learjet Model 28/29, the first 'Longhorn' Learjet [AIAA PAPER 78-1445] A78-47901  
Electromagnetic coupling analysis of a Learjet aircraft in a lightning environment A78-49920

## LIFE CYCLE COSTS

Estimated costs of extended low-rate airframe production [AD-A054834] N78-31100

## LIFT

Important simulation parameters for the experimental testing of propulsion induced lift effects [AIAA PAPER 78-1078] A78-48494  
Shockless airfoils with thicknesses of 20.6 and 20.7 percent chord analytically designed for a Mach number of 0.68 and a lift coefficient of 0.40 [NASA-TM-X-73917] N78-30046  
Approximate indicial lift function for tapered, swept wings in incompressible flow [NASA-TP-1241] N78-30054  
Investigation of a wing-rotor interaction system for helicopters [AD-A054093] N78-30092

## LIFT AUGMENTATION

An analytical and experimental investigation of diffusers for VSTOL thrust augmenting ejectors [AIAA PAPER 78-1509] A78-47945

## LIFTING BODIES

Asymptotic theory of a wing moving near a solid wall A78-48248

- Modification of the Douglas Neumann program to improve the efficiency of predicting component interference and high lift characteristics [NASA-CR-3020] N78-30051
- LIGHT AIRCRAFT**  
Large deflection static analysis of typical tail-wheel structure of light aircraft by finite element method A78-48864
- A method for localizing wing flow separation at stall to alleviate spin entry tendencies [AIAA PAPER 78-1476] A78-49787
- LIGHTING EQUIPMENT**  
A systems approach to heliport lighting A78-49238
- LIGHTNING**  
Laboratory testing of lightning and EMP susceptibility of avionic systems A78-49861
- Electromagnetic coupling analysis of a Learjet aircraft in a lightning environment A78-49920
- LINE OF SIGHT COMMUNICATION**  
Fading at 9.6 GHz on an experimentally simulated aircraft-to-ground path A78-49439
- LINEAR SYSTEMS**  
Guaranteed cost control of linear systems with uncertain parameters - Application to remotely piloted vehicle flight control systems [AIAA 78-1274] A78-50184
- LINEARIZATION**  
Linearized theory of plane, unsteady, supersonic flow through a cascade - Subsonic part of the leading edge [ONERA, TP NO. 1978-103] A78-47347
- LIQUID HYDROGEN**  
Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 1 [NASA-CR-145369-VOL-1] N78-31085
- Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 2 [NASA-CR-145369-VOL-2] N78-31086
- LOAD TESTS**  
Proposed load evaluation system for U.S. Air Force --- of airfield pavement A78-49677
- Airfield pavement evaluation - The airline view A78-49680
- LOADS (FORCES)**  
Development of a load sequence for a structural fatigue test N78-30277
- Load interaction effects in fatigue crack propagation N78-30285
- LOGIC CIRCUITS**  
LOGMOD - The fault-isolator --- for helicopter electronic systems A78-49239
- LOGISTICS MANAGEMENT**  
Digital avionics support - A retrospective view of the future A78-49903
- The feasibility of estimating avionics support costs early in the acquisition cycle. Volume 1: The basic report [AD-A054016] N78-30119
- LONGITUDINAL STABILITY**  
Dynamics of the longitudinal motion of an airplane with a variable-geometry wing A78-49285
- Calculation of the longitudinal aerodynamic characteristics of upper-surface-blown wing-flap configurations [NASA-CR-3004] N78-30050
- Simulation study of the oscillatory longitudinal motion of an airplane at the stall [NASA-TP-1242] N78-30141
- LORAN C**  
Phase-locked tracking loops for LORAN-C [NASA-CR-157582] N78-31068
- LOW SPEED**  
Section drag coefficients from pressure probe traverses of a wing wake at low speeds [AIAA PAPER 78-1479] A78-47924
- Modification of the Douglas Neumann program to improve the efficiency of predicting component interference and high lift characteristics [NASA-CR-3020] N78-30051
- LOW WING AIRCRAFT**  
Correlation of model and airplane spin characteristics for a low-wing general aviation research airplane [AIAA PAPER 78-1477] A78-47922
- M**
- MACH NUMBER**  
Shockless airfoils with thicknesses of 20.6 and 20.7 percent chord analytically designed for a Mach number of 0.68 and a lift coefficient of 0.40 [NASA-TN-X-73917] N78-30046
- Stability and performance characteristics of a fixed arrow wing supersonic transport configuration (SCAT 15P-9898) at Mach numbers from 0.60 to 1.20 [NASA-TN-78726] N78-30087
- MAGNETIC CONTROL**  
Guidance and navigation for automatic landing, rollout, and turnoff using MLS and magnetic cable sensors [AIAA 78-1296] A78-50203
- MAGNETS**  
Application of rare earth/transition metal permanent magnets to 400 Hz aircraft systems - An AF overview A78-49935
- MAPFUNCTIONS**  
LOGMOD - The fault-isolator --- for helicopter electronic systems A78-49239
- MAN MACHINE SYSTEMS**  
A hierarchical network for avionic systems A78-49868
- An investigation of potential control-display configurations for V/STOL aircraft [AIAA 78-1238] A78-50161
- MANAGEMENT SYSTEMS**  
AIDS in engine management programmes --- Airborne Integrated Data Systems A78-47865
- MANEUVERABILITY**  
Supercruiser fighter analysis N78-30107
- Analysis of advanced variable camber concepts N78-30108
- MAP MATCHING GUIDANCE**  
A parametric analysis of TERCOM false fix probability --- TERRAIN Contour Matching A78-49997
- Advanced pattern matching for navigation and guidance A78-49998
- MAPS**  
COMED - The cockpit display of the future --- Combined Map and Electronic Display A78-47268
- MARINE ENVIRONMENTS**  
Constant false alarm rate detector for a pulse radar in a maritime environment A78-49975
- MARCOV CHAINS**  
Probabilistic model of an instrument landing system A78-47407
- MATHEMATICAL MODELS**  
Probabilistic model of an instrument landing system A78-47407
- Ride quality evaluation. IV - Models of subjective reaction to aircraft motion A78-47490
- On the theory of drag calculation and profile optimization in shockless near free molecular flow A78-47887
- Experimental determination of parameters of mathematical model of airplane cabin as regulated object with respect to air temperature in the cabin A78-48234
- Modeling refinements for the rectified superconducting alternator --- airborne power supply A78-49961

**MAXIMUM LIKELIHOOD ESTIMATES**

**SUBJECT INDEX**

Demand modelling of passenger air travel: An analysis and extension, volume 2 [NASA-CR-157402] N78-30069

Structural dynamics, stability, and control of helicopters [NASA-CR-158909] N78-30139

Procedures for generation and reduction of linear models of a turbofan engine [NASA-TP-1261] N78-30896

**MAXIMUM LIKELIHOOD ESTIMATES**

Maximum likelihood identification of the longitudinal aerodynamic coefficients of the EA-6B airplane in the catapult launch configuration [PD-A054243] N78-31046

**MEASURING INSTRUMENTS**

Turbine tip clearance measurement [AD-A055765] N78-31115

A research program to reduce interior noise in general aviation airplanes: Investigation of the characteristics of an acoustic panel test facility [NASA-CR-157587] N78-31874

**MECHANICAL DRIVES**

Engine/airframe/drive train dynamic interface documentation [AD-A055766] N78-31114

**MECHANICAL ENGINEERING**

Rotor design implications for composite material properties [UCRL-80117] N78-30182

**METAL BONDING**

The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints --- in aircraft structures [DLR-PB-77-63] N78-31251

**METAL COATINGS**

Extending the service life of aircraft components made of high-strength steels --- Russian book A78-48518

**MICROMINIATURIZED ELECTRONIC DEVICES**

The AN/APX-100/V/ transponder --- for military aircraft A78-49971

**MICROPROCESSORS**

Software engineering a must for success in computerized flight test [AIAA PAPER 78-1463] A78-47913

Multiprocessing for electronic warfare avionics A78-49869

Non-volatile memory system for severe environment flight recorders A78-49872

The evolution of a remotely piloted vehicle microprocessor flight control system [AIAA 78-1273] A78-50183

**MICROSTRIP TRANSMISSION LINES**

Conformal microstrip phased array for aircraft tests with ATS-6 A78-49428

**MICROWAVE ANTENNAS**

Conformal microstrip phased array for aircraft tests with ATS-6 A78-49428

**MICROWAVE EQUIPMENT**

Demonstration of the microwave ice protection concept [AD-A055824] N78-31096

**MICROWAVE LANDING SYSTEMS**

Interscan - A new microwave approach and landing guidance system A78-48736

Use of the U.S. interim standard microwave landing system in Canada A78-49333

Landing aircraft under poor conditions A78-49549

Comparison study of MLS airborne signal processing techniques A78-49904

Navigation performance of the Triscan concept for shipboard VTOL aircraft operations [AIAA 78-1293] A78-50200

Guidance and navigation for automatic landing, rollout, and turnoff using MLS and magnetic cable sensors [AIAA 78-1296] A78-50203

TRSB microwave landing system demonstration program at Brussels, Belgium [AD-A054298] N78-30075

TRSB microwave landing system demonstration program at John F. Kennedy International Airport, Long Island, New York, USA [AD-A055447] N78-31070

TRSB microwave landing system demonstration program at Kristiansand, Norway [AD-A055317] N78-31071

TRSB microwave landing system demonstration program at Charleroi, Belgium [AD-A055920] N78-31072

**MICROWAVE SENSORS**

Scan-limited near field testing for directive airborne antennas A78-49897

**MICROWAVE TRANSMISSION**

Fading at 9.6 GHz on an experimentally simulated aircraft-to-ground path A78-49439

**MILITARY AIR FACILITIES**

APAL simulation facility/capability manual. Volume 1: Executive summary and Systems Avionics Division [AD-A055591] N78-31102

**MILITARY AIRCRAFT**

AIDS in military aircraft --- Airborne Integrated Data Systems Computer A78-47866

Integrated test mission control - Present and future at the Air Force Flight Test Center [AIAA PAPER 78-1461] A78-47911

Prospects for commercial commonality in military transports [AIAA PAPER 78-1467] A78-49784

Wing planforms for large military transports [AIAA PAPER 78-1470] A78-49786

The AN/APX-100/V/ transponder --- for military aircraft A78-49971

Technical evaluation of flying weapon systems [RAE-LIB-TRANS-1948] N78-31087

**MILITARY AVIATION**

Proposed load evaluation system for U.S. Air Force --- of airfield pavement A78-49677

MIL-STD-1553B proposed --- data bus development in avionics architecture A78-49866

Status of the Air Force's F-16 aircraft program [PB-280304/7] N78-31946

**MILITARY HELICOPTERS**

Preliminary design of an accident Information Retrieval System (AIRS) [AD-A055590] N78-31952

**MILITARY OPERATIONS**

Shipboard launch and recovery of RPV helicopters in high sea states [AIAA 78-1269] A78-50179

**MINICOMPUTERS**

Software engineering a must for success in computerized flight test [AIAA PAPER 78-1463] A78-47913

**MISSILE CONTROL**

Peace Rhine - A digital Weapon Control System for the F-4 aircraft A78-49876

Bank-to-turn /BIT/ autopilot technology --- for missiles A78-49927

In-flight alignment/calibration techniques for unaided tactical guidance --- of air-launched missiles A78-49929

Modular target acquisition and designation systems A78-49954

**MISSILE DESIGN**

Center-loaded duct integral rocket-to-ramjet transition testing [AIAA PAPER 78-937] A78-48456

**MISSILE LAUNCHERS**

Peace Rhine - A digital Weapon Control System for the F-4 aircraft A78-49876

**MISSILE SYSTEMS**

Technical evaluation of flying weapon systems [RAE-LIB-TRANS-1948] N78-31087

- MOISTURE CONTENT**  
Material evaluation of polyurethane foam, 0.05 g/  
cm<sup>3</sup> density  
[BDX-613-1836-REV] N78-31249
- MOLDS**  
Large electroformed nickel moulds for aircraft parts  
A78-47267
- MONOPOLE ANTENNAS**  
Analysis of monopole antenna arrays on cylinders  
by the geometrical theory of diffraction  
[AD-A055197] N78-31335
- MONOPULSE RADAR**  
Combinatorially derived limits on the surface  
return for an air/surface monopulse ranging radar  
A78-50001
- MOTION PERCEPTION**  
Simulator study of the effect of visual-motion  
time delays on pilot tracking performance with  
an audio side task  
[NASA-TP-1216] N78-30090
- MTBF**  
Reliability of inertial navigation systems --- for  
military and commercial aircraft  
A78-49968
- MULTIPATH TRANSMISSION**  
Fading at 9.6 GHz on an experimentally simulated  
aircraft-to-ground path  
A78-49439
- MULTIPLEXING**  
Application of the General Purpose Multiplex  
System to the A-7E avionics  
A78-49867
- MULTIPROCESSING (COMPUTERS)**  
Multiprocessing for electronic warfare avionics  
A78-49869
- MULTISPECTRAL BAND SCANNERS**  
High-accuracy three-dimensional image  
reconstruction for an airborne line-scanning  
system  
A78-49988
- N**
- NACELLES**  
Nacelle effects on stability of VSTOL  
configurations including conventional, canard,  
and tandem wing arrangements  
[AIAA PAPER 78-1504] A78-47942  
Wind Tunnel/Flight Test Correlation Program on the  
B-1 nacelle afterbody/nozzle at transonic  
conditions  
[AIAA PAPER 78-989] A78-48469
- NASA PROGRAMS**  
NASA engine system technology programs - An overview  
[AIAA PAPER 78-928] A78-48452
- NAVIER-STOKES EQUATION**  
An experimental and numerical study of  
three-dimensional turbulent jets  
[AIAA PAPER 78-994] A78-48471
- NAVIGATION AIDS**  
Aviation control system devices --- Russian book  
A78-49850  
The role of system performance analysis in the  
independent assessment of B-1 navigation software  
A78-49902  
Advanced pattern matching for navigation and  
guidance  
A78-49998
- NAVIGATION INSTRUMENTS**  
Communication and navigation antennas for aircraft  
--- Russian book  
A78-48523  
A modular adaptive, variable function flight  
control sensor  
[AD-A055175] N78-31120
- NAVSTAR SATELLITES**  
Navstar GPS field test results  
A78-49856  
A Costas loop with tangent error signal for use in  
Navstar GPS avionics  
A78-49858
- NAVY**  
The U.S. Navy bets on V/STOL --- technological  
integration for next generation aircraft design  
A78-49550
- NEAR FIELDS**  
Scan-limited near field testing for directive  
airborne antennas  
A78-49897
- NETS**  
Guidance and control problems in semiautomatic  
recovery of the Aquila RPV  
[AIAA 78-1272] A78-50182
- NEUTRALIZERS**  
Neutralization problem for a Space Shuttle  
A78-47124
- NICKEL ALLOYS**  
Large electroformed nickel moulds for aircraft parts  
A78-47267
- NIGHT FLIGHTS (AIRCRAFT)**  
A systems approach to heliport lighting  
A78-49238
- NOISE INTENSITY**  
Noise in airports, its measurement, and its effect  
on the communities in the vicinity  
A78-48374
- NOISE MEASUREMENT**  
An acoustic range for the measurement of the noise  
signature of aircraft during flyby operations  
A78-47242
- NOISE POLLUTION**  
Synthesis of social surveys on noise annoyance  
A78-48051  
Noise in airports, its measurement, and its effect  
on the communities in the vicinity  
A78-48374
- NOISE PROPAGATION**  
Long-distance focusing of Concorde sonic boom  
A78-48052
- NOISE REDUCTION**  
Some sound transmission loss characteristics of  
typical general aviation structural materials  
[AIAA PAPER 78-1480] A78-47925  
Helicopter transmission vibration and noise  
reduction program. Volume 2: User's manual  
[AD-A054827] N78-30095  
Helicopter transmission vibration and noise  
reduction program. Volume 1: Technical report  
[AD-A055104] N78-31089  
A research program to reduce interior noise in  
general aviation airplanes: Noise reduction  
through a cavity-backed flexible plate  
[NASA-CR-157588] N78-31873  
A research program to reduce interior noise in  
general aviation airplanes: Investigation of  
the characteristics of an acoustic panel test  
facility  
[NASA-CR-157587] N78-31874
- NOISE SPECTRA**  
An acoustic range for the measurement of the noise  
signature of aircraft during flyby operations  
A78-47242
- NOISE THRESHOLD**  
Synthesis of social surveys on noise annoyance  
A78-48051
- NOISE TOLERANCE**  
A further survey of some effects of aircraft noise  
in residential communities near London  
(Heathrow) airport  
[TT-7705] N78-30910  
A comparison of annoyance caused by aircraft noise  
near London, Manchester and Liverpool airports  
[TT-7706] N78-30911
- NONDESTRUCTIVE TESTS**  
NDI and the detection of fatigue  
N78-30282
- NONEQUILIBRIUM FLOW**  
Investigation of nonequilibrium two-phase flows in  
axisymmetric Laval nozzles  
A78-48244
- NONUNIFORM FLOW**  
Analysis of multistage, axial flow turbomachine  
wake production, transport, and interaction  
[AD-A055754] N78-31118
- NORWAY**  
FRSB microwave landing system demonstration  
program at Kristiansand, Norway  
[AD-A055317] N78-31071
- NOZZLE DESIGN**  
Canard configured aircraft with 2-D nozzle  
[AIAA PAPER 78-1450] A78-47904  
An experimental and numerical study of  
three-dimensional turbulent jets  
[AIAA PAPER 78-994] A78-48471  
Non-axisymmetric nozzle design and evaluation for  
F-111 flight demonstration  
[AIAA PAPER 78-1025] A78-48483

- Advance nozzle technology  
N78-30111
- NOZZLE FLOW**  
Experimental determination of propulsion induced ground effects of typical three fan type A V/STOL configurations  
[AIAA PAPER 78-1507] A78-47943  
Investigation of nonequilibrium two-phase flows in axisymmetric Laval nozzles  
A78-48244  
Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions  
[AIAA PAPER 78-989] A78-48469  
Status of a nozzle-airframe study of a highly maneuverable fighter  
[AIAA PAPER 78-990] A78-48470
- NOZZLE GEOMETRY**  
Installed performance of vectoring/reversing non-axisymmetric nozzles  
[AIAA PAPER 78-1022] A78-48482  
Vectoring non-axisymmetric nozzle jet induced effects on a V/STOL fighter model  
[AIAA PAPER 78-1080] A78-48496
- NUMERICAL ANALYSIS**  
An experimental and numerical study of three-dimensional turbulent jets  
[AIAA PAPER 78-994] A78-48471  
Volumetric pattern analysis of airborne antennas  
A78-49427  
Hermite closed splines  
A78-49713
- NUMERICAL CONTROL**  
Digital control law synthesis in the w prime domain  
A78-46962  
Design and development of a multifunctional helicopter control system  
A78-49396  
The evolution of a remotely piloted vehicle microprocessor flight control system  
[AIAA 78-1273] A78-50183  
Software development for fly-by-wire flight control systems  
[AIAA 78-1276] A78-50185
- NUMERICAL INTEGRATION**  
Methods available to ONERA for analysis of combustion chambers  
[ONERA, TP NO. 1978-93] A78-46915
- O**
- OH-6 HELICOPTER**  
Evaluation of a circulation control tail boom for yaw control --- OH-6 helicopter  
[AD-A055116] N78-31119
- OMEGA NAVIGATION SYSTEM**  
RNAV - Corporate operators set the pace  
A78-47424  
The Omega radionavigation system comes to the Pacific Ocean area  
A78-49660  
Station deselection procedures to support automatic Omega receiver operation  
A78-49965  
Performance of a differential Omega-ring laser strapdown aircraft navigator  
A78-49966
- OPERATING SYSTEMS (COMPUTERS)**  
The DAIS Executive - An introduction --- avionics computer software  
A78-49932
- OPERATIONAL PROBLEMS**  
An integrated analysis of the fundamental problems of air transport  
A78-49447  
Operational regularity in air transport  
A78-49449
- OPTICAL GYROSCOPES**  
Performance of a ring laser strapdown attitude and heading reference for aircraft  
[AIAA 78-1240] A78-50162
- OPTIMAL CONTROL**  
Stability augmentation by eigenvalues control and model matching  
A78-46965  
Optimal control synthesis in distributed systems with incomplete information --- noting aircraft applications  
A78-48215
- Optimization techniques for air traffic control problems --- Russian book  
A78-48504  
The terrain following task for the advanced tactical fighter using discrete optimal control  
A78-49862  
Performance of a ring laser strapdown attitude and heading reference for aircraft  
[AIAA 78-1240] A78-50162  
Optimal terrain-aided navigation systems  
[AIAA 78-1243] A78-50163  
Guaranteed cost control of linear systems with uncertain parameters - Application to remotely piloted vehicle flight control systems  
[AIAA 78-1274] A78-50184  
Optimal flight control synthesis via pilot modeling  
[AIAA 78-1286] A78-50193  
Trajectory optimization for some sailplane performance problems  
N78-31083
- OPTIMIZATION**  
On the theory of drag calculation and profile optimization in shockless near free molecular flow  
A78-47887  
Definition of airplane fuselage longitudinal lines by the special contour method  
A78-48222  
Control system design using vector-valued performance criteria with application to the control rate reduction in parameter insensitive control systems  
[DLR-FB-77-55] N78-31125
- OXIDATION RESISTANCE**  
Effect of jet fuel autooxidation products on thermooxidation stability  
A78-49025
- OZONE**  
An assessment of the effect of supersonic aircraft operations on the stratospheric ozone content  
[NASA-RP-1026] N78-30774  
Simultaneous measurements of ozone outside and inside cabins of two B-747 airliners and a Gates Learjet business jet  
[NASA-TM-78983] N78-31061
- P**
- PACIFIC OCEAN**  
The Omega radionavigation system comes to the Pacific Ocean area  
A78-49660
- PANEL FLUTTER**  
Wing/store active flutter suppression - Correlation of analyses and wind tunnel data  
[AIAA PAPER 78-1459] A78-47909
- PANELS**  
Fatigue crack growth in pressurized fuselage panel  
A78-48231  
Minimum weight design of stiffened panels with fracture constraints  
A78-49837
- PARACHUTE DESCENT**  
Operator work capacity during parachutist free-fall  
A78-47978
- PASSENGER AIRCRAFT**  
Airliner numbers game - Does it add up --- political and technological aspects of international aircraft industries  
A78-49524
- PASSENGERS**  
Model of aircraft passenger acceptance  
A78-49684
- PATTERN RECOGNITION**  
Pattern recognition as an aid to radar navigation  
A78-49855  
Advanced pattern matching for navigation and guidance  
A78-49998  
A learning flight control system for the F8-DFBW aircraft --- Digital Fly-By-Wire  
[AIAA 78-1288] A78-50195
- PAVEMENTS**  
Airfield pavement load evaluation - An international overview  
A78-49676  
Proposed load evaluation system for U.S. Air Force --- of airfield pavement  
A78-49677

Transport Canada airfield pavement load evaluation  
A78-49678

French procedures for airfield pavement load  
evaluation  
A78-49679

Airfield pavement evaluation - The airline view  
A78-49680

Airfield pavement evaluation - FAA viewpoint  
A78-49681

Pavement strength rating methods as viewed by  
airframe manufacturers  
A78-49682

**PAYLOADS**

Stability of a helicopter carrying an underslung  
load  
A78-49398

Design of a large span-distributed load  
flying-wing cargo airplane with laminar flow  
control  
[NASA-CR-145376]  
N78-30045

**PERFORMANCE PREDICTION**

Effects of wind on aircraft cruise performance  
[AIAA PAPER 78-1496]  
A78-47937

Operational regularity in air transport  
A78-49449

Calculation of the longitudinal aerodynamic  
characteristics of upper-surface-blown wing-flap  
configurations  
[NASA-CR-3004]  
N78-30050

A theoretical study of the performance of a number  
of different axial-flow turbine configurations  
under conditions of pulsating flow  
[ARL/MECH-ENG-REPT-149]  
N78-31104

**PERFORMANCE TESTS**

The role of system performance analysis in the  
independent assessment of B-1 navigation software  
A78-49902

Performance of a differential Omega-ring laser  
strapdown aircraft navigator  
A78-49966

Short-term performance deterioration in  
JT9D-7A (SP) engine 695743  
[NASA-CR-135431]  
N78-30121

**PERIODIC VARIATIONS**

Investigations on unsteady pressure distribution  
measurements in rotating systems  
[DLR-PB-77-43]  
N78-31135

**PHASE ERROR**

Station deselection procedures to support  
automatic Omega receiver operation  
A78-49965

**PHASE LOCKED SYSTEMS**

Phase-locked tracking loops for LORAN-C  
[NASA-CR-157582]  
N78-31068

**PHASED ARRAYS**

Conformal microstrip phased array for aircraft  
tests with ATS-6  
A78-49428

**PHOTONIC PROPULSION**

A laser-powered flight transportation system  
[AIAA PAPER 78-1484]  
A78-49781

**PILOT ERROR**

Optimal flight control synthesis via pilot modeling  
[AIAA 78-1286]  
A78-50193

**PILOT PERFORMANCE**

Flight investigation and theory of direct  
side-force control  
[AIAA 78-1287]  
A78-50194

Simulator study of the effect of visual-motion  
time delays on pilot tracking performance with  
an audio side task  
[NASA-TP-1216]  
N78-30090

IPC design validation and flight testing  
[AD-A055529]  
N78-31074

Effects of dynamic aeroelasticity on handling  
qualities and pilot rating  
N78-31084

**PILOT TRAINING**

Air-to-air combat simulation  
A78-47868

Effect of performance objectives on the design and  
cost of future USAF pilot training aircraft  
[AIAA PAPER 78-1498]  
A78-47938

A flight simulation high order language study  
A78-49957

**PITCH (INCLINATION)**

Effects of dynamic aeroelasticity on handling  
qualities and pilot rating  
N78-31084

**PLATES (STRUCTURAL MEMBERS)**

A research program to reduce interior noise in  
general aviation airplanes: Noise reduction  
through a cavity-backed flexible plate  
[NASA-CR-157588]  
N78-31873

**POINTING CONTROL SYSTEMS**

Modular target acquisition and designation systems  
A78-49954

**POLARIZATION (SPIN ALIGNMENT)**

Turbine tip clearance measurement  
[AD-A055765]  
N78-31115

**POLLUTION CONTROL**

Gas turbine engine emissions - Problems, progress  
and future  
A78-49336

**POLYURETHANE FOAM**

Material evaluation of polyurethane foam, 0.05 g/  
cm<sup>3</sup> density  
[BDX-613-1836-REV]  
N78-31249

**POROUS WALLS**

Induction of subsonic wind tunnels with slight  
perforation  
A78-48250

**POSITION (LOCATION)**

Performance in a jamming environment of a low-cost  
GPS user receiver algorithm for aiding a  
tactical INS  
[AD-A055239]  
N78-31078

**POSITION ERRORS**

Station deselection procedures to support  
automatic Omega receiver operation  
A78-49965

**POSITION INDICATORS**

Two-way - A position and orientation measurement  
system --- helicopter/VTOL landing aid application  
A78-49661

**POTENTIAL FLOW**

Modification of the Douglas Neumann program to  
improve the efficiency of predicting component  
interference and high lift characteristics  
[NASA-CR-3020]  
N78-30051

A mean camberline singularity method for  
two-dimensional steady and oscillatory aerofolds  
and control surfaces in inviscid incompressible  
flow  
[ARC-CP-1391]  
N78-30066

**POWER LIMITERS**

A frequency-selective YIG limiter for airborne  
PM/CW X-band radar  
A78-50002

**POWER SPECTRA**

F-15 inlet/engine test techniques and distortion  
methodologies studies. Volume 3: Power  
spectral density plots  
[NASA-CR-144868]  
N78-30125

**POWERED LIFT AIRCRAFT**

Conceptual design study of power augmented ram  
wing in ground effect aircraft  
[AIAA PAPER 78-1466]  
A78-47915

**PREDICTION ANALYSIS TECHNIQUES**

Fatigue S/N data in relation to variability in  
predicted life  
N78-30278

**PRESSURE DISTRIBUTION**

Investigations on unsteady pressure distribution  
measurements in rotating systems  
[DLR-PB-77-43]  
N78-31135

**PRESSURE SENSORS**

Section drag coefficients from pressure probe  
traverses of a wing wake at low speeds  
[AIAA PAPER 78-1479]  
A78-47924

**PRESSURIZED CABINS**

Fatigue crack growth in pressurized fuselage panel  
A78-48231

**PROBABILITY THEORY**

Aircraft structural reliability and risk theory:  
A review  
N78-30284

**PROCUREMENT POLICY**

Aeronautical procurement - The primary  
specification system  
[AIAA PAPER 78-1489]  
A78-47932

**PRODUCTION PLANNING**

Status of the Air Force's F-16 aircraft program  
[PB-280304/7]  
N78-31986



## PROGRAM VERIFICATION (COMPUTERS)

## SUBJECT INDEX

## PROGRAM VERIFICATION (COMPUTERS)

Subsystem verification of an AFLC organically developed F-15 simulation --- Air Force Logistics Command

The role of system performance analysis in the independent assessment of B-1 navigation software

## PROGRAMMING LANGUAGES

The DAIS Executive - An introduction --- avionics computer software

The versatility of Jovial J73 in avionics systems

A flight simulation high order language study

Higher order languages for avionics software - A survey, summary and critique

## PROPELLERS

Progress in propeller aerodynamics

## PROPULSION SYSTEM CONFIGURATIONS

NASA engine system technology programs - An overview [AIAA PAPER 78-928]

Propulsion test facilities - Capabilities and use [AIAA PAPER 78-933]

Advanced supersonic transport engine integration studies for near-term technology readiness date [AIAA PAPER 78-1052]

Propulsion system airframe integration studies - Advanced supersonic transport [AIAA PAPER 78-1053]

Evaluation of inlet reingestion for large bypass ratio V/STOL aircraft [AIAA PAPER 78-1079]

A laser-powered flight transportation system [AIAA PAPER 78-1484]

The influence of propulsion and control system concepts on design of a Navy Type A V/STOL airplane [AIAA PAPER 78-1505]

Ground effects testing of two, three, and four jet configurations [AIAA PAPER 78-1510]

## PROPULSION SYSTEM PERFORMANCE

Experimental determination of propulsion induced ground effects of typical three fan type A V/STOL configurations [AIAA PAPER 78-1507]

The impact of contingency power concepts on V/STOL aircraft take-off-gross-weight [AIAA PAPER 78-926]

Ramjet engine testing and simulation techniques [AIAA PAPER 78-935]

The effect of thrust vectoring and attitude control concepts on the propulsion system of V/STOL aircraft [AIAA PAPER 78-1020]

Propulsion for future supersonic transports - 1978 status [AIAA PAPER 78-1051]

A laser-powered flight transportation system [AIAA PAPER 78-1484]

## PROPULSION EFFICIENCY

Operating characteristics of bypass turbojet engines --- Russian book

## PROVING

TRSB microwave landing system demonstration program at John F. Kennedy International Airport, Long Island, New York, USA [AD-A055447]

## PUBLIC RELATIONS

Requirements for regional short-haul air service and the definition of a flight program to determine neighborhood reactions to small transport aircraft [NASA-CR-152151]

## PULSE RADAR

Constant false alarm rate detector for a pulse radar in a maritime environment

A high duty factor chirp radar

## PYRAMIDS

A pyramid skewed axis sensor set for multiplex flight control systems [ARC-R/M-38081]

## Q

## QUALITATIVE ANALYSIS

F-15 inlet/engine test techniques and distortion methodologies studies. Volume 2: Time variant data quality analysis plots [NASA-CR-144867]

## QUALITY CONTROL

Analysis of GTE tolerance monitoring parameter formation --- gas turbine engine

Statistical review of counting accelerometer data for Navy and Marine fleet aircraft from 1 January 1962 to 31 December 1977 [AD-A055672]

## R

## RADAR DETECTION

Constant false alarm rate detector for a pulse radar in a maritime environment

## RADAR EQUIPMENT

A frequency-selective YIG limiter for airborne FM/CW X-band radar

Avionics cost development for alternatives of selected air traffic control systems [AD-A054823]

## RADAR MEASUREMENT

Combinatorially derived limits on the surface return for an air/surface monopulse ranging radar

Optimal terrain-aided navigation systems [AIAA 78-1243]

## RADAR NAVIGATION

Pattern recognition as an aid to radar navigation

## RADAR RECEIVERS

Infrared receiver performance --- airborne warning system by detection of target spectral signature

Phase-locked tracking loops for LORAN-C [NASA-CR-157582]

## RADAR RECEPTION

Combinatorially derived limits on the surface return for an air/surface monopulse ranging radar

## RADAR TRACKING

Air-to-air designate/track with time sharing

## RADAR TRANSMISSION

A high duty factor chirp radar

## RADIO ANTENNAS

Test and evaluation of air/ground communications antennas [AD-A056148]

## RADIO COMMUNICATION

Dual band airborne SATCOM terminal

## RADIO EQUIPMENT

Evaluating avionics weight efficiency

## RADIO NAVIGATION

Navstar GPS field test results

## RADIO RECEIVERS

Station deselection procedures to support automatic Omega receiver operation

Performance in a jamming environment of a low-cost GPS user receiver algorithm for aiding a tactical INS [AD-A055239]

## RADIOGRAPHY

Radiographic examination of T55 engine [AD-A055108]

## RADOME MATERIALS

Large electroformed nickel moulds for aircraft parts

## RAILS

Test and demonstration prototype tracked air cushion vehicle (PTACV): Phase IIIC [PB-279970/8]

## RAMJET ENGINES

Ground test facility for integral rocket ramjets [AIAA PAPER 78-934]

- Ramjet engine testing and simulation techniques  
[AIAA PAPER 78-935] A78-48455
- Center-loaded duct integral rocket-to-ramjet transition testing  
[AIAA PAPER 78-937] A78-48456
- Flame stabilization in a ramjet combustion chamber by means of a pilot gas generator  
[DLR-PB-77-54] N78-31117
- RANGE FINDERS**  
A design of trajectory estimator using multiple DME range measurements  
[AD-A05519\*] N78-31077
- RAPID TRANSIT SYSTEMS**  
Test and demonstration prototype tracked air cushion vehicle (PTACV): Phase IIIC  
[PB-279970/8] N78-31007
- RARE EARTH ELEMENTS**  
Application of rare earth/transition metal permanent magnets to 400 Hz aircraft systems - An AF overview  
A78-49935
- RAREFIED GAS DYNAMICS**  
On the theory of drag calculation and profile optimization in shockless near free molecular flow  
A78-47887
- RATINGS**  
Pavement strength rating methods as viewed by airframe manufacturers  
A78-49682
- REAL TIME OPERATION**  
Integrated test mission control - Present and future at the Air Force Flight Test Center  
[AIAA PAPER 78-1461] A78-47911
- Real-time simulators for augmented inertial navigation systems  
A78-49967
- A design of trajectory estimator using multiple DME range measurements  
[AD-A055191] N78-31077
- REDUNDANCY**  
Improved combat survivability for fly-by-wire sensor systems  
[AIAA 78-1277] A78-50186
- Triplex digital fly-by-wire redundancy management techniques  
[AIAA 78-1279] A78-50187
- REFUELING**  
Investigation of electrostatic discharge in aircraft fuel tanks during refueling  
[AIAA PAPER 78-1501] A78-47941
- REGENERATION (ENGINEERING)**  
Choice of cycle for a regenerative bypass turbojet for long-range aircraft  
A78-49723
- REGRESSION ANALYSIS**  
Computerized aircraft attrition program  
[AD-A055784] N78-31094
- REINFORCED PLASTICS**  
Damping, static, dynamic, and impact characteristics of laminated beams typical of windshield construction  
[AD-A054463] N78-30093
- REINFORCED PLATES**  
Minimum weight design of stiffened panels with fracture constraints  
A78-49837
- REINFORCING FIBERS**  
Fibre composite reinforcement of cracked aircraft structures  
N78-30288
- RELIABILITY ANALYSIS**  
Reliability of inertial navigation systems --- for military and commercial aircraft  
A78-49968
- RELIABILITY ENGINEERING**  
Distribution of reliability characteristics among airplane system units to ensure given flight safety level  
A78-48221
- Comparisons of high anti-jam design techniques for GPS receivers --- Global Positioning System  
A78-49857
- Non-volatile memory system for severe environment flight recorders  
A78-49872
- Triplex digital fly-by-wire redundancy management techniques  
[AIAA 78-1279] A78-50187
- Evaluation of methods for calculating system operating time in accordance with Reliability Improvement Warranty (RIW) contractual terms  
[AD-A054822] N78-30079
- REMOTELY PILOTED VEHICLES**  
The HIMAT RPRV system  
[AIAA PAPER 78-1457] A78-47908
- Shipboard launch and recovery of RPV helicopters in high sea states  
[AIAA 78-1269] A78-50179
- RPV flying qualities design criteria  
[AIAA 78-1271] A78-50181
- Guidance and control problems in semiautomatic recovery of the Aquila RPV  
[AIAA 78-1272] A78-50182
- The evolution of a remotely piloted vehicle microprocessor flight control system  
[AIAA 78-1273] A78-50183
- Guaranteed cost control of linear systems with uncertain parameters - Application to remotely piloted vehicle flight control systems  
[AIAA 78-1274] A78-50184
- RESEARCH AIRCRAFT**  
Quiet, Short-Haul Research Aircraft - Current status and future plans  
[AIAA PAPER 78-1468] A78-47916
- Aerodynamic characteristics of a hypersonic research airplane concept having a 70 deg swept double-delta wing at Mach number 0.2  
[NASA-TP-1252] N78-31045
- RESEARCH AND DEVELOPMENT**  
10 years of contract research for the pump/compressor industrial concern  
A78-49175
- Future needs and opportunities in the air traffic control system  
[GPO-98-931] N78-31076
- RESEARCH FACILITIES**  
Status of aerial applications research in the Langley Vortex Research Facility and the Langley full-scale wind tunnel  
[AIAA PAPER 78-1481] A78-47926
- RESEARCH VEHICLES**  
The HIMAT RPRV system  
[AIAA PAPER 78-1457] A78-47908
- RESIDUAL STRESS**  
The influences of residual stresses on oscillating tensile strength and the measurement of residual stress, with emphasis on aircraft construction --- fatigue life of aircraft construction materials  
[BNVG-PBWT-77-23] N78-30603
- REVERSED FLOW**  
Installed performance of vectoring/reversing non-axisymmetric nozzles  
[AIAA PAPER 78-1022] A78-48482
- RHEOELECTRICAL SIMULATION**  
Application of electrical analogy to the substantiation and comparison of some analytical methods of determining temperature fields in gas-turbine blades  
A78-47404
- RIDING QUALITY**  
Ride quality evaluation. IV - Models of subjective reaction to aircraft motion  
A78-47490
- Model of aircraft passenger acceptance  
A78-49684
- RIGID ROTORS**  
Helicopter rotor vibration isolation  
A78-49399
- RING LASERS**  
Performance of a differential Omega-ring laser strapdown aircraft navigator  
A78-49966
- Performance of a ring laser strapdown attitude and heading reference for aircraft  
[AIAA 78-1240] A78-50162
- RISK**  
A study of analog programming for prediction of crack growth in aircraft structures subjected to random loads  
[AD-A055789] N78-31097
- ROCKET ENGINE DESIGN**  
Ground test facility for integral rocket ramjets  
[AIAA PAPER 78-934] A78-48454

- ROCKET ENGINES**  
Center-loaded duct integral rocket-to-ramjet transition testing  
[AIAA PAPER 78-937] A78-48456
- ROCKET EXHAUST**  
Ground impingement of a fan jet exhaust plume  
[AD-A054832] N78-31112
- ROLLING MOMENTS**  
Constant-control rolling maneuver A78-46961
- ROOT-MEAN-SQUARE ERRORS**  
Performance of a differential Omega-ring laser strapdown aircraft navigator A78-49966
- ROTARY WINGS**  
The influence of high twist on the dynamics of rotating blades A78-47599  
Measurement of vibratory displacements of a rotating blade A78-49397  
Helicopter rotor vibration isolation A78-49399  
Investigation of a wing-rotor interaction system for helicopters  
[AD-A054093] N78-30092  
Flight measurements of the effects of simulated leading-edge erosion on helicopter blade stall, torsional loads and performance  
[ARC-R/M-3809] N78-30098  
Experimental investigation of gust response of hingeless helicopter rotors  
[AD-A054752] N78-30142  
The transonic flow on a helicopter rotor A78-31042  
Antitorque training: Evaluation of effectiveness in reducing mishap losses  
[AD-A055040] N78-31092  
Demonstration of the microwave ice protection concept  
[AD-A055824] N78-31096
- ROTATING BODIES**  
Investigations on unsteady pressure distribution measurements in rotating systems  
[DLR-FB-77-43] N78-31135
- ROTOR AERODYNAMICS**  
Progress in propeller aerodynamics A78-47173  
The influence of high twist on the dynamics of rotating blades A78-47599  
Turbine engine rotordynamic evaluation, volume 1  
[AD-A055262] N78-31111
- ROTOR BLADES**  
The influence of high twist on the dynamics of rotating blades A78-47599  
Demonstration of the microwave ice protection concept  
[AD-A055824] N78-31096
- ROTOR BLADES (TURBOMACHINERY)**  
Performance with and without inlet radial distortion of a transonic fan stage designed for reduced loading in the tip region  
[NASA-TP-1294] N78-30057  
Advanced optical blade tip clearance measurement system  
[NASA-CR-159402] N78-31106
- ROTORCRAFT AIRCRAFT**  
REXOR 2 rotorcraft simulation model. Volume 1: Engineering documentation  
[NASA-CR-145331] N78-30042  
REXOR 2 rotorcraft simulation model. Volume 2: Computer implementation  
[NASA-CR-145332] N78-30043  
REXOR 2 rotorcraft simulation model. Volume 3: User's manual  
[NASA-CR-145333] N78-30044
- ROTBOS**  
Rotor design implications for composite material properties  
[UCRL-80117] N78-30182
- RUNWAYS**  
Engineering and development program plan: Wake vortex  
[AD-A051143] N78-30071  
Analysis of runway occupancy times at major airports  
[AD-A056052] N78-31131
- S**
- S-3 AIRCRAFT**  
Program analyses for the S-3 weapon system improvement program  
[AD-A055887] N78-31093
- SATELLITE POWER TRANSMISSION (TO EARTH)**  
A laser-powered flight transportation system  
[AIAA PAPER 78-1484] A78-49781
- SATELLITE SOLAR ENERGY CONVERSION**  
A laser-powered flight transportation system  
[AIAA PAPER 78-1484] A78-49781
- SCALE EFFECT**  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 6: Distortion analysis plots  
[NASA-CR-144871] N78-30128
- SCALE MODELS**  
Some observations on the mechanism of aircraft wing rock  
[AIAA PAPER 78-1456] A78-47907  
Stability and performance characteristics of a fired arrow wing supersonic transport configuration (SCAT 15F-9898) at Mach numbers from 0.60 to 1.20  
[NASA-TM-78726] N78-30087
- SCANNERS**  
TRSB microwave landing system demonstration program at Kristiansand, Norway  
[AD-A055317] N78-31071  
TRSB microwave landing system demonstration program at Charleroi, Belgium  
[AD-A055920] N78-31072
- SCHEDULING**  
Analysis of runway occupancy times at major airports  
[AD-A056052] N78-31131
- SEA LAUNCHING**  
Shipboard launch and recovery of RPV helicopters in high sea states  
[AIAA 78-1269] A78-50179
- SEA STATES**  
Shipboard launch and recovery of RPV helicopters in high sea states  
[AIAA 78-1269] A78-50179
- SEALERS**  
Fundamentals of noncuring sealants for aircraft fuel tanks  
[AD-A054627] N78-30247
- SEALS (STOPPERS)**  
Gas path seal  
[NASA-CASE-LEW-12131-2] N78-31103
- SENSORS**  
Improved combat survivability for fly-by-wire sensor systems  
[AIAA 78-1277] A78-50186
- SEPARATED FLOW**  
Influence of slots on effectiveness of wing mechanization and control surfaces with separated flow A78-48229  
A method for localizing wing flow separation at stall to alleviate spin entry tendencies  
[AIAA PAPER 78-1476] A78-49787
- SERVICE LIFE**  
Design for durability - The F101-GE-100 engine  
[AIAA PAPER 78-1084] A78-48497  
Approach for identifying avionics flight software operational support requirements - PAVE TACK an example A78-49900  
Computerized aircraft attrition program  
[AD-A055784] N78-31094
- SH-3 HELICOPTER**  
Stability of a helicopter carrying an underslung load A78-49398
- SHIPS**  
Navigation performance of the Triscan concept for shipboard VTOL aircraft operations  
[AIAA 78-1293] A78-50200
- SHORT HAUL AIRCRAFT**  
Ride quality evaluation. IV - Models of subjective reaction to aircraft motion A78-47490

SUBJECT INDEX

STANDARDS

The effect on block fuel consumption of a strutted versus cantilever wing for a short-haul transport including strut aeroelastic considerations [AIAA PAPER 78-1454]	A78-47905		
Quiet, Short-Haul Research Aircraft - Current status and future plans [AIAA PAPER 78-1468]	A78-47916		
Application of advanced high speed turboprop technology to future civil short-haul transport aircraft design [AIAA PAPER 78-1487]	A78-47930		
Requirements for regional short-haul air service and the definition of a flight program to determine neighborhood reactions to small transport aircraft [NASA-CR-152151]	N78-30070		
<b>SHORT TAKEOFF AIRCRAFT</b> Takeoff performance of STOL aircraft			
Wind-tunnel testing of VTOL and STOL aircraft [NASA-TM-78750]	N78-30040		
<b>SIDESLIP</b> Flight investigation and theory of direct side-force control [AIAA 78-1287]	A78-50194		
<b>SIGNAL DETECTORS</b> Phase-locked tracking loops for LORAN-C [NASA-CR-157582]	N78-31068		
<b>SIGNAL FADING</b> Fading at 9.6 GHz on an experimentally simulated aircraft-to-ground path	A78-49439		
<b>SIGNAL PROCESSING</b> Comparison study of MLS airborne signal processing techniques	A78-49904		
Station deselection procedures to support automatic Omega receiver operation	A78-49965		
A high duty factor chirp radar	A78-49976		
<b>SIGNAL TRANSMISSION</b> Flight application of optical fiber transmission on a Falcon 10 aircraft [ONERA, TP NO. 1978-105]	A78-47349		
<b>SIMPLE HARMONIC MOTION</b> Two-dimensional aerofoils and control surfaces in simple harmonic motion in incompressible inviscid flow [ARC-CP-1392]	N78-30068		
<b>SINGLE STAGE TO ORBIT VEHICLES</b> Static aerodynamic characteristics of a winged single-stage-to-orbit vehicle at Mach numbers from 0.3 to 4.63 [NASA-TP-1233]	N78-30053		
<b>SINGULARITY (MATHEMATICS)</b> A mean camberline singularity method for two-dimensional steady and oscillatory aerofoils and control surfaces in inviscid incompressible flow [ARC-CP-1391]	N78-30066		
<b>SOCIAL FACTORS</b> Synthesis of social surveys on noise annoyance	A78-48051		
<b>SOLID STATE DEVICES</b> Solid-state displays for fuel management systems --- for aircraft	A78-47900		
<b>SONIC BOOMS</b> Long-distance focusing of Concorde sonic boom	A78-48052		
<b>SOUND FIELDS</b> Theoretical and experimental studies of acoustic propagation in inhomogeneous moving media [ESA-TT-477]	N78-30909		
<b>SOUND INTENSITY</b> A research program to reduce interior noise in general aviation airplanes: Investigation of the characteristics of an acoustic panel test facility [NASA-CR-157587]	N78-31874		
<b>SOUND PRESSURE</b> Fatigue crack growth in pressurized fuselage panel	A78-48231		
<b>SOUND PROPAGATION</b> Theoretical and experimental studies of acoustic propagation in inhomogeneous moving media [ESA-TT-477]	N78-30909		
<b>SOUND TRANSMISSION</b> Some sound transmission loss characteristics of typical general aviation structural materials [AIAA PAPER 78-1480]	A78-47925		
<b>SOURCE PROGRAMS</b> Modification of the Douglas Neubann program to improve the efficiency of predicting component interference and high lift characteristics [NASA-CR-3020]	N78-30051		
<b>SPACE FLIGHT STRESS</b> Safety of space flights	A78-47952		
<b>SPACE SHUTTLES</b> Neutralization problem for a Space Shuttle	A78-47124		
<b>SPACECRAFT CHARGING</b> Neutralization problem for a Space Shuttle	A78-47124		
<b>SPACECRAFT COMMUNICATION</b> Dual band airborne SATCON terminal	A78-49972		
<b>SPACECRAFT DESIGN</b> The design process --- computer aided design for complex aerospace systems [AIAA PAPER 78-1483]	A78-47928		
The use of the AIAA-Bendix Design Competition in aerospace design courses [AIAA PAPER 78-1488]	A78-47931		
Modular Missionization Systems /MMS/, an adaptive system interface concept	A78-49852		
<b>SPECTRAL ENERGY DISTRIBUTION</b> P-15 inlet/engine test techniques and distortion methodologies studies. Volume 8: Cross spectral density plots [NASA-CR-144873]	N78-30130		
<b>SPECTRAL SIGNATURES</b> An acoustic range for the measurement of the noise signature of aircraft during flyby operations	A78-47242		
Infrared receiver performance --- airborne warning system by detection of target spectral signature	A78-49985		
<b>SPIN TESTS</b> Correlation of model and airplane spin characteristics for a low-wing general aviation research airplane [AIAA PAPER 78-1477]	A78-47922		
<b>SPLINE FUNCTIONS</b> Hermite closed splines	A78-49713		
Optimal terrain following controller for an optimized spline reference path [AD-A055234]	N78-31122		
<b>SPRAYERS</b> Modified helicopter icing spray system evaluation [AD-A055039]	N78-31091		
<b>SPRAYING</b> Status of aerial applications research in the Langley vortex research facility and the Langley full-scale wind tunnel [NASA-TM-78760]	N78-30041		
<b>STABILITY AUGMENTATION</b> Stability augmentation by eigenvalues control and model matching	A78-46965		
Evolution of a cost-effective, task-oriented, lateral-directional SAS for the A-10 aircraft --- Stability Augmentation System [AIAA PAPER 78-1460]	A78-47910		
<b>STABILITY DERIVATIVES</b> Important simulation parameters for the experimental testing of propulsion induced lift effects [AIAA PAPER 78-1078]	A78-48494		
Lateral-aerodynamic characteristics of highly-dihedral wings	A78-49234		
<b>STAGE SEPARATION</b> Graphics for the hybrid stores separation simulation of the B77 system [SAND-78-8212]	N78-31099		
<b>STANDARDS</b> MIL-STD-1553B proposed --- data bus development in avionic architecture	A78-49866		

STATIC AERODYNAMIC CHARACTERISTICS

SUBJECT INDEX

STATIC AERODYNAMIC CHARACTERISTICS

Static aerodynamic characteristics of a typical single-engine low-wing general aviation design for an angle-of-attack range of -8 deg to 90 deg [NASA-CR-297^] N78-30048

Static aerodynamic characteristics of a winged single-stage-to-orbit vehicle at Mach numbers from 0.3 to 4.63 [NASA-TP-1233] N78-30053

STATIC STABILITY

Analysis of stability contributions of high dihedral V-tails [NASA-TM-78729] N78-31044

STATISTICAL ANALYSIS

Evaluation of methods for calculating system operating time in accordance with Reliability Improvement Warranty (RIW) contractual terms [AD-A054822] N78-30079

Statistical review of counting accelerometer data for Navy and Marine fleet aircraft from 1 January 1962 to 31 December 1977 [AD-A055672] N78-31098

Rotor burst protection program: Statistics on aircraft gas turbine engine rotor failures that occurred in US commercial aviation during 1975 [NASA-CR-135304] N78-31105

STEELS

Metal technology for future aircraft design N78-30115

STRAPDOWN INERTIAL GUIDANCE

Advances in inertial navigation A78-47481

Strapdown seeker guidance for tactical weapons A78-49928

In-flight alignment/calibration techniques for unaided tactical guidance --- of air-launched missiles A78-49929

Multi-Function Inertial Reference Assembly /MIRA/ update --- digital aircraft systems A78-49941

Performance of a differential Omega-ring laser strapdown aircraft navigator A78-49966

Performance of a ring laser strapdown attitude and heading reference for aircraft [AIAA 78-1240] A78-50162

STRATOSPHERE

On the use of zirconium 95 data from Chinese atmospheric thermonuclear explosions to study stratospheric transport in a one-dimensional parameterization A78-48062

An assessment of the effect of supersonic aircraft operations on the stratospheric ozone content [NASA-EP-1026] N78-30774

STREAM FUNCTIONS (FLUIDS)

Method of calculating aerodynamic coefficients of some three-dimensional bodies with arbitrary cross section A78-48245

STRESS ANALYSIS

Recent developments in analysis of crack propagation and fracture of practical materials --- stress analysis in aircraft structures [NASA-TM-78766] N78-30606

STRESS MEASUREMENT

The influences of residual stresses on oscillating tensile strength and the measurement of residual stress, with emphasis on aircraft construction --- fatigue life of aircraft construction materials [BNVG-PBWT-77-23] N78-30603

STRESS-STRAIN RELATIONSHIPS

General aviation airplane structural crashworthiness user's manual. Volume 1: Program KRASH theory [AD-A055898] N78-31088

STRUCTURAL ANALYSIS

Large deflection static analysis of typical tail-wheel structure of light aircraft by finite element method A78-48864

STRUCTURAL DESIGN

Teaching design at all levels --- in aerospace engineering curricula [AIAA PAPER 78-1455] A78-47906  
Airfield pavement evaluation - FAA viewpoint A78-49681

Pavement strength rating methods as viewed by airframe manufacturers A78-49682

Minimum weight design of stiffened panels with fracture constraints A78-49837

Dulles control tower console design study [AD-A056200] N78-31132

STRUCTURAL DESIGN CRITERIA

Design philosophy for airframes A78-47453

STRUCTURAL ENGINEERING

Engineering data on new aerospace materials structural materials [AD-A054461] N78-30213

STRUCTURAL RELIABILITY

Aircraft structural fatigue [ARL/STRUC-REPT-363] N78-30271

Aircraft structural reliability and risk theory: A review N78-30284

STRUCTURAL STABILITY

Flutter suppressor for transonic flight [ONERA, TP NO. 1978-102] A78-47346

STRUCTURAL STRAIN

Fatigue crack growth in pressurized fuselage panel A78-48231

STRUCTURAL VIBRATION

Engine vibration in flight [AIAA PAPER 78-1475] A78-47921

Measurement of vibratory displacements of a rotating blade A78-49397

Use of ground vibration test equipment to determine unsteady aerodynamic forces A78-49708

Prediction of angular disturbances from airframe members to airborne electro-optical packages A78-49952

Computer program for vibration prediction of fighter aircraft equipments [AD-A054598] N78-30094

Considerations on wing stores flutter: Asymmetry, flutter suppression [AGARD-R-668] N78-31126

STRUTS

The effect on block fuel consumption of a strutted versus cantilever wing for a short-haul transport including strut aeroelastic considerations [AIAA PAPER 78-1454] A78-47905

Analysis of a suspension system for a wheel rolling on a flat track [NASA-CR-157563] N78-30583

SUBSONIC AIRCRAFT

Whitcomb winglet applications to general aviation aircraft [AIAA PAPER 78-1478] A78-47923

SUBSONIC FLOW

A calculator program for analyzing airloads on a wing of arbitrary planform and camber in subsonic flow [AD-A054180] N78-30058

SUBSONIC WIND TUNNELS

Induction of subsonic wind tunnels with slight perforation A78-48250

SUPERCONDUCTING POWER TRANSMISSION

Modeling refinements for the rectified superconducting alternator --- airborne power supply A78-49961

SUPERCritical WINGS

Aerodynamic characteristics induced on a supercritical wing due to vectoring twin nozzles at Mach numbers from 0.40 to 0.95 [NASA-TM-78746] N78-30039

Theoretical estimation of the transonic aerodynamic characteristics of a supercritical-wing transport model with trailing-edge controls [NASA-TP-1253] N78-30056

Control-surface hinge-moment calculations for a high-aspect-ratio supercritical wing [NASA-TM-78664] N78-31043

SUPERHIGH FREQUENCIES

Dual band airborne SATCOM terminal A78-49972

## SUBJECT INDEX

## TAIL ASSEMBLIES

**SUPERPOSITION (MATHEMATICS)**  
On the linear superposition of aerodynamic forces  
on wings in periodic gusts  
A78-47869

**SUPERPRESSURE BALLOONS**  
Aerodynamic hull design for HASPA LTA optimization  
--- High Altitude Superpressure Powered Aerostat  
Lighter Than Air  
A78-48100

**SUPERSONIC AIRCRAFT**  
Mirage 2000 - Dassault's better delta  
A78-49169  
Design evolution of a supersonic cruise  
strike-fighter  
[AIAA PAPER 78-1452] A78-49783  
Theoretical estimation of the transonic  
aerodynamic characteristics of a  
supercritical-wing transport model with  
trailing-edge controls  
[NASA-TP-1253] N78-30056

**SUPERSONIC FLIGHT**  
Ramjet engine testing and simulation techniques  
[AIAA PAPER 78-935] A78-48455

**SUPERSONIC FLOW**  
Linearized theory of plane, unsteady, supersonic  
flow through a cascade - Subsonic part of the  
leading edge  
[ONERA, TP NO: 1978-103] A78-47347  
Method of calculating aerodynamic coefficients of  
some three-dimensional bodies with arbitrary  
cross section  
A78-48245  
Linearized supersonic unsteady flow in cascades  
[ARC-R/M-3811] N78-30065

**SUPERSONIC SPEEDS**  
Supercruiser fighter analysis  
N78-30107

**SUPERSONIC TRANSPORTS**  
Propulsion for future supersonic transports - 1978  
status  
[AIAA PAPER 78-1051] A78-48486  
Advanced supersonic transport engine integration  
studies for near-term technology readiness date  
[AIAA PAPER 78-1052] A78-48487  
Propulsion system airframe integration studies -  
Advanced supersonic transport  
[AIAA PAPER 78-1053] A78-48488  
Stability and performance characteristics of a  
fixed arrow wing supersonic transport  
configuration (SCAT 15P-9898) at Mach numbers  
from 0.60 to 1.20  
[NASA-TM-78726] N78-30087  
An assessment of the effect of supersonic aircraft  
operations on the stratospheric ozone content  
[NASA-RP-1026] N78-30774

**SUPPORT SYSTEMS**  
Approach for identifying avionics flight software  
operational support requirements - PAVE TACK an  
example  
A78-49900  
Digital avionics support - A retrospective view of  
the future  
A78-49903

**SURFACE NAVIGATION**  
The Omega radionavigation system comes to the  
Pacific Ocean area  
A78-49660

**SURFACE PROPERTIES**  
Modeling ground plane influence on wing  
aerodynamic characteristics using a finite plane  
screen  
A78-48216

**SURFACE ROUGHNESS**  
Flight measurements of the effects of simulated  
leading-edge erosion on helicopter blade stall,  
torsional loads and performance  
[ARC-R/M-3809] N78-30098

**SURVEYS**  
Synthesis of social surveys on noise annoyance  
A78-48051

**SUSPENSION SYSTEMS (VEHICLES)**  
Analysis of a suspension system for a wheel  
rolling on a flat track  
[NASA-CR-157563] N78-30583

**SWEEP WINGS**  
Approximate indicial lift function for tapered,  
swept wings in incompressible flow  
[NASA-TP-1241] N78-30054

Aerodynamic characteristics of a hypersonic  
research airplane concept having a 70 deg swept  
double-delta wing at Mach number 0.2  
[NASA-TP-1252] N78-31045

**SYSTEM EFFECTIVENESS**  
Technology analysis - Candidate advanced tactical  
fighters  
[AIAA PAPER 78-1451] A78-49782  
Modular target acquisition and designation systems  
A78-49954  
A parametric analysis of TERCOM false fix  
probability --- TERRAIN COntour Matching  
A78-49997

**SYSTEM FAILURES**  
Triplex digital fly-by-wire redundancy management  
techniques  
[AIAA 78-1279] A78-50187

**SYSTEMS ANALYSIS**  
The value of aerospace design synthesis courses as  
viewed by aerospace professionals  
[AIAA PAPER 78-1493] A78-47934  
The role of system performance analysis in the  
independent assessment of B-1 navigation software  
A78-49902  
Dynamic analysis of electrical systems  
A78-49934

**SYSTEMS ENGINEERING**  
Teaching design at all levels --- in aerospace  
engineering curricula  
[AIAA PAPER 78-1455] A78-47906  
Integrated avionics for future general aviation  
aircraft  
[AIAA PAPER 78-1482] A78-47927  
The value of aerospace design synthesis courses as  
viewed by aerospace professionals  
[AIAA PAPER 78-1493] A78-47934  
A systems approach to heliport lighting  
A78-49238  
Design and development of a multifunctional  
helicopter control system  
A78-49396  
The U.S. Navy bets on V/STOL --- technological  
integration for next generation aircraft design  
A78-49550  
Modular Missionization Systems /MMS/, an adaptive  
system interface concept  
A78-49852  
Comparisons of high anti-jam design techniques for  
GPS receivers --- Global Positioning System  
A78-49857  
A hierarchical network for avionic systems  
A78-49868  
Digital system architecture for a 1980's jammer  
--- for military aircraft and ships  
A78-49973

**SYSTEMS MANAGEMENT**  
AIDS in engine management programmes --- Airborne  
Integrated Data Systems  
A78-47865

**SYSTEMS STABILITY**  
Guaranteed cost control of linear systems with  
uncertain parameters - Application to remotely  
piloted vehicle flight control systems  
[AIAA 78-1274] A78-50184

## T

**T-55 ENGINE**  
Radiographic examination of T55 engine  
[AD-A055108] N78-31113

**TABLES (DATA)**  
Evaluation of methods for calculating system  
operating time in accordance with Reliability  
Improvement Warranty (RIW) contractual terms  
[AD-A054822] N78-30079

**TACAN**  
TRACALS evaluation report. TACAN, VOR, and ILS  
station evaluation report, Andersen AFB, Guam  
[AD-A054244] N78-30078

**TAIL ASSEMBLIES**  
Correlation of model and airplane spin  
characteristics for a low-wing general aviation  
research airplane  
[AIAA PAPER 78-1477] A78-47922  
Rolling tail design and behavior as affected by  
actuator hinge moment limits --- for B-1  
maneuverability  
[AIAA PAPER 78-1500] A78-47940

## TAIL ROTORS

## SUBJECT INDEX

Large deflection static analysis of typical tail-wheel structure of light aircraft by finite element method  
A78-48864

Evaluation of a circulation control tail boom for yaw control --- OH-6 helicopter  
[AD-A055116] N78-31119

**TAIL ROTORS**  
Antitorque training: Evaluation of effectiveness in reducing mishap losses  
[AD-A055040] N78-31092

**TAKEOFF**  
Takeoff performance of STOL aircraft  
A78-49744

Flight investigation and theory of direct side-force control  
[AIAA 78-1287] A78-50194

**TARGET ACQUISITION**  
Digital area correlation tracker  
A78-49951

Modular target acquisition and designation systems  
A78-49954

Autothreshold autoscreener/FLIR system --- airborne target screener/Forward-Looking Infrared imaging system  
A78-49984

**TARGET RECOGNITION**  
Constant false alarm rate detector for a pulse radar in a maritime environment  
A78-49975

Infrared receiver performance --- airborne warning system by detection of target spectral signature  
A78-49985

**TECHNOLOGICAL FORECASTING**  
The U.S. Navy bets on V/STOL --- technological integration for next generation aircraft design  
A78-49550

Digital system architecture for a 1980's jammer --- for military aircraft and ships  
A78-49973

Metal technology for future aircraft design  
N78-30115

Future needs and opportunities in the air traffic control system  
[GPO-98-931] N78-31076

**TECHNOLOGY ASSESSMENT**  
Quiet, Short-Haul Research Aircraft - Current status and future plans  
[AIAA PAPER 78-1468] A78-47916

Sensor technology for turbine engine monitoring systems  
[AIAA PAPER 78-1474] A78-47920

Advanced supersonic transport engine integration studies for near-term technology readiness date  
[AIAA PAPER 78-1052] A78-48487

Technology analysis - Candidate advanced tactical fighters  
[AIAA PAPER 78-1451] A78-49782

Requirements for regional short-haul air service and the definition of a flight program to determine neighborhood reactions to small transport aircraft  
[NASA-CR-152151] N78-30070

Technical evaluation of flying weapon systems  
[RAE-LIB-TRANS-1948] N78-31087

**TECHNOLOGY UTILIZATION**  
The U.S. Navy bets on V/STOL --- technological integration for next generation aircraft design  
A78-49550

**TELEVISION CAMERAS**  
Guidance and control problems in semiautomatic recovery of the Aquila RPV  
[AIAA 78-1272] A78-50182

**TELEVISION SYSTEMS**  
Description and performance of the Langley visual landing display system  
[NASA-TM-78742] N78-30073

**TEMPERATURE CONTROL**  
Experimental determination of parameters of mathematical model of airplane cabin as regulated object with respect to air temperature in the cabin  
A78-48234

**TEMPERATURE DISTRIBUTION**  
Calculation of exchange coefficients for high-temperature turbine blades  
[ONERA, TP NO. 1978-104] A78-47348

Application of electrical analogy to the substantiation and comparison of some analytical methods of determining temperature fields in gas-turbine blades  
A78-47404

**TENSILE STRENGTH**  
The influences of residual stresses on oscillating tensile strength and the measurement of residual stress, with emphasis on aircraft construction --- fatigue life of aircraft construction materials  
[BMVG-PBWT-77-23] N78-30603

**TERCOM**  
A parametric analysis of TERCOM false fix probability --- TERRAIN Contour Matching  
A78-49997

**TERMINAL CONFIGURED VEHICLE PROGRAM**  
Flight demonstrations of curved, descending approaches and automatic landings using time referenced scanning beam guidance  
[NASA-TM-78745] N78-30074

**TERMINAL FACILITIES**  
Application of the General Purpose Multiplex System to the A-7E avionics  
A78-49867

**TERMINAL GUIDANCE**  
Strapdown seeker guidance for tactical weapons  
A78-49928

**TERRAIN ANALYSIS**  
Pattern recognition as an aid to radar navigation  
A78-49855

**TERRAIN FOLLOWING AIRCRAFT**  
The terrain following task for the advanced tactical fighter using discrete optimal control  
A78-49862

Optimal terrain-aided navigation systems  
[AIAA 78-1243] A78-50163

The terrain following task for the advanced tactical fighter using discrete optimal control  
[AD-A055196] N78-31121

Optimal terrain following controller for an optimized spline reference path  
[AD-A055234] N78-31122

**TEST EQUIPMENT**  
French procedures for airfield pavement load evaluation  
A78-49679

**TEST FACILITIES**  
Propulsion test facilities - Capabilities and use  
[AIAA PAPER 78-933] A78-48453

Ground test facility for integral rocket ramjets  
[AIAA PAPER 78-934] A78-48454

A research program to reduce interior noise in general aviation airplanes: Investigation of the characteristics of an acoustic panel test facility  
[NASA-CR-157587] N78-31874

**TEST STANDS**  
Use of a field bench for testing turbojet engines  
A78-49731

**TF-41 ENGINE**  
TF41-A-2/A7E inflight engine condition monitoring system /IECHS/  
[AIAA PAPER 78-1472] A78-47918

**THERMAL CYCLING TESTS**  
Aspects of the thermal fatigue strength of gas-turbine engine components  
A78-49176

**THERMAL STABILITY**  
Effect of jet fuel autooxidation products on thermooxidation stability  
A78-49025

**THERMOCHEMICAL PROPERTIES**  
Assessment of relative flammability and thermochemical properties of some thermoplastic materials  
A78-49693

**THERMODYNAMIC CYCLES**  
Choice of cycle for a regenerative bypass turbojet for long-range aircraft  
A78-49723

Use of a field bench for testing turbojet engines  
A78-49731

**THERMONUCLEAR EXPLOSIONS**  
On the use of zirconium 95 data from Chinese atmospheric thermonuclear explosions to study stratospheric transport in a one-dimensional parameterization  
A78-48062

- THERMOPLASTIC RESINS**  
Assessment of relative flammability and thermochemical properties of some thermoplastic materials  
A78-49693
- THICKNESS RATIO**  
Shockless airfoils with thicknesses of 20.6 and 20.7 percent chord analytically designed for a Mach number of 0.68 and a lift coefficient of 0.40 [NASA-TM-X-73917]  
N78-30046
- THIN WINGS**  
Asymptotic theory of a wing moving near a solid wall  
A78-48248  
Unsteady hypersonic gas flow past a thin wing of finite span  
A78-49792
- THREE DIMENSIONAL FLOW**  
Method of calculating aerodynamic coefficients of some three-dimensional bodies with arbitrary cross section  
A78-48245  
An experimental and numerical study of three-dimensional turbulent jets [AIAA PAPER 78-994]  
A78-48471
- THROTTLING**  
The influence of throttle augmented stability (APCS) and short period control characteristics on the landing approach [AD-A055892]  
N78-31123
- THRUST AUGMENTATION**  
An analytical and experimental investigation of diffusers for VSTOL thrust augmenting ejectors [AIAA PAPER 78-1509]  
A78-47945
- THRUST VECTOR CONTROL**  
The effect of thrust vectoring and attitude control concepts on the propulsion system of V/STOL aircraft [AIAA PAPER 78-1020]  
A78-48481  
Installed performance of vectoring/reversing non-axisymmetric nozzles [AIAA PAPER 78-1022]  
A78-48482  
Non-axisymmetric nozzle design and evaluation for F-111 flight demonstration [AIAA PAPER 78-1025]  
A78-48483  
Vectoring non-axisymmetric nozzle jet induced effects on a V/STOL fighter model [AIAA PAPER 78-1080]  
A78-48496  
Aerodynamic characteristics induced on a supercritical wing due to vectoring twin nozzles at Mach numbers from 0.40 to 0.95 [NASA-TM-78746]  
N78-30039  
Optimal terrain following controller for an optimized spline reference path [AD-A055234]  
N78-31122
- THRUST-WEIGHT RATIO**  
The impact of contingency power concepts on V/STOL aircraft take-off-gross-weight [AIAA PAPER 78-926]  
A78-48451
- TIPT ROTOR AIRCRAFT**  
The promise of tilt rotor  
A78-47266  
Approach guidance logic for a tilt-rotor aircraft [AIAA 78-1295]  
A78-50202
- TIME DEPENDENCE**  
Flight demonstrations of curved, descending approaches and automatic landings using time referenced scanning beam guidance [NASA-TM-78745]  
N78-30074
- TIME LAG**  
Evaluation of several secondary tasks in the determination of permissible time delays in simulator visual and motion cues [NASA-TP-1214]  
N78-30089  
Simulator study of the effect of visual-motion time delays on pilot tracking performance with an audio side task [NASA-TP-1216]  
N78-30090
- TIME SHARING**  
Air-to-air designate/track with time sharing  
A78-49977
- TITANIUM ALLOYS**  
Metal technology for future aircraft design  
N78-30115
- TOLEANCES (MECHANICS)**  
Analysis of GTE tolerance monitoring parameter formation --- gas turbine engine  
A78-482 2
- TORQUE**  
Rolling tail design and behavior as affected by actuator hinge moment limits --- for B-1 maneuverability [AIAA PAPER 78-1500]  
A78-47940  
Control-surface hinge-moment calculations for a high-aspect-ratio supercritical wing [NASA-TM-78664]  
N78-31043  
Antitorque training: Evaluation of effectiveness in reducing mishap losses [AD-A055040]  
N78-31092
- TRACKING (POSITION)**  
Digital area correlation tracker  
A78-49951  
Evaluation of several secondary tasks in the determination of permissible time delays in simulator visual and motion cues [NASA-TP-1214]  
N78-30089
- TRACKING NETWORKS**  
Modular target acquisition and designation systems  
A78-49954
- TRAILING EDGES**  
Trailing vortices. II  
A78-47172  
Uniformly exact conformal transformation of exterior of circle onto exterior of wing profile  
A78-48224  
Theoretical estimation of the transonic aerodynamic characteristics of a supercritical-wing transport model with trailing-edge controls [NASA-TP-1253]  
N78-30056
- TRAINING AIRCRAFT**  
Effect of performance objectives on the design and cost of future USAF pilot training aircraft [AIAA PAPER 78-1498]  
A78-47938
- TRAINING SIMULATORS**  
Air-to-air combat simulation  
A78-47868  
A flight simulation high order language study  
A78-49957
- TRAJECTORIES**  
A design of trajectory estimator using multiple DME range measurements [AD-A055191]  
N78-31077  
Trajectory optimization for some sailplane performance problems  
N78-31083
- TRAJECTORY ANALYSIS**  
A method for determining the stability characteristics of aircraft in a helicoid flight path  
A78-49741
- TRAJECTORY CONTROL**  
Software structured weapon delivery  
A78-49875
- TRAJECTORY OPTIMIZATION**  
Characteristics of constrained optimum trajectories with specified range [NASA-TM-78519]  
N78-30072
- TRANSITION METALS**  
Application of rare earth/transition metal permanent magnets to 400 Hz aircraft systems - An AF overview  
A78-49935
- TRANSMISSION LOSS**  
Some sound transmission loss characteristics of typical general aviation structural materials [AIAA PAPER 78-1480]  
A78-47925
- TRANSMISSIONS (MACHINE ELEMENTS)**  
Helicopter transmission vibration and noise reduction program. Volume 2: User's manual [AD-A054827]  
N78-30095  
Helicopter transmission vibration and noise reduction program. Volume 1: Technical report [AD-A055104]  
N78-31089
- TRANSONIC COMPRESSORS**  
Performance with and without inlet radial distortion of a transonic fan stage designed for reduced loading in the tip region [NASA-TP-1294]  
N78-30057
- TRANSONIC FLIGHT**  
Canard configured aircraft with 2-D nozzle [AIAA PAPER 78-1450]  
A78-47904
- TRANSONIC FLOW**  
Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions [AIAA PAPER 78-989]  
A78-48469



- The transonic flow on a helicopter rotor  
N78-31042
- An automated procedure for computing the three-dimensional transonic flow over wing-body combinations, including viscous effects. Volume 1: Description of analysis methods and applications  
[AD-A055899] N78-31052
- TRANSONIC FLUTTER**  
Flutter suppressor for transonic flight  
[ONERA, TP NO. 1978-102] A78-47346
- Drones for aerodynamic and structural testing /DAST/ - A status report  
[AIAA PAPER 78-1485] A78-47929
- TRANSONIC WIND TUNNELS**  
Some observations on the mechanism of aircraft wing rock  
[AIAA PAPER 78-1456] A78-47907
- TRANSPONDERS**  
The AN/APX-00/V/ transponder --- for military aircraft  
A78-49971
- TRANSPORT AIRCRAFT**  
From Challenger to winner --- Canadair executive jet design and development  
A78-47570
- Use of onboard computerized flight test analysis systems  
[AIAA PAPER 78-1462] A78-47912
- Conceptual design study of power augmented ram wing in ground effect aircraft  
[AIAA PAPER 78-1466] A78-47915
- Application of advanced high speed turboprop technology to future civil short-haul transport aircraft design  
[AIAA PAPER 78-1487] A78-47930
- Takeoff performance of STOL aircraft  
A78-49744
- Prospects for commercial commonality in military transports  
[AIAA PAPER 78-1467] A78-49784
- Wing planforms for large military transports  
[AIAA PAPER 78-1470] A78-49786
- Requirements for regional short-haul air service and the definition of a flight program to determine neighborhood reactions to small transport aircraft  
[NASA-CR-152151] N78-30070
- Measurements and analysis of the forces acting on a small aircraft flying in the upwash of a large aircraft  
[AD-A055286] N78-31048
- Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 1  
[NASA-CR-145369-VOL-1] N78-31085
- Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 2  
[NASA-CR-145369-VOL-2] N78-31086
- Energy efficient engine: Preliminary design and integration studies  
[NASA-CR-135444] N78-31108
- TRANSPORT PROPERTIES**  
Analysis of multistage, axial flow turbomachine wake production, transport, and interaction  
[AD-A055754] N78-31118
- TURBINE BLADES**  
Calculation of exchange coefficients for high-temperature turbine blades  
[ONERA, TP NO. 1978-104] A78-47348
- Solution of an adjoint problem of steady-state heat transfer associated with the cooling of gas-turbine blades, by means of a quasi-analog/digital system  
A78-47402
- Application of electrical analogy to the substantiation and comparison of some analytical methods of determining temperature fields in gas-turbine blades  
A78-47404
- Gas path seal  
[NASA-CASE-LEW-12131-2] N78-31103
- TURBINE ENGINES**  
Effects of high availability fuels on combustor properties  
[AD-A054229] N78-30259
- Gas path seal  
[NASA-CASE-LEW-12131-2] N78-31103
- Turbine engine rotordynamic evaluation, volume 1  
[AD-A055262] N78-31111
- Turbine tip clearance measurement  
[AD-A055765] N78-31115
- TURBINES**  
A theoretical study of the performance of a number of different axial-flow turbine configurations under conditions of pulsating flow  
[ARL/MECH-ENG-REPT-149] N78-31104
- TURBOCOMPRESSORS**  
Analysis of multistage, axial flow turbomachine wake production, transport, and interaction  
[AD-A055754] N78-31118
- TURBOFAN ENGINES**  
The second generation of high-bypass turbofans - A market clouded by uncertainty  
A78-47423
- Design for durability - The F101-GE-100 engine  
[AIAA PAPER 78-1084] A78-48497
- Choice of cycle for a regenerative bypass turbojet for long-range aircraft  
A78-49723
- Short-term performance deterioration in JT9D-7A(SF) engine 695743  
[NASA-CR-135431] N78-30121
- Procedures for generation and reduction of linear models of a turbofan engine  
[NASA-TP-1261] N78-30896
- Energy efficient engine: Preliminary design and integration studies  
[NASA-CR-135444] N78-31108
- TURBOJET ENGINES**  
An analytical and experimental investigation of diffusers for VSTOL thrust augmenting ejectors  
[AIAA PAPER 78-1509] A78-47945
- Use of a field bench for testing turbojet engines  
A78-49731
- Operating characteristics of bypass turbojet engines --- Russian book  
A78-50125
- Ground impingement of a fan jet exhaust plume  
[AD-A054832] N78-31112
- TURBOMACHINE BLADES**  
Rotor burst protection program: Statistics on aircraft gas turbine engine rotor failures that occurred in US commercial aviation during 1975  
[NASA-CR-135304] N78-31105
- TURBOPROP AIRCRAFT**  
The promise of tilt rotor  
A78-47266
- Application of advanced high speed turboprop technology to future civil short-haul transport aircraft design  
[AIAA PAPER 78-1487] A78-47930
- TURBOSHAPTS**  
Radiographic examination of T55 engine  
[AD-A055108] N78-31113
- TURBULENT FLOW**  
Calculation of exchange coefficients for high-temperature turbine blades  
[ONERA, TP NO. 1978-104] A78-47348
- TURBULENT HEAT TRANSFER**  
Solution of an adjoint problem of steady-state heat transfer associated with the cooling of gas-turbine blades, by means of a quasi-analog/digital system  
A78-47402
- TURBULENT JETS**  
An experimental and numerical study of three-dimensional turbulent jets  
[AIAA PAPER 78-994] A78-48471
- TURNING FLIGHT**  
Bank-to-turn /BIT/ autopilot technology --- for missiles  
A78-49927
- TWISTED WINGS**  
The influence of high twist on the dynamics of rotating blades  
A78-47599
- TWO DIMENSIONAL FLOW**  
Linearized theory of plane, unsteady, supersonic flow through a cascade - Subsonic part of the leading edge  
[ONERA, TP NO. 1978-103] A78-47347
- TWO PHASE FLOW**  
Investigation of nonequilibrium two-phase flows in axisymmetric Laval nozzles  
A78-48244

- ULTRAHIGH FREQUENCIES**  
 Test and evaluation of air/ground communications antennas  
 [AD-A056148] N78-31325
- UNSTEADY FLOW**  
 Linearized theory of plane, unsteady, supersonic flow through a cascade - subsonic part of the leading edge  
 [ONERA, TP NO. 1978-103] A78-47347  
 Unsteady hypersonic gas flow past a thin wing of finite span  
 A78-49792  
 Linearized supersonic unsteady flow in cascades  
 [ARC-R/M-3811] N78-30065  
 A theoretical study of the performance of a number of different axial-flow turbine configurations under conditions of pulsating flow  
 [ARL/MECH-ENG-REPT-149] N78-31104  
 Investigations on unsteady pressure distribution measurements in rotating systems  
 [DLR-FB-77-43] N78-31135
- UNSTEADY STATE**  
 Use of ground vibration test equipment to determine unsteady aerodynamic forces  
 A78-49708
- UPPER SURFACE BLOWN FLAPS**  
 Calculation of the longitudinal aerodynamic characteristics of upper-surface-blown wing-flap configurations  
 [NASA-CR-3004] N78-30050
- UPWASH**  
 Measurements and analysis of the forces acting on a small aircraft flying in the upwash of a large aircraft  
 [AD-A055286] N78-31048
- USER MANUALS (COMPUTER PROGRAMS)**  
 REXOR 2 rotorcraft simulation model. Volume 3: User's manual  
 [NASA-CR-145333] N78-30044  
 APAL simulation facility/capability manual. Volume 1: Executive summary and Systems Avionics Division  
 [AD-A055591] N78-31102
- V**
- V/STOL AIRCRAFT**  
 Nacelle effects on stability of VSTOL configurations including conventional, canard, and tandem wing arrangements  
 [AIAA PAPER 78-1504] A78-47942  
 Experimental determination of propulsion induced ground effects of typical three fan type A V/STOL configurations  
 [AIAA PAPER 78-1507] A78-47943  
 An analytical and experimental investigation of diffusers for VSTOL thrust augmenting ejectors  
 [AIAA PAPER 78-1509] A78-47945  
 Studies of aerodynamic technology for VSTOL fighter/attack aircraft  
 [AIAA PAPER 78-1511] A78-47946  
 The impact of contingency power concepts on V/STOL aircraft take-off-gross-weight  
 [AIAA PAPER 78-926] A78-48451  
 The effect of thrust vectoring and attitude control concepts on the propulsion system of V/STOL aircraft  
 [AIAA PAPER 78-1020] A78-48481  
 Important simulation parameters for the experimental testing of propulsion induced lift effects  
 [AIAA PAPER 78-1078] A78-48494  
 Evaluation of inlet reingestion for large bypass ratio V/STOL aircraft  
 [AIAA PAPER 78-1079] A78-48495  
 Vectoring non-axisymmetric nozzle jet induced effects on a V/STOL fighter model  
 [AIAA PAPER 78-1080] A78-48496  
 The U.S. Navy bets on V/STOL --- technological integration for next generation aircraft design  
 A78-49550  
 The influence of propulsion and control system concepts on design of a Navy Type A V/STOL airplane  
 [AIAA PAPER 78-1505] A78-49788
- Ground effects testing of two, three, and four jet configurations  
 [AIAA PAPER 78-1510] A78-49789  
 V/STOL aircraft simulation - Requirements and capabilities at Ames Research Center  
 [AIAA PAPER 78-1515] A78-49790  
 An investigation of potential control-display configurations for V/STOL aircraft  
 [AIAA 78-1238] A78-50161
- VARIABLE CYCLE ENGINES**  
 Variable-cycle engine fighter aircraft: Advance in performance and development problems  
 N78-30109
- VARIABLE SWEEP WINGS**  
 Dynamics of the longitudinal motion of an airplane with a variable-geometry wing  
 A78-49285
- VECTORS (MATHEMATICS)**  
 Control system design using vector-valued performance criteria with application to the control rate reduction in parameter insensitive control systems  
 [DLR-FB-77-55] N78-31125
- VERTICAL LANDING**  
 Shipboard launch and recovery of RPV helicopters in high sea states  
 [AIAA 78-1269] A78-50179  
 Navigation performance of the Triscan concept for shipboard VTOL aircraft operations  
 [AIAA 78-1293] A78-50200
- VERTICAL TAKEOFF**  
 The impact of contingency power concepts on V/STOL aircraft take-off-gross-weight  
 [AIAA PAPER 78-926] A78-48451
- VERTICAL TAKEOFF AIRCRAFT**  
 Navigation performance of the Triscan concept for shipboard VTOL aircraft operations  
 [AIAA 78-1293] A78-50200  
 Wind-tunnel testing of VTOL and STOL aircraft  
 [NASA-TM-78750] N78-30040
- VERY HIGH FREQUENCIES**  
 TRACALS evaluation report. TACAN, VOR, and ILS station evaluation report, Andersen AFB, Guam  
 [AD-A054244] N78-30078  
 Test and evaluation of air/ground communications antennas  
 [AD-A056148] N78-31325
- VIBRATION**  
 Helicopter transmission vibration and noise reduction program. Volume 1: Technical report  
 [AD-A055104] N78-31089
- VIBRATION DAMPING**  
 Helicopter rotor vibration isolation  
 A78-49399  
 Considerations on wing stores flutter: Asymmetry, flutter suppression  
 [AGARD-R-668] N78-31126  
 Demonstration of aircraft wing/store flutter suppression systems  
 N78-31128
- VIBRATION ISOLATORS**  
 Flutter suppressor for transonic flight  
 [ONERA, TP NO. 1978-102] A78-47346  
 Helicopter rotor vibration isolation  
 A78-49399
- VIBRATION MEASUREMENT**  
 Engine vibration in flight  
 [AIAA PAPER 78-1475] A78-47921
- VIBRATION TESTS**  
 Experimental determination of the rattle of simple models  
 [NASA-TM-78756] N78-30291
- VISCOUS FLOW**  
 An automated procedure for computing the three-dimensional transonic flow over wing-body combinations, including viscous effects. Volume 1: Description of analysis methods and applications  
 [AD-A055899] N78-31052
- VISUAL AIDS**  
 Description and performance of the Langley visual landing display system  
 [NASA-TM-78742] N78-30073
- VISUAL PERCEPTION**  
 Simulator study of the effect of visual-motion time delays on pilot tracking performance with an audio side task  
 [NASA-TP-1216] N78-30090

## VISUAL TASKS

## SUBJECT INDEX

## VISUAL TASKS

Evaluation of several secondary tasks in the determination of permissible time delays in simulator visual and motion cues  
[NASA-TP-1214] N78-30089

**VOLT-AMPERE CHARACTERISTICS**  
Impact of aircraft electrical power quality on utilization equipment  
A78-49962

**VORTICES**  
Trailing vortices. II  
A78-47172

Progress in propeller aerodynamics  
A78-47173

Engineering and development program plan: Wake vortex  
[AD-A051143] N78-30071

Measurements and analysis of the forces acting on a small aircraft flying in the upwash of a large aircraft  
[AD-A055286] N78-31048

## W

## WAKES

Section drag coefficients from pressure probe traverses of a wing wake at low speeds  
[AIAA PAPER 78-1479] A78-47924

Status of aerial applications research in the Langley Vortex Research Facility and the Langley full-scale wind tunnel  
[AIAA PAPER 78-1481] A78-47926

Analysis of multistage, axial flow turbomachine wake production, transport, and interaction  
[AD-A055754] N78-31118

**WALL FLOW**  
Asymptotic theory of a wing moving near a solid wall  
A78-48248

## WARNING SYSTEMS

Infrared receiver performance --- airborne warning system by detection of target spectral signature  
A78-49985

Experimental test plan for the evaluation of aircraft separation assurance displays using airline flight simulators  
[AD-A055849] N78-31134

## WAVEGUIDES

Demonstration of the microwave ice protection concept  
[AD-A055824] N78-31096

## WEAPON SYSTEMS

Interface design considerations for F-16 sensors and weapons  
A78-49874

Software structured weapon delivery  
A78-49875

Peace Rhine - A digital Weapon Control System for the F-4 aircraft  
A78-49876

Digital avionics support - A retrospective view of the future  
A78-49903

Strapdown seeker guidance for tactical weapons  
A78-49928

Modular target acquisition and designation systems  
A78-49954

F-45 avionics Built-in-Test  
A78-49991

Technical evaluation of flying weapon systems  
[RAE-LIB-TRANS-1948] N78-31087

Program analyses for the S-3 weapon system improvement program  
[AD-A055887] N78-31093

## WEAPONS DEVELOPMENT

Technology analysis - Candidate advanced tactical fighters  
[AIAA PAPER 78-1451] A78-49782

## WEIGHT ANALYSIS

The impact of contingency power concepts on V/STOL aircraft take-off-gross-weight  
[AIAA PAPER 78-926] A78-48451

## WEIGHT REDUCTION

Aerodynamic hull design for HASPA LTA optimization --- High Altitude Superpressure Powered Aerostat Lighter Than Air  
A78-48100

Evaluating avionics weight efficiency  
A78-48228

Minimum weight design of stiffened panels with fracture constraints  
A78-49837

Fiber optic development for tactical fighter applications  
A78-49906

## WHEELS

Large deflection static analysis of typical tail-wheel structure of light aircraft by finite element method  
A78-48864

Analysis of a suspension system for a wheel rolling on a flat track  
[NASA-CR-157563] N78-30583

## WIND EFFECTS

Effects of wind on aircraft cruise performance  
[AIAA PAPER 78-1496] A78-47937

Approach guidance logic for a tilt-rotor aircraft  
[AIAA 78-1295] A78-50202

## WIND SHEAR

Improving the accuracy of HUD approaches in wind shear with a new control law  
[AIAA PAPER 78-1494] A78-47935

The airborne detection of low-level wind shear  
[AIAA PAPER 78-1495] A78-47936

## WIND TUNNEL MODELS

Analysis of stability contributions of high dihedral V-tails  
[NASA-TN-78729] N78-31044

## WIND TUNNEL STABILITY TESTS

Stability and performance characteristics of a fixed arrow wing supersonic transport configuration (SCAT 15F-9898) at Mach numbers from 0.60 to 1.20  
[NASA-TN-78726] N78-30087

## WIND TUNNEL TESTS

Some observations on the mechanism of aircraft wing rock  
[AIAA PAPER 78-1456] A78-47907

Wing/store active flutter suppression - Correlation of analyses and wind tunnel data  
[AIAA PAPER 78-1459] A78-47909

Status of aerial applications research in the Langley Vortex Research Facility and the Langley full-scale wind tunnel  
[AIAA PAPER 78-1481] A78-47926

Aerodynamic hull design for HASPA LTA optimization --- High Altitude Superpressure Powered Aerostat Lighter Than Air  
A78-48100

Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions  
[AIAA PAPER 78-989] A78-48469

Application of cryogenics in experimental aerodynamics  
A78-48982

Use of ground vibration test equipment to determine unsteady aerodynamic forces  
A78-49708

Wind-tunnel testing of VTOL and STOL aircraft  
[NASA-TN-78750] N78-30040

Status of aerial applications research in the Langley vortex research facility and the Langley full-scale wind tunnel  
[NASA-TN-78760] N78-30041

Static aerodynamic characteristics of a typical single-engine low-wing general aviation design for an angle-of-attack range of -8 deg to 90 deg  
[NASA-CR-2971] N78-30048

Rotary balance data for a typical single-engine low-wing general aviation design for an angle-of-attack range of 30 deg to 90 deg  
[NASA-CR-2972] N78-30049

Investigation of a wing-rotor interaction system for helicopters  
[AD-A054093] N78-30092

F-15 inlet/engine test techniques and distortion methodologies studies. Volume 1: Technical discussion  
[NASA-CR-144866] N78-30123

Experimental investigation of gust response of hingeless helicopter rotors  
[AD-A054752] N78-30142

Two-dimensional subsonic wind tunnel evaluation of two related cambered 15-percent thick circulation control airfoils  
[AD-A055140] N78-31047

**WIND TUNNEL WALLS**  
Induction of subsonic wind tunnels with slight perforation  
A78-48250

**WINDSHIELDS**  
Damping, static, dynamic, and impact characteristics of laminated beams typical of windshield construction  
[AD-A054463] N78-30093

**WING FLOW METHOD TESTS**  
Asymptotic theory of a wing moving near a solid wall  
A78-48248  
A method for localizing wing flow separation at stall to alleviate spin entry tendencies  
[AIAA PAPER 78-1476] A78-49787

**WING LOADING**  
Trailing vortices. II  
A78-47172

**WING OSCILLATIONS**  
Some observations on the mechanism of aircraft wing rock  
[AIAA PAPER 78-1456] A78-47907

**WING PANELS**  
Wing/store active flutter suppression - Correlation of analyses and wind tunnel data  
[AIAA PAPER 78-1459] A78-47909

**WING PLANFORMS**  
Lateral-aerodynamic characteristics of highly-dihedraled wings  
A78-49334  
Wing planforms for large military transports  
[AIAA PAPER 78-1470] A78-49786  
A calculator program for analyzing airloads on a wing of arbitrary planform and camber in subsonic flow  
[AD-A054180] N78-30058

**WING PROFILES**  
The effect on block fuel consumption of a strutted versus cantilever wing for a short-haul transport including strut aeroelastic considerations  
[AIAA PAPER 78-1454] A78-47905  
Conceptual design study of power augmented ram wing in ground effect aircraft  
[AIAA PAPER 78-1466] A78-47915  
Section drag coefficients from pressure probe traverses of a wing wake at low speeds  
[AIAA PAPER 78-1479] A78-47924  
Drones for aerodynamic and structural testing /DAST/ - A status report  
[AIAA PAPER 78-1485] A78-47929  
Uniformly exact conformal transformation of exterior of circle onto exterior of wing profile  
A78-48224  
Aerodynamics of the new generation of combat aircraft with delta wings  
N78-30106

**WING SLOTS**  
Influence of slots on effectiveness of wing mechanization and control surfaces with separated flow  
A78-48229

**WING TANKS**  
Flutter suppressor for transonic flight  
[ONERA, TP NO. 1978-102] A78-47346

**WING TIP VORTICES**  
Status of aerial applications research in the Langley Vortex Research Facility and the Langley full-scale wind tunnel  
[AIAA PAPER 78-1481] A78-47926

**WING TIPS**  
Measurements and analysis of the forces acting on a small aircraft flying in the upwash of a large aircraft  
[AD-A055286] N78-31048

**WING-FUSELAGE STORES**  
Considerations on wing stores flutter: Asymmetry, flutter suppression  
[AGARD-R-668] N78-31126  
Asymmetric store flutter  
N78-31127  
Demonstration of aircraft wing/store flutter suppression systems  
N78-31128

**WINGLETS**  
Gates Learjet Model 28/29, the first 'Longhorn' Learjet  
[AIAA PAPER 78-1445] A78-47901

Whitcomb winglet applications to general aviation aircraft  
[AIAA PAPER 78-1478] A78-47923

**WINGS**  
On the linear superposition of aerodynamic forces on wings in periodic gusts  
A78-47869  
Modeling ground plane influence on wing aerodynamic characteristics using a finite plane screen  
A78-48216

**WORK CAPACITY**  
Operator work capacity during parachutist free-fall  
A78-47978

**X**

**YV-15 AIRCRAFT**  
The promise of tilt rotor  
A78-47266

**Y**

**YAW**  
Evaluation of a circulation control tail boom for yaw control --- OH-6 helicopter  
[AD-A055116] N78-31119

**YTTTRIUM-IRON GARNET**  
A frequency-selective YIG limiter for airborne PM/CW X-band radar  
A78-50002

**Z**

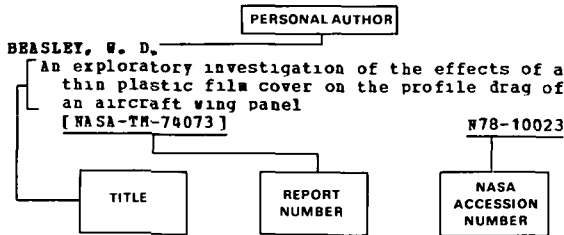
**ZIRCONIUM 95**  
On the use of zirconium 95 data from Chinese atmospheric thermonuclear explosions to study stratospheric transport in a one-dimensional parameterization  
A78-48062

# PERSONAL AUTHOR INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Suppl 103)

DECEMBER 1978

## 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. N78-10023). Under any one author's name the accession numbers are arranged in sequence with the AA accession numbers appearing first.

## A

- ABRAMSON, J.**  
Two-dimensional subsonic wind tunnel evaluation of two related cambered 15-percent thick circulation control airfoils [AD-A055140] N78-31047
- ADOLPH, C. E.**  
Integrated test mission control - Present and future at the Air Force Flight Test Center [AIAA PAPER 78-1461] A78-47911
- AKSENOV, O. M.**  
Superelement method for helicopter fuselage analysis A78-48209
- ALBRECHT, R.**  
Investigation of electrostatic discharge in aircraft fuel tanks during refueling [AIAA PAPER 78-1501] A78-47941
- ALEXANDER, J. D.**  
Design philosophy for engine forgings A78-47452
- ALLISON, D. O.**  
Shockless airfoils with thicknesses of 20.6 and 20.7 percent chord analytically designed for a Mach number of 0.68 and a lift coefficient of 0.40 [NASA-TN-X-73917] N78-30046
- ALTHOP, W.**  
The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints [DLR-FB-77-63] N78-31251
- ALTIS, H. D.**  
Fighter superiority by design N78-30105
- ALWANG, J. R.**  
Engine/airframe/drive train dynamic interface documentation [AD-A055766] N78-31114
- AMOS, W.**  
Program analyses for the S-3 weapon system improvement program [AD-A055887] N78-31093
- ANDERSON, S. B.**  
A method for localizing wing flow separation at stall to alleviate spin entry tendencies [AIAA PAPER 78-1476] A78-49787
- ANDERSSON, L.**  
Laboratory testing of lightning and EMP susceptibility of avionic systems A78-49861
- ANDERTON, G. L.**  
The design process [AIAA PAPER 78-1483] A78-47928

## B

- ANDRE, W. L.**  
LOGMOD - The fault-isolator A78-49239
- ANDREWS, J. W.**  
IPC design validation and flight testing [AD-A055529] N78-31074
- ARGUE, G. H.**  
Transport Canada airfield pavement load evaluation A78-49678
- ASK, H. R.**  
Preliminary design of an accident information Retrieval System (AIRS) [AD-A055590] N78-31952
- ASPINALL, J. W.**  
Solid-state displays for fuel management systems A78-47900
- AUBORA, R.**  
The U.S. Navy bets on V/STOL A78-49550
- AUTRY, R. G.**  
Fiber optic development for tactical fighter applications A78-49906
- BABIAK, M. J.**  
Digital avionics support - A retrospective view of the future A78-49903
- BAERST, C. P.**  
Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 1 [NASA-CR-145369-VOL-1] N78-31085  
Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 2 [NASA-CR-145369-VOL-2] N78-31086
- BAILLIE, I. L. G.**  
Design philosophy for airframes A78-47453
- BAIRD, G. T.**  
Proposed load evaluation system for U.S. Air Force A78-49677
- BAKER, A. A.**  
Fibre composite reinforcement of cracked aircraft structures N78-30288
- BAKER, L. C.**  
Turbine tip clearance measurement [AD-A055765] N78-31115
- BALIS-CREMA, L.**  
Air traffic control in the terminal area - Use of a simulation technique for the definition of an operative model A78-49733
- BALL, J. W.**  
Rolling tail design and behavior as affected by actuator hinge moment limits [AIAA PAPER 78-1500] A78-47940
- BALLHAUS, W. P.**  
An automated procedure for computing the three-dimensional transonic flow over wing-body combinations, including viscous effects. Volume 1: Description of analysis methods and applications [AD-A055899] N78-31052
- BANNER, B. D.**  
Section drag coefficients from pressure probe traverses of a wing wake at low speeds [AIAA PAPER 78-1479] A78-47924
- BARBER, E. A.**  
Prospects for commercial commonality in military transports [AIAA PAPER 78-1467] A78-49784

- BARNES, A. G.  
Air-to-air combat simulation  
The design of a high g cockpit  
A78-47868  
N78-30118
- BARNHART, B.  
Static aerodynamic characteristics of a typical single-engine low-wing general aviation design for an angle-of-attack range of -8 deg to 90 deg [NASA-CR-2971] N78-30048
- BARSBY, J. E.  
Calculations of the effects of blowing from the leading edges of a cambered delta wing [ARC-R/M-3800] N78-30064
- BARTON, J. M.  
An experimental and numerical study of three-dimensional turbulent jets [AIAA PAPER 78-994] A78-48471
- BASU, B. C.  
A mean camberline singularity method for two-dimensional steady and oscillatory aerofoils and control surfaces in inviscid incompressible flow [ARC-CP-1391] N78-30066  
Two-dimensional aerofoils and control surfaces in simple harmonic motion in incompressible inviscid flow [ARC-CP-1392] N78-30068
- BAUER, E.  
On the use of zirconium 95 data from Chinese atmospheric thermonuclear explosions to study stratospheric transport in a one-dimensional parameterization A78-48062
- BEAL, T. R.  
Guidance and control problems in semiautomatic recovery of the Aquila RPV [AIAA 78-1272] A78-50182
- BEAVER, E. W.  
Peace Rhine - A digital Weapon Control System for the F-4 aircraft A78-49876
- BECKMAN, W. R.  
L-1011 flight data recording systems - Background, features, implications and benefits [AIAA PAPER 78-1471] A78-47917
- BELL, G. D.  
Pirfield pavement load evaluation - An international overview A78-49676
- BENDER, G. L.  
Modified helicopter icing spray system evaluation [AD-A055039] N78-31091
- BENNETT, G.  
The role of the computer in the flight testing of general aviation aircraft [AIAA PAPER 78-1465] A78-47914
- BENSON, J. L.  
Propulsion system airframe integration studies - Advanced supersonic transport [AIAA PAPER 78-1053] A78-48488
- BERKSTRESSER, B. K.  
Integrated avionics for future general aviation aircraft [AIAA PAPER 78-1482] A78-47927
- BERMAN, H.  
Improved combat survivability for fly-by-wire sensor systems [AIAA 78-1277] A78-50186
- BERRY, T.  
Experimental test plan for the evaluation of aircraft separation assurance displays using airline flight simulators [AD-A055849] N78-31134
- BESER, J.  
Approach guidance logic for a tilt-rotor aircraft [AIAA 78-1295] A78-50202
- BEYERLY, W. R.  
Short-term performance deterioration in JT9D-7A (SP) engine 695743 [NASA-CR-135431] N78-30121
- BIHRLE, W., JR.  
Static aerodynamic characteristics of a typical single-engine low-wing general aviation design for an angle-of-attack range of -8 deg to 90 deg [NASA-CR-2971] N78-30048
- Rotary balance data for a typical single-engine low-wing general aviation design for an angle-of-attack range of 30 deg to 90 deg [NASA-CR-2972] N78-30049
- BIKCHANTAEV, M. KH.  
Analysis of GTE tolerance monitoring parameter formation A78-48212
- BIKLE, P. F.  
Section drag coefficients from pressure probe traverses of a wing wake at low speeds [AIAA PAPER 78-1479] A78-47924
- BIKOWSKI, J.  
Preliminary design of an accident Information Retrieval System (AIRS) [AD-A055590] N78-31952
- BILL, R. C.  
Gas path seal [NASA-CASE-LEW-12131-2] N78-31103
- BILODEAU, A. A.  
Evaluation of methods for calculating system operating time in accordance with Reliability Improvement Warranty (RIW) contractual terms [AD-A054822] N78-30079
- BINNIE, W. B.  
Flight investigation and theory of direct side-force control [AIAA 78-1287] A78-50194
- BIRCH, S. P.  
An experimental and numerical study of three-dimensional turbulent jets [AIAA PAPER 78-994] A78-48471
- BISCHOFF, D. E.  
Maximum likelihood identification of the longitudinal aerodynamic coefficients of the EA-6B airplane in the catapult launch configuration [AD-A054243] N78-31046
- BLAND, L. M.  
Aircraft structural life monitoring and the problem of corrosion N78-30281
- BLATTNER, D. G.  
Prospects for commercial commonality in military transports [AIAA PAPER 78-1467] A78-49784
- BOGATKO, V. T.  
Unsteady hypersonic gas flow past a thin wing of finite span A78-49792
- BOHN, M. P.  
Aerodynamics of the new generation of combat aircraft with delta wings N78-30106
- BOISSEVAIN, A. G.  
Quiet, Short-Haul Research Aircraft - Current status and future plans [AIAA PAPER 78-1468] A78-47916
- BOLBOT, A. A.  
Communication and navigation antennas for aircraft A78-48523
- BOLLINGER, L.  
Requirements for regional short-haul air service and the definition of a flight program to determine neighborhood reactions to small transport aircraft [NASA-CR-152151] N78-30070
- BORELLI, L.  
Design of a horizontal tail unit and related adjustments A78-49736
- BORGER, W. U.  
Application of rare earth/transition metal permanent magnets to 400 Hz aircraft systems - An AP overview A78-49935
- BORGHI, R.  
Methods available to ONERA for analysis of combustion chambers [ONERA, TP NO. 1978-93] A78-46915
- BOSCH, J. A.  
Software development for fly-by-wire flight control systems [AIAA 78-1276] A78-50185
- BOSE, S. C.  
Real-time simulators for augmented inertial navigation systems A78-49967

BOTTIGLIERI, C.  
Air traffic control in the terminal area - Use of a simulation technique for the definition of an operative model  
A78-49733

BOUCHARD, R. J.  
Short-term performance deterioration in JT9D-7A(SP) engine 695743  
[NASA-CR-135431] N78-30121

BOUDEZAG, J.  
Improved combat survivability for fly-by-wire sensor systems  
[AIAA 78-1277] A78-50186

BOWERS, D. L.  
Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions  
[AIAA PAPER 78-989] A78-48469

BOWLES, J. V.  
Application of advanced high speed turboprop technology to future civil short-haul transport aircraft design  
[AIAA PAPER 78-1487] A78-47930

Requirements for regional short-haul air service and the definition of a flight program to determine neighborhood reactions to small transport aircraft  
[NASA-CR-152151] N78-30070

BOWMAN, J. S., JR.  
Correlation of model and airplane spin characteristics for a low-wing general aviation research airplane  
[AIAA PAPER 78-1477] A78-47922

BOYD, G. H.  
Interscan - A new microwave approach and landing guidance system  
A78-48736

BRADLEY, J. R., JR.  
Dulles control tower console design study  
[AD-A056200] N78-31132

BRAGG, M. B.  
Status of aerial applications research in the Langley Vortex Research Facility and the Langley full-scale wind tunnel  
[AIAA PAPER 78-1481] A78-47926

Status of aerial applications research in the Langley vortex research facility and the Langley full-scale wind tunnel  
[NASA-TM-78760] N78-30041

BRANDEAU, G.  
Evolution of a cost-effective, task-oriented, lateral-directional SAS for the A-10 aircraft  
[AIAA PAPER 78-1460] A78-47910

BRANDIN, D. H.  
In-flight alignment/calibration techniques for unaided tactical guidance  
A78-49929

BRANN, A. J.  
Reliability of inertial navigation systems  
A78-49968

BRATT, R. W.  
Technology analysis - Candidate advanced tactical fighters  
[AIAA PAPER 78-1451] A78-49782

BRAUN, C. L.  
A flight simulation high order language study  
A78-49957

BREER, M. D.  
Boundary layers in axisymmetric inlets at angle of attack. I - Measurements  
[AIAA PAPER 78-1109] A78-48499

BREIDENBACH, D. P.  
Effect of performance objectives on the design and cost of future USAP pilot training aircraft  
[AIAA PAPER 78-1498] A78-47938

BREWER, G. D.  
Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 1  
[NASA-CR-145369-VOL-1] N78-31085

Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 2  
[NASA-CR-145369-VOL-2] N78-31086

BREZA, M. J.  
The terrain following task for the advanced tactical fighter using discrete optimal control  
A78-49862

BRIEL, D.  
Simultaneous measurements of ozone outside and inside cabins of two B-747 airliners and a Gates Learjet business jet  
[NASA-TM-78983] N78-31061

BRIGGS, P.  
Software development for fly-by-wire flight control systems  
[AIAA 78-1276] A78-50185

BRINDLEY, J. F.  
The second generation of high-bypass turbofans - A market clouded by uncertainty  
A78-47423

BRISTOW, D. R.  
Modification of the Douglas Neumann program to improve the efficiency of predicting component interference and high lift characteristics  
[NASA-CR-3020] N78-30051

BROCK, L.  
Preliminary design of an accident information Retrieval System (AIRS)  
[AD-A055590] N78-31952

BRODZKI, Z.  
Progress in propeller aerodynamics  
A78-47173

BRODZKI, L. D.  
Extending the service life of aircraft components made of high-strength steels  
A78-48518

BROTHERHOOD, P.  
Flight measurements of the effects of simulated leading-edge erosion on helicopter blade stall, torsional loads and performance  
[ARC-E/M-3809] N78-30098

BROUGHTON, R. H.  
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[AIAA PAPER 78-1448] A78-47903

BROWN, C. E.  
Measurements and analysis of the forces acting on a small aircraft flying in the upwash of a large aircraft  
[AD-A055286] N78-31048

BROWN, D. L.  
Prediction of angular disturbances from airframe members to airborne electro-optical packages  
A78-49952

BROWN, D. W.  
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[ARC-R/M-3809] N78-30098

BROWN, H.  
Application of the General Purpose Multiplex System to the A-7E avionics  
A78-49867

A standard programmable I/O for the advanced aircraft electrical system power control set  
A78-49936

BROWN, L. E., JR.  
The HINAT RPRV system  
[AIAA PAPER 78-1457] A78-47908

BRUTON, R. A.  
Structural fatigue testing  
N78-30279

BULLEN, P. P.  
A model of crack-tip behaviour for fatigue life determination  
N78-30286

BURHANS, R. W.  
Phase-locked tracking loops for LORAN-C  
[NASA-CR-157582] N78-31068

BURK, S. M., JR.  
Correlation of model and airplane spin characteristics for a low-wing general aviation research airplane  
[AIAA PAPER 78-1477] A78-47922

BURMAN, Z. I.  
Superelement method for helicopter fuselage analysis  
A78-48209

BURNS, R. C.  
Multi-Function Inertial Reference Assembly /MIRA/ update  
A78-49941

BURNSIDE, W. D.  
Volumetric pattern analysis of airborne antennas  
A78-49427

BURTON, G. T.  
HSD demonstration model development  
[AD-A054437] N78-30120

## C

- CALLAS, G. P.  
Integrated avionics for future general aviation aircraft  
[AIAA PAPER 78-1482] A78-47927
- CALLEN, T. R.  
Strapdown seeker guidance for tactical weapons A78-49928
- CANDEL, S.  
Theoretical and experimental studies of acoustic propagation in inhomogeneous moving media  
[ESA-TT-477] N78-30909
- CAPONE, F. J.  
Aerodynamic characteristics induced on a supercritical wing due to vectoring twin nozzles at Mach numbers from 0.40 to 0.95  
[NASA-TM-78746] N78-30039
- CAPONE, L. A.  
An assessment of the effect of supersonic aircraft operations on the stratospheric ozone content  
[NASA-RP-1026] N78-30774
- CAPRILLI, H.  
A method for determining the stability characteristics of aircraft in a helicoid flight path A78-49741
- CAPUTO, E. J.  
Aircraft electrical system testing and data reduction using digital techniques A78-49937
- CARADONNA, F. X.  
The transonic flow on a helicopter rotor N78-31042
- CARDEN, H. D.  
Improved aircraft dynamic response and fatigue life during ground operations using an active control landing gear system  
[AIAA PAPER 78-1499] A78-47939
- CARROLL, J. T.  
Radiographic examination of T55 engine  
[AD-A055108] N78-31113
- CASAROSA, C.  
A method for determining the stability characteristics of aircraft in a helicoid flight path A78-49741  
Takeoff performance of STOL aircraft A78-49744
- CERNY, O. P.  
Subsystem verification of an AFLC organically developed F-15 simulation A78-49901
- CHEATUM, T. G.  
Interface design considerations for F-16 sensors and weapons A78-49874
- CHEN, I.  
Trajectory optimization for some sailplane performance problems N78-31083
- CHEN, P. P.  
Accuracy requirement and cost effectiveness of GPS-aided INS for tactical fighters A78-49989
- CHEN, P.-W.  
Constant false alarm rate detector for a pulse radar in a maritime environment A78-49975
- CHEETKOVA, N. IA.  
Effect of jet fuel autooxidation products on thermooxidation stability A78-49025
- CHILD, R. D.  
Canard configured aircraft with 2-D nozzle  
[AIAA PAPER 78-1450] A78-47904
- CHISTIAKOV, F. K.  
Definition of airplane fuselage longitudinal lines by the special contour method A78-48222
- CLAY, B. R.  
HHSD demonstration model development  
[AD-A054437] N78-30120
- CLOSE, D. H.  
Advanced pattern matching for navigation and guidance A78-49998
- CLOUD, E. L.  
Modular Missionization Systems /MMS/, an adaptive system interface concept A78-49852
- COBB, E. H.  
Center-loaded duct integral rocket-to-ramjet transition testing  
[AIAA PAPER 78-937] A78-48456
- COCHRANE, J. A.  
Quiet, Short-Haul Research Aircraft - Current status and future plans  
[AIAA PAPER 78-1468] A78-47916
- COLANTONIO, A.  
Use of a field bench for testing turbojet engines A78-49731
- COLE, L. G.  
Constant false alarm rate detector for a pulse radar in a maritime environment A78-49975
- COMPITELLO, F. E.  
Propulsion test facilities - Capabilities and use  
[AIAA PAPER 78-933] A78-48453
- CONLON, J. A.  
Application of advanced high speed turboprop technology to future civil short-haul transport aircraft design  
[AIAA PAPER 78-1487] A78-47930
- CONRAD, E. W.  
NASA engine system technology programs - An overview  
[AIAA PAPER 78-928] A78-48452
- CONROW, E. H.  
A parametric analysis of TERCOM false fix probability A78-49997
- COOLEY, D. E.  
Close encounters of the aeroservoelastic kind  
[AIAA 78-1289] A78-50196
- CORBIN, J. C., JR.  
Electromagnetic coupling analysis of a Learjet aircraft in a lightning environment A78-49920
- CORREGE, G.  
New structures made of composite materials for high performance combat aircraft N78-30114
- COUCH, R. P.  
Detecting abnormal turbine engine deterioration using electrostatic methods  
[AIAA PAPER 78-1473] A78-47919
- COYLE, J. J.  
Test and evaluation of air/ground communications antennas  
[AD-A056148] N78-31325
- CREEL, T. R., JR.  
Aerodynamic characteristics of a hypersonic research airplane concept having a 70 deg swept double-delta wing at Mach number 0.2  
[NASA-TP-1252] N78-31045
- CREWS, L. L.  
Software structured weapon delivery A78-49875
- CROSS, S. E.  
Performance in a jamming environment of a low-cost GPS user receiver algorithm for aiding a tactical INS  
[AD-A055239] N78-31078
- CROSSGROVE, W. A.  
MIL-STD-1553B proposed A78-49866
- CROUCH, R. W.  
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[AIAA PAPER 78-994] A78-48471
- CROWELL, H. A.  
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[AIAA PAPER 78-1483] A78-47928
- CUNNINGTON, G. R., JR.  
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[NASA-CR-145369-VOL-1] N78-31085  
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[NASA-CR-145369-VOL-2] N78-31086
- CURTISS, H. C., JR.  
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[AD-A054281] N78-30091



- CWYNAR, D. S.  
Procedures for generation and reduction of linear models of a turbofan engine  
[NASA-TP-1261] N78-30896
- D**
- DABBS, R. S.  
Metal technology for future aircraft design N78-30115
- DAHLEN, V., III  
Supercruiser fighter analysis N78-30107
- DALEY, E.  
AIDS in military aircraft A78-47866
- DALLAS, J.  
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[PB-279970/8] N78-31007
- DALLOSTA, P. M.  
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- DAVIDSON, J.  
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- DAVIES, A. E.  
AIDS in engine management programmes A78-47865
- DAVIS, G. W.  
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[NASA-CR-145369-VOL-1] N78-31085  
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- DAVIS, J. A.  
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[AIAA PAPER 78-1474] A78-47920
- DAZZO, J. J.  
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- DECKER, J. P.  
Stability and performance characteristics of a fixed arrow wing supersonic transport configuration (SCAT 15F-9898) at Mach numbers from 0.60 to 1.20  
[NASA-TM-78726] N78-30087
- DEEL, O.  
Engineering data on new aerospace materials structural materials  
[AD-A054461] N78-30213
- DEGTIAREV, G. L.  
Optimal control synthesis in distributed systems with incomplete information A78-48215
- DEJAUNETTE, F. R.  
Investigation of a wing-rotor interaction system for helicopters  
[AD-A054093] N78-30092
- DELANUNTY, A.  
AIDS in military aircraft A78-47866
- DELAURIER, J.  
Lateral-aerodynamic characteristics of highly-dihedral wings A78-49334
- DELUCIA, R. A.  
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[NASA-CR-135304] N78-31105
- DEMOTT, L. R.  
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- DENARO, R. P.  
Navstar GPS field test results A78-49856
- DENERY, D. G.  
Integrated avionics for future general aviation aircraft  
[AIAA PAPER 78-1482] A78-47927
- DENKSCHERZ, H.  
Display systems and cockpit design N78-30116
- DENTON, W. R.  
Flight deck display trends A78-47899
- DESJARDINS, R. A.  
Helicopter rotor vibration isolation A78-49399
- DESTUYNDER, R.  
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[ONERA, TP NO. 1978-102] A78-47346
- DEYST, J. J., JR.  
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- DILLON, J. L.  
Aerodynamic characteristics of a hypersonic research airplane concept having a 70 deg swept double-delta wing at Mach number 0.2  
[NASA-TP-1252] N78-31045
- DOBBS, M. W.  
Minimum weight design of stiffened panels with fracture constraints A78-49837
- DOMINGUEZ RODRIGUEZ, L.  
Operational regularity in air transport A78-49449
- DOW, J. P.  
Let's put fuel efficiency into perspective A78-47269
- DOWNING, J. R.  
A systems approach to heliport lighting A78-49238
- DRAGO, R. J.  
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[AD-A054827] N78-30095  
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- DREYFUSS, D. J.  
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[AD-A054834] N78-31100
- DROGIN, E. H.  
Digital system architecture for a 1980's jammer A78-49973
- DUNHAM, J.  
Intake design for fighter aircraft N78-30110
- DUNNING, S. J.  
Infrared receiver performance A78-49985
- DUNSWORTH, L. C.  
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[AIAA PAPER 78-935] A78-48455
- DURENBERGER, D.  
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[AIAA PAPER 78-1480] A78-47925
- DUTOYA, D.  
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[ONERA, TP NO. 1978-104] A78-47348
- DYBES, R. S.  
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- DZYGADLO, Z.  
Dynamics of the longitudinal motion of an airplane with a variable-geometry wing A78-49285
- E**
- EARP, R. L.  
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- ECKSTROM, C. V.  
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[AIAA PAPER 78-1485] A78-47929

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[AIAA PAPER 78-1499] A78-47939
- EDWARDS, J. A.  
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- EDWARDS, R. H.  
A further survey of some effects of aircraft noise in residential communities near London (Heathrow) airport  
[TT-7705] N78-30910
- EHREICH, R. D.  
Strapdown seeker guidance for tactical weapons A78-49928
- ELBER, W.  
Recent developments in analysis of crack propagation and fracture of practical materials  
[NASA-TM-78766] N78-30606
- EMERSON, R.  
Digital simulation and flight verification of the F-5E/F Flight Director Computer A78-49905
- EMBERT, R. I.  
Bank-to-turn /BIT/ autopilot technology A78-49927
- ERM, L.  
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[ARL/MECH-ENG-REPT-149] N78-31104
- ERMOLENKO, S. D.  
Modeling ground plane influence on wing aerodynamic characteristics using a finite plane screen A78-482\*6
- ERZBERGER, H.  
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[NASA-TM-78519] N78-30072
- EULRICH, B. J.  
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- EVELYN, G. B.  
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[AIAA PAPER 78-1051] A78-48486
- F**
- FAERY, H. F., JR.  
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[AIAA PAPER 78-1478] A78-47923
- FANNING, A. E.  
Advance nozzle technology N78-30111
- FANT, K.  
Autothreshold autoscreener/FLIR system A78-49984
- FARMER, M. G.  
Demonstration of aircraft wing/store flutter suppression systems N78-31128
- FARRELL, J. L.  
Air-to-air designate/track with time sharing A78-49977
- FEDOTOV, B. B.  
Method of calculating aerodynamic coefficients of some three-dimensional bodies with arbitrary cross section A78-48245
- FEHER, K.  
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[NASA-CR-15215] N78-30070
- FEHER, B. E.  
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[AD-A054811] N78-30088
- FEISTEL, T. W.  
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[AIAA PAPER 78-1476] A78-49787
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- FENDER, J. R.  
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[BDX-613-1836-REV] N78-31249
- FILISOPOV, V. K.  
Operator work capacity during parachutist free-fall A78-47978
- FINNEY, J. M.  
Fatigue S/N data in relation to variability in predicted life N78-30278  
Load interaction effects in fatigue crack propagation N78-30285
- FISHER, D. P.  
Flight experience on the need and use of inflight leading edge washing for a laminar flow airfoil  
[AIAA PAPER 78-1512] A78-47947
- PITZSIMMONS, R. D.  
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[AIAA PAPER 78-1052] A78-48487
- FLOOD, J. D.  
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[AIAA PAPER 78-1078] A78-48494
- FOGGIE, P. R.  
Advances in inertial navigation A78-47481
- FORD, D. G.  
The development of the theory of structural fatigue N78-30283
- FORD, M. J.  
Advanced optical blade tip clearance measurement system  
[NASA-CR-159402] N78-31106
- FORTENBAUGH, R. L.  
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[AIAA PAPER 78-1504] A78-47942
- FOURNIER, R. H.  
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[NASA-TP-1233] N78-30053
- FREED, M. H.  
The role of system performance analysis in the independent assessment of B-1 navigation software A78-49902
- FREEMAN, C. E.  
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[NASA-TM-78729] N78-31044
- FREEMAN, D. C., JR.  
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[NASA-TP-1233] N78-30053
- FRICK, J.  
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[AD-A055899] N78-31052
- FRINK, M. T.  
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[AD-A054093] N78-30092
- FULLER, A. B.  
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[AD-A054016] N78-30119
- FUNK, J. E.  
The terrain following task for the advanced tactical fighter using discrete optimal control A78-49862

PUZIK, M. I.  
Probabilistic model of an instrument landing system  
A78-47407

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GAMBLE, A. C.  
Transport Canada airfield pavement load evaluation  
A78-49678

GAMON, H. A.  
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crashworthiness user's manual. Volume 1:  
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[AD-A055898] N78-31088

GARMONG, G.  
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transport aircraft, volume 1  
[NASA-CR-145369-VOL-1] N78-31085  
Study of fuel systems for LH2-fueled subsonic  
transport aircraft, volume 2  
[NASA-CR-145369-VOL-2] N78-31086

GAUKROGER, D. R.  
Measurement of vibratory displacements of a  
rotating blade  
A78-49397

GEOKEZAS, M.  
Autothreshold autoscreener/FLIR system  
A78-49984

GERTSEN, W. M.  
Gates Learjet Model 28/29, the first 'Longhorn'  
Learjet  
[AIAA PAPER 78-1445] A78-47901

GEVAERT, G.  
Shipboard launch and recovery of RPV helicopters  
in high sea states  
[AIAA 78-1269] A78-50179

GILBREATH, H. C.  
Volumetric pattern analysis of airborne antennas  
A78-49427

GLAZUNOV, A. A.  
Investigation of nonequilibrium two-phase flows in  
axisymmetric Laval nozzles  
A78-48244

GODFREY, J. T.  
Capture effect array glide slope guidance study  
[AD-A055678] N78-31073

GOETZ, G. F.  
Non-axisymmetric nozzle design and evaluation for  
P-111 flight demonstration  
[AIAA PAPER 78-1025] A78-48483

GOGOLIN, V. P.  
Evaluating avionics weight efficiency  
A78-48228

GOLDIE, H.  
A frequency-selective YIG limiter for airborne  
FM/CW X-band radar  
A78-50002

GOLDSCHMIED, F. R.  
Aerodynamic hull design for HASPA LTA optimization  
A78-48100

GONZALEZ CRISTOBAL, P.  
An integrated analysis of the fundamental problems  
of air transport  
A78-49447

GOODE, M. W.  
Simulation and flight evaluation of a head-up  
landing aid for general aviation  
[NASA-TP-1276] N78-31101

GRADY, G. E.  
Turbine tip clearance measurement  
[AD-A055765] N78-31115

GRAVES, G. L.  
Laboratory testing of lightning and EMP  
susceptibility of avionic systems  
A78-49861

GREENE, R. A.  
The airborne detection of low-level wind shear  
[AIAA PAPER 78-1495] A78-47936

GRIB, A. A.  
Unsteady hypersonic gas flow past a thin wing of  
finite span  
A78-49792

GRIEB, H.  
Variable-cycle engine fighter aircraft: Advance  
in performance and development problems  
N78-30109

GRIFFIN, W. R.  
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fuel tanks  
[AD-A054627] N78-30247

GRIPFITH, S. L.  
Investigation of a wing-rotor interaction system  
for helicopters  
[AD-A054093] N78-30092

GRIMAK, L. P.  
Operator work capacity during parachutist free-fall  
A78-47978

GRIMM, K. R.  
Scan-limited near field testing for directive  
airborne antennas  
A78-49897

GROSE, G. G.  
Modification of the Douglas Neumann program to  
improve the efficiency of predicting component  
interference and high lift characteristics  
[NASA-CR-3020] N78-30051

GROSSMAN, H. L.  
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effects on a V/STOL fighter model  
[AIAA PAPER 78-1080] A78-48496

Design evolution of a supersonic cruise  
strike-fighter  
[AIAA PAPER 78-1452] A78-49783

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typical general aviation structural materials  
[AIAA PAPER 78-1480] A78-47925

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general aviation airplanes: Investigation of  
the characteristics of an acoustic panel test  
facility  
[NASA-CR-157587] N78-31874

GULIAEV, V. V.  
Influence of slots on effectiveness of wing  
mechanization and control surfaces with  
separated flow  
A78-48229

GUREEV, A. A.  
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thermooxidation stability  
A78-49025

## H

HACKER, T.  
Constant-control rolling maneuver  
A78-46961

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AFAL simulation facility/capability manual.  
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Avionics Division  
[AD-A055591] N78-31102

HAINES, A. L.  
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airport capacity/delay  
[AD-A055482] N78-31130

HAINSLIP, D. T.  
The Omega radionavigation system comes to the  
Pacific Ocean area  
A78-49660

HALE, A. L.  
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helicopters  
[NASA-CR-158909] N78-30139

HALE, P. J.  
Effects of wind on aircraft cruise performance  
[AIAA PAPER 78-1496] A78-47937

HALLER, M. H.  
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fighter aircraft equipments  
[AD-A054598] N78-30094

HAMMOCK, H. S.  
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methodologies studies. Volume 1: Technical  
discussion  
[NASA-CR-144866] N78-30123

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methodologies studies. Volume 2: Time variant  
data quality analysis plots  
[NASA-CR-144867] N78-30124

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spectral density plots  
[NASA-CR-144868] N78-30125

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[NASA-CR-144874] N78-30131
- HAMPTON, T. L.**  
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[AIAA PAPER 78-1084] A78-48497
- HANCOCK, G. J.**  
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- HANWAN, B.**  
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- HARDRATH, H. P.**  
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[NASA-TM-78766] N78-30606
- HARDY, G. H.**  
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[AIAA PAPER 78-1482] A78-47927
- HARE, E. W.**  
COMED - The cockpit display of the future  
A78-47268
- HARRIS, R. F.**  
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[AD-A055789] N78-31097
- HARRIS, R. L., SR.**  
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[NASA-TP-1276] N78-31101
- HARTLEY, H. F.**  
Capture effect array glide slope guidance study  
[AD-A055678] N78-31073
- HASSAL, C. J. W.**  
Measurement of vibratory displacements of a rotating blade  
A78-49397
- HEALY, R. D.**  
Station deselection procedures to support automatic Omega receiver operation  
A78-49965
- HENDERSON, H. R.**  
An acoustic range for the measurement of the noise signature of aircraft during flyby operations  
A78-47242
- HENDERSON, W. P.**  
Canard configured aircraft with 2-D nozzle  
[AIAA PAPER 78-1450] A78-47904
- HENDRICKSON, R. H.**  
Design evolution of a supersonic cruise strike-fighter  
[AIAA PAPER 78-1452] A78-49783
- HERTZBERG, A.**  
A laser-powered flight transportation system  
[AIAA PAPER 78-1484] A78-49781
- HEWISH, M.**  
Airliner numbers game - Does it add up  
A78-49524
- HEYSON, H. H.**  
Wind-tunnel testing of VTOL and STOL aircraft  
[NASA-TM-78750] N78-30040
- HIGGINBOTHAM, R.**  
Multiprocessing for electronic warfare avionics  
A78-49869
- HILEY, P. E.**  
Installed performance of vectoring/reversing non-axisymmetric nozzles  
[AIAA PAPER 78-1022] A78-48482
- HILL, W. G., JR.**  
Ground impingement of a fan jet exhaust plume  
[AD-A054832] N78-31112
- HILTON, D. A.**  
An acoustic range for the measurement of the noise signature of aircraft during flyby operations  
A78-47242
- HIRSCHKRON, R.**  
Energy efficient engine: Preliminary design and integration studies  
[NASA-CR-135444] N78-31108
- HIRSINGER, P.**  
Methods available to ONERA for analysis of combustion chambers  
[ONERA, TP NO. 1978-93] A78-46915
- HOPMANN, L. G.**  
Digital control law synthesis in the w prime domain  
A78-46962
- HOWEYCUIT, R. E.**  
Advanced optical blade tip clearance measurement system  
[NASA-CR-159402] N78-31106
- HOOKER, P. H.**  
Safety against fatigue in flight: A perspective of Australian experience and research  
Aircraft structural reliability and risk theory: A review  
N78-30272  
N78-30284
- HOOPER, W. E.**  
Helicopter rotor vibration isolation  
A78-49399
- HOPKINS, A. L., JR.**  
Highly survivable integrated avionics  
A78-49163
- HOSKIN, B. C.**  
Fracture mechanics fundamentals with reference to aircraft structural applications  
N78-30274
- HOSTETLER, L. D.**  
Optimal terrain-aided navigation systems  
[AIAA 78-1243] A78-50163
- HOTTNER, T.**  
Application of cryogenics in experimental aerodynamics  
A78-48982
- HOUGHTON, D. E. A.**  
Air-to-air combat simulation  
A78-47868
- HOWARD, P. J.**  
Development of a load sequence for a structural fatigue test  
N78-30277
- HOWELLS, R. W.**  
Helicopter transmission vibration and noise reduction program. Volume 2: User's manual  
[AD-A054827] N78-30095  
Helicopter transmission vibration and noise reduction program. Volume 1: Technical report  
[AD-A055104] N78-31089
- HUBANS, P., JR.**  
A hierarchical network for avionic systems  
A78-49868
- HUESCHEN, R. M.**  
Guidance and navigation for automatic landing, rollout, and turnoff using MLS and magnetic cable sensors  
[AIAA 78-1296] A78-50203
- HUGHES, I.**  
Preliminary design of an accident Information Retrieval System (AIRS)  
[AD-A055590] N78-31952
- HULTBERG, R. S.**  
Rotary balance data for a typical single-engine low-wing general aviation design for an angle-of-attack range of 30 deg to 90 deg  
[NASA-CR-2972] N78-30049
- HUNTER, L. B. R.**  
Transport Canada airfield pavement load evaluation  
A78-49678

- HUTCHISON, H. H.  
Fibre composite reinforcement of cracked aircraft structures  
N78-30288
- HUTTSSELL, L. J.  
Wing/store active flutter suppression - Correlation of analyses and wind tunnel data [AIAA PAPER 78-1459] A78-47909  
Close encounters of the aeroservoelastic kind [AIAA 78-1289] A78-50196
- HWANG, C.  
Some observations on the mechanism of aircraft wing rock [AIAA PAPER 78-1456] A78-47907  
Demonstration of aircraft wing/store flutter suppression systems  
N78-31128
- I
- IGONIN, V. I.  
Solution of an adjoint problem of steady-state heat transfer associated with the cooling of gas-turbine blades, by means of a quasi-analog/digital system  
A78-47402  
Application of electrical analogy to the substantiation and comparison of some analytical methods of determining temperature fields in gas-turbine blades  
A78-47404
- ILNITSKII, L. IA.  
Probabilistic model of an instrument landing system  
A78-47407  
Communication and navigation antennas for aircraft  
A78-48523
- IRONS, J. J.  
The use of the AIAA-Bendix Design Competition in aerospace design courses [AIAA PAPER 78-1488] A78-47931
- ISKHAKOV, I. A.  
Evaluating avionics weight efficiency  
A78-48228
- IVERSON, H. W.  
Modular target acquisition and designation systems  
A78-49954
- J
- JACKSON, C. T., JR.  
Integrated avionics for future general aviation aircraft [AIAA PAPER 78-1482] A78-47927
- JACOBS, P. F.  
Stability and performance characteristics of a fixed arrow wing supersonic transport configuration (SCAT 15P-9898) at Mach numbers from 0.60 to 1.20 [NASA-TM-78726] N78-30087
- JACOBSON, I. D.  
Ride quality evaluation. IV - Models of subjective reaction to aircraft motion  
A78-47490  
Model of aircraft passenger acceptance  
A78-49684  
Demand modelling of passenger air travel: An analysis and extension, volume 2 [NASA-CR-157402] N78-30069
- JAMES, H. B.  
Fading at 9.6 GHz on an experimentally simulated aircraft-to-ground path  
A78-49439
- JENKINS, E. C.  
Ground impingement of a fan jet exhaust plume [AD-A054832] N78-31112
- JOBE, C. E.  
Wing planforms for large military transports [AIAA PAPER 78-1470] A78-49786
- JOHNSON, E. S.  
Advanced supersonic transport engine integration studies for near-term technology readiness date [AIAA PAPER 78-1052] A78-48487
- JOHNSON, H. W.  
NASA engine system technology programs - An overview [AIAA PAPER 78-928] A78-48452
- JOHNSON, P. E.  
Propulsion for future supersonic transports - 1978 status [AIAA PAPER 78-1051] A78-48486
- JOHNSON, T. W.  
A qualitative analysis of redundant asynchronous operation  
A78-49863
- JOHNSTON, E. W.  
Technology analysis - Candidate advanced tactical fighters [AIAA PAPER 78-1451] A78-49782
- JOHNSTON, R. P.  
Energy efficient engine: Preliminary design and integration studies [NASA-CR-135444] N78-31108
- JONES, H. L.  
Comparisons of high anti-jam design techniques for GPS receivers  
A78-49857
- JONES, J. L.  
Application of the General Purpose Multiplex System to the A-7E avionics  
A78-49867
- JONES, R. E.  
Gas turbine engine emissions - Problems, progress and future  
A78-49336
- JONES, W. S.  
A laser-powered flight transportation system [AIAA PAPER 78-1484] A78-49781
- JORDAN, P. L., JR.  
Status of aerial applications research in the Langley Vortex Research Facility and the Langley full-scale wind tunnel [AIAA PAPER 78-1481] A78-47926  
Status of aerial applications research in the Langley vortex research facility and the Langley full-scale wind tunnel [NASA-TM-78760] N78-30041
- K
- KADYSHEV, I. K.  
Aviation control system devices  
A78-49850
- KAMCHI, J. S.  
Propulsion test facilities - Capabilities and use [AIAA PAPER 78-933] A78-48453
- KANISS, A. M.  
Statistical review of counting accelerometer data for Navy and Marine fleet aircraft from 1 January 1962 to 31 December 1977 [AD-A055672] N78-31098
- KAPLUN, A. B.  
Fatigue crack growth in pressurized fuselage panel  
A78-48231
- KEE, E.  
Application of the General Purpose Multiplex System to the A-7E avionics  
A78-49867
- KELLY, R. J.  
Landing aircraft under poor conditions  
A78-49549  
Comparison study of MLS airborne signal processing techniques  
A78-49904
- KELLY, R. T.  
Optimal terrain following controller for an optimized spline reference path [AD-A055234] N78-31122
- KESKAR, D. A.  
Approximate indicial lift function for tapered, swept wings in incompressible flow [NASA-TP-1241] N78-30054
- KHACHATURIAN, L. S.  
Safety of space flights  
A78-47952  
Operator work capacity during parachutist free-fall  
A78-47978
- KHOROLSKII, V. M.  
Application of electrical analogy to the substantiation and comparison of some analytical methods of determining temperature fields in gas-turbine blades  
A78-47404
- KHRUNOV, E. V.  
Safety of space flights  
A78-47952
- KIENAPPEL, K.  
Investigations on unsteady pressure distribution measurements in rotating systems [DLR-PB-77-43] N78-31135

- KIKUCHI, H.  
Neutralization problem for a Space Shuttle  
A78-47124
- KIMBERLEY, D.  
A pyramid skewed axis sensor set for multiplex  
flight control systems  
[ARC-R/M-3808] N78-30143
- KITZMILLER, D. E.  
Installed performance of vectoring/reversing  
non-axisymmetric nozzles  
[AIAA PAPER 78-1022] A78-48482
- KLEINEBERT, H.-J.  
10 years of contract research for the  
pump/compressor industrial concern  
A78-49175
- KLIECHKIN, A. L.  
Operating characteristics of bypass turbojet engines  
A78-50125
- KLINGER, G.  
The influence of the environment on the  
elastoplastic properties of adhesives in metal  
bonded joints  
[DLR-FB-77-63] N78-31251
- KLOETZLI, J. W.  
Measurements and analysis of the forces acting on  
a small aircraft flying in the upwash of a large  
aircraft  
[AD-A055286] N78-31048
- KLOS, L. C.  
An interface management approach to software  
development  
A78-49933
- KOCH, C. C.  
Energy efficient engine: Preliminary design and  
integration studies  
[NASA-CR-135444] N78-31108
- KOEGLER, J. C.  
IPC design validation and flight testing  
[AD-A055529] N78-31074
- KOENIG, S. E.  
Analysis of runway occupancy times at major airports  
[AD-A056052] N78-31131
- KOLESHNIKOV, G. M.  
Operator work capacity during parachutist free-fall  
A78-47978
- KOLTON, G. A.  
Unsteady hypersonic gas flow past a thin wing of  
finite span  
A78-49792
- KOPPELMAN, R.  
Multiprocessing for electronic warfare avionics  
A78-49869
- KOSTIN, L. C.  
Wind Tunnel/Flight Test Correlation Program on the  
B-1 nacelle afterbody/nozzle at transonic  
conditions  
[AIAA PAPER 78-989] A78-48469
- KOTELNIKOV, G. N.  
Distribution of reliability characteristics among  
airplane system units to ensure given flight  
safety level  
A78-48221
- KOURTIDES, D. A.  
Assessment of relative flammability and  
thermochemical properties of some thermoplastic  
materials  
A78-49693
- KOWALSKI, S. H.  
Avionics cost development for alternatives of  
selected air traffic control systems  
[AD-A054823] N78-30080
- KOZHEVNIKOV, I. V.  
Analysis of GTE tolerance monitoring parameter  
formation  
A78-48212
- KRAEMER, J. W.  
In-flight alignment/calibration techniques for  
unaided tactical guidance  
A78-49929
- KREISSLEHNER, G.  
Control system design using vector-valued  
performance criteria with application to the  
control rate reduction in parameter insensitive  
control systems  
[DLR-FB-77-55] N78-31125
- KRETSINGER, P. H.  
REXOR 2 rotorcraft simulation model. Volume 1:  
Engineering documentation  
[NASA-CR-145331] N78-30042
- REXOR 2 rotorcraft simulation model. Volume 2:  
Computer implementation  
[NASA-CR-145332] N78-30043
- REXOR 2 rotorcraft simulation model. Volume 3:  
User's manual  
[NASA-CR-145333] N78-30044
- KROEGER, R. A.  
A method for localizing wing flow separation at  
stall to alleviate spin entry tendencies  
[AIAA PAPER 78-1476] A78-49787
- KROEKER, B.  
Lateral-aerodynamic characteristics of  
highly-dihedraled wings  
A78-49334
- KRUTOV, V. I.  
Experimental determination of parameters of  
mathematical model of airplane cabin as  
regulated object with respect to air temperature  
in the cabin  
A78-48234
- KRYZHANOVSKII, G. A.  
Optimization techniques for air traffic control  
problems  
A78-48504
- KUBBAT, W. J.  
Design and development of a multifunctional  
helicopter control system  
A78-49396
- Advanced control concepts for future fighter  
aircraft  
N78-30104
- KUIPERS, J.  
Two-way - A position and orientation measurement  
system  
A78-49661
- KULPAN, R. M.  
Wing planforms for large military transports  
[AIAA PAPER 78-1470] A78-49786
- KULIEV, V. D.  
Fatigue crack growth in pressurized fuselage panel  
A78-48231
- KUPRIANOV, I. I.  
Communication and navigation antennas for aircraft  
A78-48523
- KUZNETSOV, N. D.  
Aspects of the thermal fatigue strength of  
gas-turbine engine components  
A78-49176
- L**
- LABERGE, E. F. C.  
Comparison study of MLS airborne signal processing  
techniques  
A78-49904
- LACROIX, D.  
French procedures for airfield pavement load  
evaluation  
A78-49679
- LAMPARD, G. W. H.  
The effect of thrust vectoring and attitude  
control concepts on the propulsion system of  
V/STOL aircraft  
[AIAA PAPER 78-1020] A78-48481
- LANDGRAF, B. C.  
A flight qualified graphics generator  
A78-50007
- LANE, R. E.  
Flight controls of Army/Hughes YAH-64 advanced  
attack helicopter  
[AIAA 78-1237] A78-50160
- LANG, L. E.  
F-15 avionics Built-in-Test  
A78-49991
- LARGE, J. P.  
Estimated costs of extended low-rate airframe  
production  
[AD-A054834] N78-31100
- LARSON, R.  
Putothreshold autoscreener/FLIR system  
A78-49984
- LAZZERETTI, R.  
A method for determining the stability  
characteristics of aircraft in a helicoild flight  
path  
A78-49741
- LEAKE, R. J.  
Alternatives for jet engine control  
[NASA-CR-157578] N78-31107

- LEBACQZ, J. V.  
An investigation of potential control-display configurations for V/STOL aircraft [AIAA 78-1238] A78-50161
- LECCCE, L.  
Use of ground vibration test equipment to determine unsteady aerodynamic forces A78-49708
- LECKMAN, P.  
The role of the computer in the flight testing of general aviation aircraft [AIAA PAPER 78-1465] A78-47914
- LEE, H.  
Characteristics of constrained optimum trajectories with specified range [NASA-TM-78519] N78-30072
- LELIUSHENKO, S. I.  
Definition of airplane fuselage longitudinal lines by the special contour method A78-48222
- LENSKI, J. W., JR.  
Helicopter transmission vibration and noise reduction program. Volume 2: User's manual [AD-A054827] N78-30095  
Helicopter transmission vibration and noise reduction program. Volume 1: Technical report [AD-A055104] N78-31089
- LEONARD, K. C., JR.  
Modular Missionization Systems /MMS/, an adaptive system interface concept A78-49852
- LEONG, P. J.  
Dynamic analysis of electrical systems A78-49934
- LIMAGE, C. R.  
Evaluation of inlet reingestion for large bypass ratio V/STOL aircraft [AIAA PAPER 78-1079] A78-48495
- LINN, R. J.  
'Supermarket' airplanes [AIAA PAPER 78-1533] A78-49769
- LISZKA, L.  
Long-distance focusing of Concorde sonic boom A78-48052
- LOGAN, A. H.  
Evaluation of a circulation control tail boom for yaw control [AD-A055116] N78-31119
- LORENZINI, D. A.  
Navstar GPS field test results A78-49856
- LOTZE, A.  
Asymmetric store flutter N78-31127
- LOVELL, W. A.  
Design of a large span-distributed load flying-wing cargo airplane with laminar flow control [NASA-CR-145376] N78-30045
- LOWE, J. R.  
Improving the accuracy of HUD approaches in windshear with a new control law [AIAA PAPER 78-1494] A78-47935
- LUCKRING, J. H.  
Theoretical estimation of the transonic aerodynamic characteristics of a supercritical-wing transport model with trailing-edge controls [NASA-TP-1253] N78-30056
- LUDWIG, L. P.  
Gas path seal [NASA-CASE-LEW-12131-2] N78-31103
- LYNCH, S. P.  
Mechanisms of fatigue and fracture N78-30273
- M**
- MACDONALD, T. J.  
Comparisons of high anti-jam design techniques for GPS receivers A78-49857
- MACKENZIE, D.  
An automated procedure for computing the three-dimensional transonic flow over wing-body combinations, including viscous effects. Volume 1: Description of analysis methods and applications [AD-A055899] N78-31052
- MAGENHEIM, B.  
Demonstration of the microwave ice protection concept [AD-A055824] N78-31096
- MANGANO, G. J.  
Rotor burst protection program: Statistics on aircraft gas turbine engine rotor failures that occurred in US commercial aviation during 1975 [NASA-CR-135304] N78-31105
- MANN, J. Y.  
Fatigue S/N data in relation to variability in predicted life N78-30278
- MANN, M. J.  
Theoretical estimation of the transonic aerodynamic characteristics of a supercritical-wing transport model with trailing-edge controls [NASA-TP-1253] N78-30056
- MARJOR, D.  
Whitcomb winglet applications to general aviation aircraft [AIAA PAPER 78-1478] A78-47923
- MARCHMAN, J. P., III  
Whitcomb winglet applications to general aviation aircraft [AIAA PAPER 78-1478] A78-47923  
The use of the AIAA-Bendix Design Competition in aerospace design courses [AIAA PAPER 78-1488] A78-47931
- MAREVTSEVA, W. A.  
Induction of subsonic wind tunnels with slight perforation A78-48250
- MARHEFKA, R. J.  
Prospects for commercial commonality in military transports [AIAA PAPER 78-1467] A78-49784
- MARION, R. G.  
Graphics for the hybrid stores separation simulation of the B77 system [SAND-78-8212] N78-31099
- MARQUINA SANCHEZ, L.  
Noise in airports, its measurement, and its effect on the communities in the vicinity A78-48374
- MARTIN, D. L.  
Application techniques for digital flight control systems N78-30117
- MARUSZKIEWICZ, J.  
Dynamics of the longitudinal motion of an airplane with a variable-geometry wing A78-49285
- MASON, W. H.  
An automated procedure for computing the three-dimensional transonic flow over wing-body combinations, including viscous effects. Volume 1: Description of analysis methods and applications [AD-A055899] N78-31052
- MATHEWS, M. S., III  
Modified helicopter icing spray system evaluation [AD-A055039] N78-31091
- MATSUMOTO, G. T.  
A computerized undergraduate aircraft design course [AIAA PAPER 78-1492] A78-47933
- MATYSEK, T. E.  
The versatility of Jovial J73 in avionics systems A78-49956
- MAUCH, H. R.  
Turbine tip clearance measurement [AD-A055765] N78-31115
- MAYFIELD, J. P.  
Software engineering a must for success in computerized flight test [AIAA PAPER 78-1463] A78-47913
- MCCARTHY, J. P., JR.  
A study of analog programming for prediction of crack growth in aircraft structures subjected to random loads [AD-A055789] N78-31097
- MCCLUNG, D. A.  
A Costas loop with tangent error signal for use in Navstar GPS avionics A78-49858

- MCDANIEL, W. C.  
Antitorture training: Evaluation of effectiveness  
in reducing mishap losses  
[AD-A055040] N78-31092
- MCGEE, L. A.  
Navigation performance of the Triscan concept for  
shipboard VTOL aircraft operations  
[AIAA 78-1293] A78-50200
- MCGHEE, J. E.  
Improved aircraft dynamic response and fatigue  
life during ground operations using an active  
control landing gear system  
[AIAA PAPER 78-1499] A78-47939
- MCGHEE, R. M.  
Bank-to-turn /BIT/ autopilot technology  
A78-49927
- MCGINNESS, H.  
Analysis of a suspension system for a wheel  
rolling on a flat track  
[NASA-CR-157563] N78-30583
- MCINTURFF, J. A.  
Engine vibration in flight  
[AIAA PAPER 78-1475] A78-47921
- MCKILLIP, R. M., JR.  
A study of the precision hover capabilities of the  
aerocrane hybrid heavy lift vehicles  
[AD-A054281] N78-30091
- MCLMORE, H. C.  
Status of aerial applications research in the  
Langley Vortex Research Facility and the Langley  
full-scale wind tunnel  
[AIAA PAPER 78-1481] A78-47926
- Status of aerial applications research in the  
Langley vortex research facility and the Langley  
full-scale wind tunnel  
[NASA-TM-78760] N78-30041
- MCHARY, C. A.  
Advanced pattern matching for navigation and  
guidance  
A78-49998
- MEHDI, I. S.  
Dynamic analysis of electrical systems  
A78-49934
- MEIROVITCH, L.  
Structural dynamics, stability, and control of  
helicopters  
[NASA-CR-158909] N78-30139
- MEKEL, R.  
A learning flight control system for the F8-DFBW  
aircraft  
[AIAA 78-1288] A78-50195
- MENDENHALL, H. E.  
Calculation of the longitudinal aerodynamic  
characteristics of upper-surface-blown wing-flap  
configurations  
[NASA-CR-3004] N78-30050
- MEYER, D. D.  
The design process  
[AIAA PAPER 78-1483] A78-47928
- MICHARD, P.  
Calculation of exchange coefficients for  
high-temperature turbine blades  
[ONERA, TP NO. 1978-104] A78-47348
- MIKHAILOV, A. A.  
Influence of slots on effectiveness of wing  
mechanization and control surfaces with  
separated flow  
A78-48229
- MILLER, G. E.  
The influence of throttle augmented stability  
(APCS) and short period control characteristics  
on the landing approach  
[AD-A055892] N78-31123
- MILLER, G. K., JR.  
Evaluation of several secondary tasks in the  
determination of permissible time delays in  
simulator visual and motion cues  
[NASA-TP-1214] N78-30089
- Simulator study of the effect of visual-motion  
time delays on pilot tracking performance with  
an audio side task  
[NASA-TP-1216] N78-30090
- MILLER, L. E.  
Supercruiser fighter analysis  
N78-30107
- MINHETT, H. C.  
Interscan - A new microwave approach and landing  
guidance system  
A78-48736
- MINNICK, J. I.  
Operations and economics of U.S. air transportation  
[AIAA PAPER 78-1545] A78-49770
- MIYASHIRO, S. K.  
Navigation performance of the Triscan concept for  
shipboard VTOL aircraft operations  
[AIAA 78-1293] A78-50200
- HOFFATT, M. E.  
Preliminary design of an accident information  
retrieval system (AIPS)  
[AD-A055590] N78-31952
- MONACO, R.  
On the theory of drag calculation and profile  
optimization in shockless near free molecular flow  
A78-47887
- MONAKHOV, N. M.  
Uniformly exact conformal transformation of  
exterior of circle onto exterior of wing profile  
A78-48224
- MONTGOMERY, H. A.  
Approach for identifying avionics flight software  
operational support requirements - PAVE TACK an  
example  
A78-49900
- MONTGOMERY, R. C.  
A learning flight control system for the F8-DFBW  
aircraft  
[AIAA 78-1288] A78-50195
- MONTOLA, L. C.  
Section drag coefficients from pressure probe  
traverses of a wing wake at low speeds  
[AIAA PAPER 78-1479] A78-47924
- MOORE, J. W.  
Conceptual design study of power augmented ram  
wing in ground effect aircraft  
[AIAA PAPER 78-1466] A78-47915
- MOORE, R. A.  
Capture effect array glide slope guidance study  
[AD-A055678] N78-31073
- MORGAN, J. D.  
The feasibility of estimating avionics support  
costs early in the acquisition cycle. Volume 1:  
The basic report  
[AD-A054016] N78-30119
- MORRIS, R. E.  
Study of fuel systems for LH2-fueled subsonic  
transport aircraft, volume 1  
[NASA-CR-145369-VOL-1] N78-31085
- Study of fuel systems for LH2-fueled subsonic  
transport aircraft, volume 2  
[NASA-CR-145369-VOL-2] N78-31086
- MORRIS, S. J.  
Computer program for the design and off-design  
performance of turbojet and turbofan engine cycles  
[NASA-TM-78653] N78-30122
- MOSES, C. A.  
Effects of high availability fuels on combustor  
properties  
[AD-A054229] N78-30259
- MOUSSALLY, G. J.  
Capture effect array glide slope guidance study  
[AD-A055678] N78-31073
- MUDD, L. E.  
Airfield pavement evaluation - FAA viewpoint  
A78-49681
- MULCAY, W.  
Rotary balance data for a typical single-engine  
low-wing general aviation design for an  
angle-of-attack range of 30 deg to 90 deg  
[NASA-CR-2972] N78-30049
- MURDEN, W. P.  
Fighter superiority by design  
N78-30105
- MURRAY, J. J.  
Investigation of a wing-rotor interaction system  
for helicopters  
[AD-A054093] N78-30092
- MURROW, H. N.  
Drones for aerodynamic and structural testing  
/DAST/ - A status report  
[AIAA PAPER 78-1485] A78-47929
- MUSSELWHITE, R. A.  
The impact of contingency power concepts on V/STOL  
aircraft take-off-gross-weight  
[AIAA PAPER 78-926] A78-48451
- MYERS, T. D.  
Ground test facility for integral rocket ramjets  
[AIAA PAPER 78-934] A78-48454



## N

**NACHNIAS, S.**  
A learning flight control system for the F8-DPBW aircraft  
[AIAA 78-1288] A78-50195

**NAEGELI, D. W.**  
Effects of high availability fuels on combustor properties  
[AD-A054229] N78-30259

**NAGASHIMA, T.**  
Linearized supersonic unsteady flow in cascades  
[ARC-R/M-3811] N78-30065

**NAPOLITANO, L. G.**  
Hermite closed splines  
A78-49713

**NEIGHBOR, T. L.**  
RPV flying qualities design criteria  
[AIAA 78-1271] A78-50181

**NEITZEL, R. E.**  
Energy efficient engine: Preliminary design and integration studies  
[NASA-CR-135444] N78-31108

**NELMS, W. P.**  
Studies of aerodynamic technology for VSTOL fighter/attack aircraft  
[AIAA PAPER 78-1511] A78-47946

**NELSON, R. E.**  
Minimum weight design of stiffened panels with fracture constraints  
A78-49837

**NESEC, C.**  
Air-to-air designate/track with time sharing  
A78-49977

**NEUMANN, G.**  
The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints  
[DLR-FB-77-63] N78-31251

**NEWMAN, J. C., JR.**  
Recent developments in analysis of crack propagation and fracture of practical materials  
[NASA-TM-78766] N78-30606

**NIELSEN, J. P.**  
Proposed load evaluation system for U.S. Air Force  
A78-49677

**NINGAIAH**  
Load interaction effects in fatigue crack propagation  
N78-30285

**NISHT, M. I.**  
Influence of slots on effectiveness of wing mechanization and control surfaces with separated flow  
A78-48229

**NIX, P. W.**  
TRACALS evaluation report. TACAN, VOR, and ILS station evaluation report, Andersen AFB, Guam  
[AD-A054244] N78-30078

**NOLL, T. E.**  
Wing/store active flutter suppression - Correlation of analyses and wind tunnel data  
[AIAA PAPER 78-1459] A78-47909  
Close encounters of the aeroservoelastic kind  
[AIAA 78-1289] A78-50196  
Demonstration of aircraft wing/store flutter suppression systems  
N78-31128

**NORDLUND, R. E.**  
Advanced optical blade tip clearance measurement system  
[NASA-CR-159402] N78-31106

**NUBERT, J.**  
Status of a nozzle-airframe study of a highly maneuverable fighter  
[AIAA PAPER 78-990] A78-48470

**OKIISHI, T. H.**  
Analysis of multistage, axial flow turbomachine wake production, transport, and interaction  
[AD-A055754] N78-31118

## O

**OLIVER, R. C.**  
On the use of zirconium 95 data from Chinese atmospheric thermonuclear explosions to study stratospheric transport in a one-dimensional parameterization  
A78-48062

**OLLERHEAD, J. B.**  
A further survey of some effects of aircraft noise in residential communities near London (Heathrow) airport  
[TT-7705] N78-30910  
A comparison of annoyance caused by aircraft noise near London, Manchester and Liverpool airports  
[TT-7706] N78-30911

**ORMSBY, C. C.**  
High-accuracy three-dimensional image reconstruction for an airborne line-scanning system  
A78-49988

**ORRINGER, O.**  
A study of analog programming for prediction of crack growth in aircraft structures subjected to random loads  
[AD-A055789] N78-31097

**OSTAPKOWICZ, H.**  
Operation of oil seals of aircraft piston engines under conditions of cavitation. I  
A78-47175

**P**

**PAGE, W. A.**  
Hazard assessment of aircraft gun compartments  
[AD-A055026] N78-31064

**PAINTER, J. H.**  
A Costas loop with tangent error signal for use in Navstar GPS avionics  
A78-49858

**PANTASON, P.**  
Static aerodynamic characteristics of a typical single-engine low-wing general aviation design for an angle-of-attack range of -8 deg to 90 deg  
[NASA-CR-2971] N78-30048

**PARK, P. H.**  
The effect on block fuel consumption of a strutted versus cantilever wing for a short-haul transport including strut aeroelastic considerations  
[AIAA PAPER 78-1454] A78-47905

**PARKER, J. A.**  
Assessment of relative flammability and thermochemical properties of some thermoplastic materials  
A78-49693

**PATCHING, C. A.**  
Structural fatigue testing  
N78-30279

**PATEL, M. H.**  
On the linear superposition of aerodynamic forces on wings in periodic gusts  
A78-47869

**PATTON, J. H., JR.**  
Correlation of model and airplane spin characteristics for a low-wing general aviation research airplane  
[AIAA PAPER 78-1477] A78-47922

**PAYNE, A. O.**  
Current developments in the life of aircraft structure  
N78-30280

**PAYNTER, G. C.**  
An experimental and numerical study of three-dimensional turbulent jets  
[AIAA PAPER 78-994] A78-48471

**PECK, K. I.**  
Engine vibration in flight  
[AIAA PAPER 78-1475] A78-47921

**PELED, U.**  
The effect of prefilter design on sample rate selection in digital flight control systems  
[AIAA 78-1308] A78-50209

**PENDERGRAFT, O. C., JR.**  
Status of a nozzle-airframe study of a highly maneuverable fighter  
[AIAA PAPER 78-990] A78-48470

- PENLAND, J. A.  
Aerodynamic characteristics of a hypersonic research airplane concept having a 70 deg swept double-delta wing at Mach number 0.2 [NASA-TP-1252] N78-31045
- PERDUE, E. H.  
Dual band airborne SATCOM terminal A78-49972
- PERDZOCK, J. H.  
Multi-Function Inertial Reference Assembly /MIRA/ update A78-49941
- PERKINS, J. E.  
Application of the General Purpose Multiplex System to the A-7E avionics A78-49867  
A standard programmable I/O for the advanced aircraft electrical system power control set A78-49936
- PERKINS, P. J.  
Simultaneous measurements of ozone outside and inside cabins of two B-747 airliners and a Gates Learjet business jet [NASA-TM-78983] N78-31061
- PERRY, B., III  
Control-surface hinge-moment calculations for a high-aspect-ratio supercritical wing [NASA-TM-78664] N78-31043
- PETERSON, J. B., JR.  
Flight experience on the need and use of inflight leading edge washing for a laminar flow airfoil [AIAA PAPER 78-1512] A78-47947
- PETIT, J. E.  
Non-axisymmetric nozzle design and evaluation for P-111 flight demonstration [AIAA PAPER 78-1025] A78-48483
- PHILLIPS, W. H.  
Simulation study of the oscillatory longitudinal motion of an airplane at the stall [NASA-TP-1242] N78-30141
- PI, W. S.  
Some observations on the mechanism of aircraft wing rock [AIAA PAPER 78-1456] A78-47907
- PINES, S.  
Guidance and navigation for automatic landing, rollout, and turnoff using MLS and magnetic cable sensors [AIAA 78-1296] A78-50203
- PITTMAN, R.  
A modular adaptive, variable function flight control sensor [AD-A055175] N78-31120
- POE, C. C., JR.  
Recent developments in analysis of crack propagation and fracture of practical materials [NASA-TM-78766] N78-30606
- POPPOFF, I. G.  
An assessment of the effect of supersonic aircraft operations on the stratospheric ozone content [NASA-RP-1026] N78-30774
- PORTER, B.  
Synthesis of digital flight control systems by the method of entire eigenstructure assignment A78-49864
- POWELL, J. D.  
The effect of prefilter design on sample rate selection in digital flight control systems [AIAA 78-1308] A78-50209
- PRABHAKAR, A.  
Stability of a helicopter carrying an underslung load A78-49398
- PRICE, E. A., JR.  
Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions [AIAA PAPER 78-989] A78-48469
- PRICE, J. E.  
Design of a large span-distributed load flying-wing cargo airplane with laminar flow control [NASA-CR-145376] N78-30045
- PRZYJEMSKI, J. H.  
A compensation technique for acceleration-induced frequency changes in crystal oscillators A78-49859
- PUTMAN, W. F.  
A study of the precision hover capabilities of the aerocrane hybrid heavy lift vehicles [AD-A054281] N78-30091
- Q**
- QUARTERO, C. B.  
Design of a large span-distributed load flying-wing cargo airplane with laminar flow control [NASA-CR-145376] N78-30045
- QUEIJO, M. J.  
Approximate indicial lift function for tapered, swept wings in incompressible flow [NASA-TP-1241] N78-30054
- QUIGLEY, H. C.  
V/STOL aircraft simulation - Requirements and capabilities at Ames Research Center [AIAA PAPER 78-1515] A78-49790
- QUINN, G. F.  
Effect of performance objectives on the design and cost of future USAF pilot training aircraft [AIAA PAPER 78-1498] A78-47938
- R**
- RADGOWSKI, E.  
Investigation of electrostatic discharge in aircraft fuel tanks during refueling [AIAA PAPER 78-1501] A78-47941
- RAJU, P. N.  
Large deflection static analysis of typical tail-wheel structure of light aircraft by finite element method A78-48864
- RAMEY, M. L.  
Fighter superiority by design N78-30105
- RAMSDEN, J. H.  
Mirage 2000 - Dassault's better delta A78-49169
- READEY, H. J., JR.  
Center-loaded duct integral rocket-to-ramjet transition testing [AIAA PAPER 78-937] A78-48456
- REASER, J. S.  
REXOR 2 rotorcraft simulation model. Volume 1: Engineering documentation [NASA-CR-145331] N78-30042  
REXOR 2 rotorcraft simulation model. Volume 2: Computer implementation [NASA-CR-145332] N78-30043  
REXOR 2 rotorcraft simulation model. Volume 3: User's manual [NASA-CR-145333] N78-30044
- REDLIEN, H. W.  
Landing aircraft under poor conditions A78-49549
- REED, G. J.  
Ramjet engine testing and simulation techniques [AIAA PAPER 78-935] A78-48455
- REED, W. C.  
Use of the U.S. interim standard microwave landing system in Canada A78-49333
- REEVE, W. H.  
Software design for a Visually-Coupled Airborne Systems Simulator (VCASS) [AD-A055226] N78-31133
- REIBAUD, J.  
Flight application of optical fiber transmission on a Falcon 10 aircraft [ONERA, TP NO. 1978-105] A78-47349
- REININGER, R. C.  
A Costas loop with tangent error signal for use in Navstar GPS avionics A78-49858
- REIQMAN, E. T.  
Impact of aircraft electrical power quality on utilization equipment A78-49962
- RETCHFORD, J. A.  
A model of crack-tip behaviour for fatigue life determination N78-30286

REVILL, G. W.  
Load interaction effects in fatigue crack propagation  
N78-30285

REVUK, A. G.  
Probabilistic model of an instrument landing system  
A78-47407

REYNOLDS, P. T.  
Gates Learjet Model 28/29, the first 'Longhorn' Learjet  
[AIAA PAPER 78-1445] A78-47901

RHODES, G. P.  
Damping, static, dynamic, and impact characteristics of laminated beams typical of windshield construction  
[AD-A054463] N78-30093

RIABOI, A. IA.  
Extending the service life of aircraft components made of high-strength steels  
A78-48518

RICHARDS, L. G.  
Ride quality evaluation. IV - Models of subjective reaction to aircraft motion  
A78-47490

RICHARDSON, D.  
Mirage 2000 - Dassault's better delta  
A78-49169

RICHARDSON, D. A.  
Engine/airframe/drive train dynamic interface documentation  
[AD-A055766] N78-31114

RICHEY, G. K.  
Wind Tunnel/Flight Test Correlation Program on the B-1 nacelle afterbody/nozzle at transonic conditions  
[AIAA PAPER 78-989] A78-48469

RIBSTER, E.  
Plane stabilization in a ramjet combustion chamber by means of a pilot gas generator  
[DLR-FB-77-54] N78-31117

RIGGINS, R.  
A design of trajectory estimator using multiple DME range measurements  
[AD-A055191] N78-31077

RILEY, D. R.  
Evaluation of several secondary tasks in the determination of permissible time delays in simulator visual and motion cues  
[NASA-TP-1214] N78-30089  
Simulator study of the effect of visual-motion time delays on pilot tracking performance with an audio side task  
[NASA-TP-1216] N78-30090

RINGEL, M. B.  
A high duty factor chirp radar  
A78-49976

RIO, R. A.  
Turbine engine rotordynamic evaluation, volume 1  
[AD-A055262] N78-31111

RIPLE, J. C.  
Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 1  
[NASA-CR-145369-VOL-1] N78-31085  
Study of fuel systems for LH2-fueled subsonic transport aircraft, volume 2  
[NASA-CR-145369-VOL-2] N78-31086

ROBINSON, S. R.  
Infrared receiver performance  
A78-49985

ROBINSON, W. W.  
Advanced optical blade tip clearance measurement system  
[NASA-CR-159402] N78-31106

ROE, H. H.  
The HiMAT RPRV system  
[AIAA PAPER 78-1457] A78-47908

ROESSLER, N. J.  
In-flight alignment/calibration techniques for unaided tactical guidance  
A78-49929

ROGERS, C. B.  
A model of crack-tip behaviour for fatigue life determination  
N78-30286

ROGOZIN, IU. A.  
Modeling ground plane influence on wing aerodynamic characteristics using a finite plane screen  
A78-48216

ROLLINS, J. D.  
Description and performance of the Langley visual landing display system  
[NASA-TN-78742] N78-30073

ROSKAM, J.  
Some sound transmission loss characteristics of typical general aviation structural materials  
[AIAA PAPER 78-1480] A78-47925  
A research program to reduce interior noise in general aviation airplanes: Noise reduction through a cavity-backed flexible plate  
[NASA-CR-157588] N78-31873

ROWE, W. T.  
Advanced supersonic transport engine integration studies for near-term technology readiness date  
[AIAA PAPER 78-1052] A78-48487

ROZHDESTVENSKIY, K. V.  
Asymptotic theory of a wing moving near a solid wall  
A78-48248

RUBEL, H. J.  
Engine vibration in flight  
[AIAA PAPER 78-1475] A78-47921

RUBEY, R. J.  
Higher order languages for avionics software - A survey, summary and critique  
A78-49959

RUEDGER, W. H.  
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[AD-A055591] N78-31102

RUGGERI, R. S.  
Performance with and without inlet radial distortion of a transonic fan stage designed for reduced loading in the tip region  
[NASA-TP-1294] N78-30057

RUSSO, A.  
Use of a field bench for testing turbojet engines  
A78-49731

RYCHKOV, A. D.  
Investigation of nonequilibrium two-phase flows in axisymmetric Laval nozzles  
A78-48244

**S**

SAIN, M. K.  
Alternatives for jet engine control  
[NASA-CR-157578] N78-31107

SALAUB, P.  
Linearized theory of plane, unsteady, supersonic flow through a cascade - Subsonic part of the leading edge  
[ONERA, TP NO. 1978-103] A78-47347

SALLER, G. E.  
Short-term performance deterioration in JT9D-7A (SP) engine 695743  
[NASA-CR-135431] N78-30121

SAHUSSON, L.  
Test and demonstration prototype tracked air cushion vehicle (PTACV): Phase IIIC  
[PB-279970/8] N78-31007

SAN GIOVANNI, C., JR.  
Performance of a differential Omega-ring laser strapdown aircraft navigator  
A78-49966

Performance of a ring laser strapdown attitude and heading reference for aircraft  
[AIAA 78-1240] A78-50162

SANFORD, G. G.  
Conformal microstrip phased array for aircraft tests with ATS-6  
A78-49428

SAVOL, A. H.  
Pattern recognition as an aid to radar navigation  
A78-49855

SCHAEFFER, R. G.  
Helicopter transmission vibration and noise reduction program. Volume 1: Technical report  
[AD-A055104] N78-31089

SCHLOTHAUER, J.  
The influence of the environment on the elastoplastic properties of adhesives in metal bonded joints  
[DLR-FB-77-63] N78-31251

SCHMIDT, A. W.  
Impact of aircraft electrical power quality on utilization equipment  
A78-49962

- SCHMIDT, B.  
Scan-limited near field testing for directive  
airborne antennas  
A78-49897
- SCHMIDT, D. K.  
Optimal flight control synthesis via pilot modeling  
[AIAA 78-1286] A78-50193
- SCHMIDT, J. F.  
Performance with and without inlet radial  
distortion of a transonic fan stage designed for  
reduced loading in the tip region  
[NASA-TP-1294] N78-30057
- SCHMIDT, S. F.  
Navigation performance of the Triscan concept for  
shipboard VTOL aircraft operations  
[AIAA 78-1293] A78-50200
- SCHNELL, W. C.  
Vectoring non-axisymmetric nozzle jet induced  
effects on a V/STOL fighter model  
[AIAA PAPER 78-1080] A78-48496
- SCHOENBORN, W. E.  
Design for durability - The F101-GE-100 engine  
[AIAA PAPER 78-1084] A78-48497
- SCHRADER, P.  
The influences of residual stresses on oscillating  
tensile strength and the measurement of residual  
stress, with emphasis on aircraft construction  
[BMVG-PBWT-77-23] N78-30603
- SCHURTZ, W.  
The influences of residual stresses on oscillating  
tensile strength and the measurement of residual  
stress, with emphasis on aircraft construction  
[BMVG-PBWT-77-23] N78-30603
- SCHULTZ, T. J.  
Synthesis of social surveys on noise annoyance  
A78-48051
- SCHULZE, E.  
Shipboard launch and recovery of RPV helicopters  
in high sea states  
[AIAA 78-1269] A78-50179
- SCHUM, E. F.  
An analytical and experimental investigation of  
diffusers for VSTOL thrust augmenting ejectors  
[AIAA PAPER 78-1509] A78-47945
- SCHUSTER, E. P.  
Important simulation parameters for the  
experimental testing of propulsion induced lift  
effects  
[AIAA PAPER 78-1078] A78-48494
- SCIARRA, J. J.  
Helicopter transmission vibration and noise  
reduction program. Volume 2: User's manual  
[AD-A054827] N78-30095  
Helicopter transmission vibration and noise  
reduction program. Volume 1: Technical report  
[AD-A055104] N78-31089
- SCLAFANI, A. S.  
Design evolution of a supersonic cruise  
strike-fighter  
[AIAA PAPER 78-1452] A78-49783
- SCOTT, I. G.  
NDI and the detection of fatigue  
N78-30282
- SCROFANI, O.  
Choice of cycle for a regenerative bypass turbojet  
for long-range aircraft  
A78-49723
- SCULL, D. C.  
The Omega radionavigation system comes to the  
Pacific Ocean area  
A78-49660
- SECKEL, E.  
The influence of throttle augmented stability  
(APCS) and short period control characteristics  
on the landing approach  
[AD-A055892] N78-31123
- SEIFERT, R.  
Display systems and cockpit design  
N78-30116
- SEILER, H. R.  
An analytical and experimental investigation of  
diffusers for VSTOL thrust augmenting ejectors  
[AIAA PAPER 78-1509] A78-47945
- SELDNER, K.  
Procedures for generation and reduction of linear  
models of a turbofan engine  
[NASA-TP-1261] N78-30896
- SENBONGI, S.  
The influence of throttle augmented stability  
(APCS) and short period control characteristics  
on the landing approach  
[AD-A055892] N78-31123
- SENWE, K. D.  
IPC design validation and flight testing  
[AD-A055529] N78-31074
- SENSBURG, O.  
Impact of active control on structures design  
N78-30113
- SERREYN, D.  
Autothreshold autoscreener/FLIR system  
A78-49984
- SEVY, R. W.  
Computer program for vibration prediction of  
fighter aircraft equipments  
[AD-A054598] N78-30094
- SHAGENA, J. L.  
Landing aircraft under poor conditions  
A78-49549
- SHANBHAG, M. R.  
Large deflection static analysis of typical  
tail-wheel structure of light aircraft by finite  
element method  
A78-48864
- SHARP, J. B.  
Subsystem verification of an AFPLC organically  
developed F-15 simulation  
A78-49901
- SHCHERBAKOV, A. V.  
Experimental determination of parameters of  
mathematical model of airplane cabin as  
regulated object with respect to air temperature  
in the cabin  
A78-48234
- SHERMAN, C. A.  
Experimental determination of the rattle of simple  
models  
[NASA-TN-78756] N78-30291
- SHERMAN, D. J.  
Gust measurements and the N sub o problem  
N78-30276
- SHERMAN, W. L.  
Airplane stability calculations with a card  
programmable pocket calculator  
[NASA-TN-78678] N78-30138
- SHERRIEB, H. E.  
Ground effects testing of two, three, and four jet  
configurations  
[AIAA PAPER 78-1510] A78-49789
- SHEVELL, E. S.  
The value of aerospace design synthesis courses as  
viewed by aerospace professionals  
[AIAA PAPER 78-1493] A78-47934
- SHIRLEY, T. E.  
The role of system performance analysis in the  
independent assessment of B-1 navigation software  
A78-49902
- SHOENAKER, W.  
Comparison monitoring in redundant digital flight  
control systems  
A78-49865
- SIEWERT, R. F.  
Analysis of advanced variable camber concepts  
N78-30108
- SIGALLA, A.  
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[AIAA PAPER 78-1051] A78-48486
- SIMMONS, E. L.  
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tactical fighter using discrete optimal control  
A78-49862  
The terrain following task for the advanced  
tactical fighter using discrete optimal control  
[AD-A055196] N78-31121
- SIRAZETDINOV, T. K.  
Optimal control synthesis in distributed systems  
with incomplete information  
A78-48215
- SKIBA, G. G.  
Method of calculating aerodynamic coefficients of  
some three-dimensional bodies with arbitrary  
cross section  
A78-48245
- SKUDRNA, J. T.  
The AN/APX-100/V/ transponder  
A78-49971

- SLIVINSKY, C.  
Comparison monitoring in redundant digital flight control systems  
A78-49865  
Inherent errors in asynchronous digital flight controls  
[AD-A055649] N78-31124
- SMITH, A. K.  
Test and demonstration prototype tracked air cushion vehicle (PTACV): Phase IIIC  
[PB-279970/8] N78-31007
- SMITH, H. W.  
Teaching design at all levels  
[AIAA PAPER 78-1455] A78-47906
- SMITH, R. E.  
Software engineering a must for success in computerized flight test  
[AIAA PAPER 78-1463] A78-47913
- SOLODUKHIN, V. A.  
Optimization techniques for air traffic control problems  
A78-48504
- SOPER, W. P. C.  
Design philosophy for airframes  
A78-47453
- SOUTHALL, J. W.  
The design process  
[AIAA PAPER 78-1483] A78-47928
- SPANGLER, S. B.  
Calculation of the longitudinal aerodynamic characteristics of upper-surface-blown wing-flap configurations  
[NASA-CR-3004] N78-30050
- SPARKS, J. C.  
A calculator program for analyzing airloads on a wing of arbitrary planform and camber in subsonic flow  
[AD-A054180] N78-30058
- SPEITEL, L. C.  
A preliminary comparison of thermal decomposition products of aircraft interior materials using the National Bureau of Standards smoke chamber and the combustion tube furnace  
[AD-A054811] N78-30088
- SPIRO, P.  
Large electroformed nickel moulds for aircraft parts  
A78-47267
- SPONG, E. D.  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 1: Technical discussion  
[NASA-CR-144866] N78-30123  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 2: Time variant data quality analysis plots  
[NASA-CR-144867] N78-30124  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 3: Power spectral density plots  
[NASA-CR-144868] N78-30125  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 4: Autocorrelation functions  
[NASA-CR-144869] N78-30126  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 5: Effect of filter cutoff frequency on turbulence plots  
[NASA-CR-144870] N78-30127  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 6: Distortion analysis plots  
[NASA-CR-144871] N78-30128  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 7: Cross correlation functions.  
[NASA-CR-144872] N78-30129  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 8: Cross spectral density plots  
[NASA-CR-144873] N78-30130  
F-15 inlet engine test techniques and distortion methodologies studies. Volume 9: Stability audits  
[NASA-CR-144874] N78-30131
- SPURGEON, J. C.  
A preliminary comparison of thermal decomposition products of aircraft interior materials using the National Bureau of Standards smoke chamber and the combustion tube furnace  
[AD-A054811] N78-30088
- STABENAU, W. F.  
The role of system performance analysis in the independent assessment of B-1 navigation software  
A78-49902
- STASZEK, J.  
Trailing vortices. II  
A78-47172
- STEELE, R.  
The U.S. Navy bets on V/STOL  
A78-49550
- STEIGER, A. R.  
Effects of wind on aircraft cruise performance  
[AIAA PAPER 78-1496] A78-47937
- STENGEL, R. F.  
Flight investigation and theory of direct side-force control  
[AIAA 78-1287] A78-50194
- STERN, H.  
An automated procedure for computing the three-dimensional transonic flow over wing-body combinations, including viscous effects. Volume 1: Description of analysis methods and applications  
[AD-A055899] N78-31052
- STEVENS, C. H.  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 1: Technical discussion  
[NASA-CR-144866] N78-30123  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 2: Time variant data quality analysis plots  
[NASA-CR-144867] N78-30124  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 3: Power spectral density plots  
[NASA-CR-144868] N78-30125  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 4: Autocorrelation functions  
[NASA-CR-144869] N78-30126  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 5: Effect of filter cutoff frequency on turbulence plots  
[NASA-CR-144870] N78-30127  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 6: Distortion analysis plots  
[NASA-CR-144871] N78-30128  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 7: Cross correlation functions.  
[NASA-CR-144872] N78-30129  
F-15 inlet/engine test techniques and distortion methodologies studies. Volume 8: Cross spectral density plots  
[NASA-CR-144873] N78-30130  
F-15 inlet engine test techniques and distortion methodologies studies. Volume 9: Stability audits  
[NASA-CR-144874] N78-30131
- STINSON, J. L.  
Software design for a Visually-Coupled Airborne Systems Simulator (VCASS)  
[AD-A055226] N78-31133
- STITZER, S. H.  
A frequency-selective YIG limiter for airborne PH/CW I-band radar  
A78-50002
- STOUGH, H. P.  
Correlation of model and airplane spin characteristics for a low-wing general aviation research airplane  
[AIAA PAPER 78-1477] A78-47922
- STRAWB, D. F.  
Electromagnetic coupling analysis of a Learjet aircraft in a lightning environment  
A78-49920
- STROMBERG, G. F.  
Ground test facility for integral rocket ramjets  
[AIAA PAPER 78-934] A78-48454

STUART, T. A.

PERSONAL AUTHOR INDEX

STUART, T. A.  
Modeling refinements for the rectified -  
superconducting alternator A78-49961

SUN, K. C.  
A laser-powered flight transportation system  
[AIAA PAPER 78-1484] A78-49781

SUSSMAN, M. B.  
Non-axisymmetric nozzle design and evaluation for  
F-111 flight demonstration  
[AIAA PAPER 78-1025] A78-48483

SUTORMIN, V. A.  
Operator work capacity during parachutist free-fall  
A78-47978

SWIHART, J. M.  
Operations and economics of U.S. air transportation  
[AIAA PAPER 78-1545] A78-49770

**T**

TAILLET, J.  
Flight application of optical fiber transmission  
on a Falcon 10 aircraft  
[ONERA, TP NO. 1978-105] A78-47349

TAILLON, M. V.  
Status of a nozzle-airframe study of a highly  
maneuverable fighter  
[AIAA PAPER 78-990] A78-48470

TAKALLU, M. A.  
Investigation of a wing-rotor interaction system  
for helicopters  
[AD-A054093] N78-30092

TATE, R. O.  
Computerized aircraft attrition program  
[AD-A055784] N78-31094

TEHNIKOV, A. V.  
Solution of an adjoint problem of steady-state  
heat transfer associated with the cooling of  
gas-turbine blades, by means of a  
quasi-analog/digital system A78-47402

Application of electrical analogy to the  
substantiation and comparison of some analytical  
methods of determining temperature fields in  
gas-turbine blades A78-47404

THIEMAN, B. A.  
Analysis of monopole antenna arrays on cylinders  
by the geometrical theory of diffraction  
[AD-A055197] N78-31335

THOMASON, T. H.  
The promise of tilt rotor A78-47266

THOMPSON, E. H.  
Peace Rhine - A digital Weapon Control System for  
the F-4 aircraft A78-49876

THOMPSON, M. C., JR.  
Pading at 9.6 GHz on an experimentally simulated  
aircraft-to-ground path A78-49439

TICHTINSKY, H.  
Methods available to ONERA for analysis of  
combustion chambers  
[ONERA, TP NO. 1978-93] A78-46915

TOLAND, R. H.  
Rotor design implications for composite material  
properties  
[UCRL-80117] N78-30182

TOM, M.  
Air-to-air designate/track with time sharing  
A78-49977

TORELLA, G.  
Use of a field bench for testing turbojet engines  
A78-49731

TRAGESER, J. H.  
Non-volatile memory system for severe environment  
flight recorders A78-49872

TRIPP, M. W.  
Modeling refinements for the rectified  
superconducting alternator A78-49961

TSAO, G. K. H.  
Dual band airborne SATCOM terminal A78-49972

TULLOCH, J. S.  
Modified helicopter icing spray system evaluation  
[AD-A055039] N78-31091

TURCO, R. P.  
An assessment of the effect of supersonic aircraft  
operations on the stratospheric ozone content  
[NASA-RP-1026] N78-30774

TURK, R. L.  
Approach for identifying avionics flight software  
operational support requirements - PAVE TACK an  
example A78-49900

TURNAGE, W. T.  
A standard programmable I/O for the advanced  
aircraft electrical system power control set  
A78-49936

TURRIZIANI, R. V.  
Design of a large span-distributed load  
flying-wing cargo airplane with laminar flow  
control  
[NASA-CR-145376] N78-30045

**U**

UHLHORN, R. W.  
Fiber optic development for tactical fighter  
applications A78-49906

URIE, D. M.  
Piloted flight simulation for active control  
design development  
[AIAA PAPER 78-1553] A78-49771

**V**

VACHAL, J. D.  
Wing planforms for large military transports  
[AIAA PAPER 78-1470] A78-49786

VAHLBERG, C. J.  
High-accuracy three-dimensional image  
reconstruction for an airborne line-scanning  
system A78-49988

VAN DAM, C.  
Some sound transmission loss characteristics of  
typical general aviation structural materials  
[AIAA PAPER 78-1480] A78-47925

VAN DEN BROEK, M.  
Digital avionics support - A retrospective view of  
the future A78-49903

VANAKEN, J.  
A research program to reduce interior noise in  
general aviation airplanes: Investigation of  
the characteristics of an acoustic panel test  
facility  
[NASA-CR-157587] N78-31874

VANDAM, C. P. G.  
A research program to reduce interior noise in  
general aviation airplanes: Noise reduction  
through a cavity-backed flexible plate  
[NASA-CR-157588] N78-31873

VANDEVER, W. H., JR.  
The DAIS Executive - An introduction  
A78-49932

VANDYKE, P.  
Measurements and analysis of the forces acting on  
a small aircraft flying in the upwash of a large  
aircraft  
[AD-A055286] N78-31048

VEHLOW, C. A.  
Experimental investigation of gust response of  
hingeless helicopter rotors  
[AD-A054752] N78-30142

VELUPILLAI, D.  
Marage 2000 - Dassault's better delta  
A78-49169

VERSAW, E. F.  
Study of fuel systems for LH2-fueled subsonic  
transport aircraft, volume 1  
[NASA-CR-145369-VOL-1] N78-31085

Study of fuel systems for LH2-fueled subsonic  
transport aircraft, volume 2  
[NASA-CR-145369-VOL-2] N78-31086

VINKLER, A.  
Guaranteed cost control of linear systems with  
uncertain parameters - Application to remotely  
piloted vehicle flight control systems  
[AIAA 78-1274] A78-50184

VINSON, P. W.  
Energy efficient engine: Preliminary design and integration studies  
[NASA-CR-135444] N78-31108

VOGT, G. L.  
The AN/APX-100/V/ transponder A78-49971

VOORHEES, C. G.  
Gates Learjet Model 28/29, the first 'Longhorn' Learjet  
[AIAA PAPER 78-1445] A78-47901

VOROBEV, V. G.  
Aviation control system devices A78-49850

VOROVIN, V. G.  
Experimental determination of parameters of mathematical model of airplane cabin as regulated object with respect to air temperature in the cabin A78-48234

VYTSIKOV, I. S.  
Solution of an adjoint problem of steady-state heat transfer associated with the cooling of gas-turbine blades, by means of a quasi-analog/digital system A78-47402

**W**

WAGDI, H. H.  
Stability augmentation by eigenvalues control and model matching A78-46965

WAGNER, J. H.  
Analysis of multistage, axial flow turbomachine wake production, transport, and interaction  
[AD-A055754] N78-31118

WAKEFIELD, C.  
Assessment of dynamic coordinate alignment for elastic aircraft A78-49987

WALLACE, E. L.  
Use of onboard computerized flight test analysis systems  
[AIAA PAPER 78-1462] A78-47912

WARWICK, G.  
Mirage 2000 - Dassault's better delta A78-49169

WASHBURN, G. F.  
Design of a large span-distributed load flying-wing cargo airplane with laminar flow control  
[NASA-CR-145376] N78-30045

WASYLKIWSKI, W.  
On the use of zirconium 95 data from Chinese atmospheric thermonuclear explosions to study stratospheric transport in a one-dimensional parameterization A78-48062

WATERS, M. H.  
Requirements for regional short-haul air service and the definition of a flight program to determine neighborhood reactions to small transport aircraft  
[NASA-CR-152151] N78-30070

WATTS, J. D.  
Interface design considerations for F-16 sensors and weapons A78-49874

WEAVER, R. E.  
Digital simulation and flight verification of the F-5E/F Flight Director Computer A78-49905

WEBER, W. B.  
Experimental determination of propulsion induced ground effects of typical three fan type A V/STOL configurations  
[AIAA PAPER 78-1507] A78-47943

WEEKS, R. A.  
Digital simulation and flight verification of the F-5E/F Flight Director Computer A78-49905

WEILER, W.  
Variable-cycle engine fighter aircraft: Advance in performance and development problems N78-30109

WEINGARTEN, J. L.  
Aeronautical procurement - The primary specification system  
[AIAA PAPER 78-1489] A78-47932

Cargo aircraft and spacecraft forward restraint criteria  
[AD-A055343] N78-31095

WEINREICH, H.  
A study of analog programming for prediction of crack growth in aircraft structures subjected to random loads  
[AD-A055789] N78-31097

WEIST, G.  
Variable-cycle engine fighter aircraft: Advance in performance and development problems N78-30109

WEISZ, C. P.  
Airfield pavement evaluation - The airline view A78-49680

WELLS, W. R.  
Approximate indicial lift function for tapered, swept wings in incompressible flow  
[NASA-TP-1241] N78-30054

WESTERMEIER, T. F.  
In-line monitoring of digital flight control computers A78-49860

Triplex digital fly-by-wire redundancy management techniques  
[AIAA 78-1279] A78-50187

WHALEY, P. W.  
Prediction of angular disturbances from airframe members to airborne electro-optical packages A78-49952

WHISWANT, B. A.  
AFAP simulation facility/capability manual. Volume 1: Executive summary and Systems Avionics Division  
[AD-A055591] N78-31102

WHITBECK, R. F.  
Digital control law synthesis in the w prime domain A78-46962

WHITE, W. F.  
Flight demonstrations of curved, descending approaches and automatic landings using time referenced scanning beam guidance  
[NASA-TM-78745] N78-30074

WHITE, W. F., JR.  
The influence of high twist on the dynamics of rotating blades A78-47599

WHITEHEAD, D. S.  
Linearized supersonic unsteady flow in cascades  
[ARC-R/M-3811] N78-30065

WHITEHEAD, R. E.  
Analysis of advanced variable camber concepts N78-30108

WHITTEN, R. C.  
An assessment of the effect of supersonic aircraft operations on the stratospheric ozone content  
[NASA-EP-1026] N78-30774

WICKS, B. J.  
A model of crack-tip behaviour for fatigue life determination N78-30286

WILCOX, D. E.  
V/STOL aircraft simulation - Requirements and capabilities at Ames Research Center  
[AIAA PAPER 78-1515] A78-49790

WILCOX, R. E.  
Combinatorially derived limits on the surface return for an air/surface monopulse ranging radar A78-50001

WILER, C. D.  
The HINAT RPRV system  
[AIAA PAPER 78-1457] A78-47908

RPV flying qualities design criteria  
[AIAA 78-1271] A78-50181

WILES, D.  
Multiprocessing for electronic warfare avionics A78-49869

WILLARD, C. H.  
Installed performance of vectoring/reversing non-axisymmetric nozzles  
[AIAA PAPER 78-1022] A78-48482

- WILLIAMS, R. W.  
Experimental determination of propulsion induced  
ground effects of typical three fan type A  
V/STOL configurations  
[AIAA PAPER 78-1507] A78-47943
- WILSON, J. R.  
Propulsion system airframe integration studies -  
advanced supersonic transport  
[AIAA PAPER 78-1053] A78-48488
- WINTHER, B. A.  
Demonstration of aircraft wing/store flutter  
suppression systems N78-31128
- WISE, C.  
Multiprocessing for electronic warfare avionics  
A78-49869
- WITSHEER, A. J.  
Pattern recognition as an aid to radar navigation  
A78-49855
- WOLFE, L. D.  
Advance nozzle technology N78-30111
- WOLKOVITCH, J.  
Nacelle effects on stability of VSTOL  
configurations including conventional, canard,  
and tandem wing arrangements  
[AIAA PAPER 78-1504] A78-47942
- WOOD, L. J.  
Guaranteed cost control of linear systems with  
uncertain parameters - Application to remotely  
piloted vehicle flight control systems  
[AIAA 78-1274] A78-50184
- WOODCOCK, D. L.  
Diverse forms and derivations of the equations of  
motion of deformable aircraft and their mutual  
relationship  
[RAE-TR-77077] N78-30097
- WOODCOCK, W. A.  
Pavement strength rating methods as viewed by  
airframe manufacturers A78-49682
- WOOLFSON, M. G.  
Digital area correlation tracker  
A78-49951
- WOOLLEY, M.  
The evolution of a remotely piloted vehicle  
microprocessor flight control system  
[AIAA 78-1273] A78-50183
- WOOTEN, E.  
RNAV - Corporate operators set the pace  
A78-47424
- WUNNENBERG, H.  
Advanced control concepts for future fighter  
aircraft N78-30104

## Y

- YEAGER, W. T., JR.  
Analysis of stability contributions of high  
dihedral V-tails  
[NASA-TM-78729] N78-31044
- YEN, W. Y.  
Effects of dynamic aeroelasticity on handling  
qualities and pilot rating N78-31084
- YENNI, K. R.  
Simulation and flight evaluation of a head-up  
landing aid for general aviation  
[NASA-TP-1276] N78-31101
- YU, C. L.  
Volumetric pattern analysis of airborne antennas  
A78-49427

## Z

- ZABINSKY, J. M.  
The influence of propulsion and control system  
concepts on design of a Navy Type A V/STOL  
airplane  
[AIAA PAPER 78-1505] A78-49788
- ZIMMERMANN, H.  
Impact of active control on structures design  
N78-30113



# CONTRACT NUMBER INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Suppl 103)

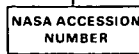
DECEMBER 1978

## Typical Contract Number Index Listing

NASW-2483



N78-11061



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.

\* F PROJ. 2202 N78-30093  
 \* F PROJ. 2307 N78-31048  
 \* F PROJ. 3066 N78-31111  
 \* F PROJ. 6146 N78-30094  
 \* F PROJ. 7381 N78-30213  
 \* F PROJ. 6095 N78-49859  
 \* F PROJ. 7629 N78-49987  
 \* F PROJ. 2460A-74 N78-49837  
 \* F PROJ. 2889A-76 N78-49713  
 \* F PROJ. 2968-76 N78-49865  
 \* F PROJ. 2997-76 N78-49961  
 \* F PROJ. 3005A-76 N78-49864  
 \* F PROJ. 3413-77 N78-49961  
 \* F PROJ. 2916-76 N78-31118  
 \* F PROJ. 2968-76 N78-31124  
 CNR-77,01087,91,115,9694 N78-49733  
 CNR-115,2648,07,CT-76,00480 N78-49708  
 DA PROJ. 1P2-62209-AH-76 N78-31952  
 DA PROJ. 1G2-62207-AH-89 N78-31089  
 DA PROJ. 1G2-62207-AH-8902 N78-30095  
 DA PROJ. 1L1-61102-AH-45 N78-31044  
 DA PROJ. 1L2-62209-AH-76 N78-31096  
 DAAG29-76-G-0045 N78-30092  
 DAAG29-76-G-0318 N78-30092  
 DAAG53-76-C-0003 N78-30259  
 DAAJ01-77-C-0354 N78-31113  
 DAAJ02-74-C-0040 N78-30095  
 DAAJ02-74-C-0040 N78-31089  
 DAAJ02-75-C-0046 N78-31115  
 DAAJ02-76-C-0052 N78-31096  
 DAAJ02-76-C-0058 N78-31952  
 DAAJ02-77-C-0018 N78-31119  
 DAAJ02-77-C-0040 N78-31114

DAAK70-78-C-0001 N78-30259  
 DAHC04-74-G-0007 N78-30092  
 DAHC04-75-G-0023 N78-30092  
 DAHC15-73-C-0200 N78-30119  
 DOT-PA72WAI-261 N78-31074  
 DOT-PA74WA-3353 N78-31073  
 DOT-PA75WA-3707 N78-31088  
 DOT-PA76WA-3157 N78-48062  
 DOT-PA76WA-3788 N78-30080  
 DOT-PA77WA-3965 N78-48062  
 DOT-PA78WA-4075 N78-31130  
 DOT-PA78WA-4075 N78-31131  
 DOT-PA78WA-4091 N78-31134  
 DOT-PR-54089 N78-31007  
 DOT-TSC-763 N78-49428  
 EY-76-C-04-789 N78-31099  
 EY-76-C-04-0613 N78-31249  
 F08635-77-C-0210 N78-49929  
 F09603-77-A-3104 N78-30079  
 F19628-70-C-0218 N78-49975  
 F19628-77-C-0033 N78-49965  
 F19628-78-C-0002 N78-31074  
 F30602-75-F-0256 N78-49439  
 F30602-76-C-0074 N78-49998  
 F30602-77-C-0049 N78-49998  
 F33615-73-C-4036 N78-49972  
 F33615-75-C-1149 N78-49859  
 F33615-75-C-2035 N78-31111  
 F33615-75-C-3073 N78-31052  
 F33615-75-C-3105 N78-30093  
 F33615-75-C-3154 N78-31120  
 F33615-75-C-5065 N78-30213  
 F33615-76-C-1036 N78-50002  
 F33615-76-C-1308 N78-31102

F33615-76-C-2051 N78-31064  
 F33615-76-C-3107 N78-48483  
 F33615-76-C-3109 N78-31097  
 F33615-76-R-0029 N78-49957  
 F33615-77-C-1121 N78-49987  
 F33615-77-C-1227 N78-49998  
 F33615-77-C-3026 N78-46962  
 F33615-77-C-3041 N78-50186  
 F33657-77-C-0004 N78-49902  
 F33657-77-C-0189 N78-49876  
 P44620-76-C-0073 N78-31048  
 P49620-77-C-0023 N78-31100  
 NASA ORDER C-41581-B N78-31105  
 NAS1-13500 N78-30045  
 NAS1-14086 N78-30050  
 NAS1-14311 N78-50203  
 NAS1-14570 N78-30042  
 NAS1-14614 N78-30043  
 NAS1-14614 N78-30044  
 NAS1-14614 N78-31085  
 NAS1-14614 N78-31086  
 NAS1-14756 N78-30051  
 NAS1-14849 N78-30048  
 NAS1-14849 N78-30049  
 NAS2-8734 N78-47907  
 NAS2-9050 N78-30070  
 NAS3-20479 N78-31106  
 NAS3-20627 N78-31108  
 NAS3-20632 N78-30121  
 NAS4-2364 N78-30123  
 N78-30124  
 N78-30125  
 N78-30126  
 N78-30127  
 N78-30128  
 N78-30129  
 N78-30130  
 N78-30131  
 NAS7-100 N78-30583  
 NGL-05-020-007 N78-50202  
 NGL-36-008-138 N78-49427  
 NGL-49-002-044 N78-49781  
 NGR-36-009-017 N78-31068  
 NGR-47-005-181 N78-47490  
 N78-49684  
 NIVR-1725 N78-30620  
 NSG-1114 N78-30139  
 NSG-1301 N78-47925  
 N78-31873  
 N78-31874  
 NSG-1374 N78-49858  
 NSG-3048 N78-31107  
 NSG-4002 N78-50209  
 NSG-7266 N78-30069  
 N00019-75-C-0528 N78-31123  
 N00019-77-C-0495 N78-31093  
 N00140-77-C-0105 N78-49852  
 N62269-76-C-0390 N78-30120  
 N62269-77-C-0074 N78-30091  
 N62269-77-C-0561 N78-50161

ORERA-18,884/SAT,2/LL N78-50194  
 PROJ. 034-241-012 N78-31074  
 SN/1170/012 N78-30910  
 N78-30911  
 W-7405-ENG-48 N78-30182  
 WF41411000 N78-30091  
 198-30-02 N78-30774  
 505-02-33-03 N78-30606  
 505-04 N78-30057  
 505-05 N78-30896  
 505-06-31-03 N78-30046  
 505-06-63-02 N78-30054  
 N78-30089  
 N78-30090  
 505-07-10 N78-30072  
 505-08-23-01 N78-30138  
 505-09-13-11 N78-30291  
 505-10-13-00 N78-30141  
 505-10-13-02 N78-31101  
 505-10-13-07 N78-30049  
 505-10-1307 N78-30048  
 505-11-16-07 N78-30056  
 505-11-23-06 N78-30039  
 505-11-33-01 N78-31045  
 506-26-33-03 N78-30053  
 514-54-04 N78-30123  
 N78-30124  
 N78-30125  
 N78-30126  
 N78-30127  
 N78-30128  
 N78-30129  
 N78-30130  
 N78-30131  
 516-50-23-01 N78-30040  
 N78-30045  
 516-53-03-21 N78-31043  
 716-01-02 N78-31108  
 743-04-13-01 N78-30122  
 743-04-13-02 N78-30087

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